Bankruptcy Prediction for Large and Small Firms in Asia: A Comparison of Ohlson and Altman

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Abstract  
This paper reports the results of a research study examining the comparative ability of Ohlson’s Logit model and Altman’s four-variance model for predicting bankruptcy of large and small firms in Thailand. A matched pair sample of 60 bankrupt and 60 nonbankrupt firms were examined over the years 1998 to 2003. The study concludes that while each of the two methods have predictive ability when applied to Thai firms, there is no significant difference in their respective predictive abilities for either large asset or small asset Thai firms.

Keywords: Bankruptcy, Ohlson’s Model, Altman’s Model
Introduction

Bankruptcy for a company is a final declaration of its inability to sustain current operations given its current debt obligations. Practically all firms must have some debt load to expand operations or just to survive. Good economic planning often requires a firm to finance some of its operations with debt. The degree to which a firm has debt in excess of assets or is unable to pay its debt as it comes due are the two most common factors in bankruptcy.

Because business failure is a major concern to the parties involved and can create high costs and heavy losses, its prediction is highly beneficial. If bankruptcy could be predicted with reasonable accuracy ahead of time, firms could better protect their businesses and could take action to minimize risk and loss of business and perhaps even prevent the bankruptcy itself.

While bankruptcy is a worldwide problem, Thailand has been especially hard hit by bankruptcy since the Asian crisis in 1997. As a result of the crisis, Thailand instituted a new bankruptcy act to boost the Thai economy. There were many purposes of the act but one of the most important was the protections it offered insolvent companies. According to Urapeepatanapong, Sethsathira and Okanurak (1998), the Act provides incentives to foreign creditors that allow them to inject funds to reorganize businesses without some of the fears that had held them back in the past.

Numerous studies have been conducted to analyze the impact of bankruptcy in Thailand (Reynolds, et al, 2002; Urapeepatanapong, Sethsathira and Okanurak (1998). Some of these have used business ratios to analyze bankruptcy potential. (See: Clark & Jung, 2002; Brietzke, 2001; Pugh & Dehesh, 2001; Haley, 2000; and Tirapat & Nittayagasetwat, (1999). Only two of these studies specifically addressed bankruptcy in Thailand (Reynolds, et al, 2002 & Tirapat & Nittayagasetwat, 1999) with the rest addressing the overall Asian crises with a general emphasis in South Korea (Clark & Jung, 2002; Haley, (2000), Indonesia (Brietzke, 2001), and Taiwan (Clark & Jung, 2002).

The studies indicated above have generally tended to indicate that financial strength is a critical factor in determining a firm’s longevity. Environmental factors such as global competition, changing customer preferences, new legal requirements and changing social norms exert tremendous pressure on a firm and can force it into bankruptcy. As these pressures continue to accelerate, financial analysts seek better ways to predict bankruptcy and avoid the corresponding losses that come with it. It would seem intuitive, therefore, that finding better ways to predict bankruptcy in Thailand would enhance its position on the world stage and make it a more attractive alternative for investment dollars. This is all the more important today given that so
much of the investment that would have come to Thailand in the past now appears to be going to China.

A review of the literature indicates that Fitzpatrick (1931) was, perhaps, the first researcher to use ratio analysis to compare firms that had failed and firms that had not failed. Fitzpatrick used a univariate analysis of 13 ratios to indicate failure. The Fitzpatrick model did not, however, show a significant relationship with failure.

Beaver (1966a and 1968a) also used univariate analysis in his prediction model and did find a significant relationship. His work is generally considered to be the first significant work in the area.

Altman (1968b) expanded on the work of Beaver by using multiple discriminant analysis to various bankrupt and non-bankrupt groups and to use a variety of different ratio groups to predict business failures. After almost forty years, Altman’s Z-Score is still widely regarded by researchers as an indicator of a company’s financial well being. In 1993, Altman revised his model to incorporate a “four variable Z-Score” prediction model (Altman, 1993). Altman felt this revised model significantly improved the predictive ability of his model and made it simpler to incorporate.

Ohlson (1980) is believed to be the first to develop a model using Multiple Logistic Regression (Logit) to construct a probabilistic bankruptcy model in predicting bankruptcy. Ohlson claimed that his study had one important advantage: the reports indicated at what point in time the financial statements were released to the public, and one could therefore check whether the company entered bankruptcy prior to, or after the date of release for the financials. Ohlson claimed that the previous studies did not explicitly consider the timing issue.

Advances in the field have continued to be made. As artificial intelligence has developed with new computer capabilities, artificial neural network models have been developed. While such models date back to the 1950s, it was not until the development of faster computers that such analysis could be practically used in the analysis of bankruptcy. The work of Luther (1998) significantly expanded the use of the artificial neural network to bankruptcy prediction.

The use of recursive partitioning algorithms has also been used in bankruptcy prediction. This model uses a binary classification tree wherein a univariate rule is associated to any node. The risk of the final nodes and the risk of the entire tree are calculated after the classification tree is constructed. New objects descend the tree and fall into a final node where they are identified as to group membership for that object. The associated probability is also determined.

The above studies inspired later researchers to attempt to find out if analysis of the financial statements could be used to proactively predict bankruptcy rather than to merely react to it when it occurred. According to Cybinski (2001), the major
difference between the early and late studies was that early studies were concerned with explanation rather than prediction and they focused on process rather than outcome.

The “Z Scores” developed by Altman, and the “Logit” analysis developed by Ohlson, became tools that were invaluable to financial managers in managing their bankruptcy exposure. This is particularly important for firms engaged in the riskier activities of investing in foreign firms where they do not have a good understanding of the cultural, legal and ethical environment of the foreign country. This is a significant problem for Thailand since it depends so heavily on foreign investment and the trust of international financiers.

The purpose of this study therefore, is to determine whether the work of Ohlson and Altman can be applied to firms operating in Thailand. Specifically, the study seeks to compare the accuracy level between Ohlson’s O-score and Altman’s Z-score to bankrupt and nonbankrupt firms with different asset sizes. While other studies have already studied Altman’s Z-score in Thailand, a review of the literature does not indicate that a comparison of the two methods using the same data has been done there.

Given the above purpose, this study seeks to answer the question:

What is the difference in bankruptcy predictive ability between Altman’s and Ohlson’s models to Thai firms with different asset sizes?

Altman’s Z-Score has been examined on numerous occasions for firms in all parts of the world – including Thailand (see, for example, Tirapat & Nittayagasetwat, 1999). This same review of the literature (late 2003) does not indicate the use of the O-Score in Thailand, nonetheless, it would be useful to make a side by side comparison of the two methods using the same data to determine if one performs better than the other in the Thai environment. There have been numerous studies outside of Thailand that compare the two methods (See for example, Holmen, 1988; Grice & Ingram, 2001; Ginoglou et al, 2002). The results of these side-by-side studies have not been conclusive. For example Ginoglous et al, (2002) compared 40 Grecian firms – 20 healthy and 20 problematic – using both a logit model and a multiple discriminant analysis model but did not find that one performed significantly better than the other. Whether this same result would be found in Thailand is of interest and could provide an impetus for others to further investigate the two methods in Thailand.

The hypotheses addressed in this study are:

H₀₁. There is no difference in predictive ability between Ohlson’s logit model and Altman’s four-variable model of large asset firms.

H₀₂. There is no difference in predictive ability between Ohlson’s logit model and Altman’s four-variable model of small asset firms.

The population of this study is the firms listed on the Stock Exchange of Thailand. From this population a sample of 60 failed or financially distressed firms and 60
non-failed firms was selected. A failed firm or financially distressed firm is one that either: (1) had been liquidated during the current year, (2) had received an audit that expresses concern about the going concern capabilities of the firm, (3) had been closed down by governmental authorities, (4) had been asked to submit restructuring plans by the Bank of Thailand or the Stock Exchange of Thailand or (5) had filed bankruptcy proceedings in one or more countries or some other notification indicating bankruptcy proceedings. These activities must have occurred sometimes between 1998 and 2004. To be selected for study, all firms must have been in business and published financial statements for each of the three years prior to failure.

Financial information, including all financial statements was drawn from the e-library of the Stock Exchange of Thailand. For each of the firms selected, all the appropriate ratios required by Ohlson and Altman were calculated. A few adjustments had to be made to the published statements to make them more uniform and comparable.

A coding sheet was used for data collection. The coding sheet was developed on an Excel spreadsheet and included the name of company, ticker symbol, SIC code, most recent year of financials, and date financial distress was detected (for failed firms only). For each of the three preceding years prior to distress the coding sheet listed total assets, total liabilities, current assets, current liabilities, net income (for four years) and cash flows from operations.

Each of the 60 failed and non-failed firms were matched using the SIC code and asset size. They were then analyzed using Ohlson’s logit bankruptcy prediction model and Altman’s Z-score as discussed earlier. The computer program selected for use was SPSS.

Results of the Study:

The results of the classification accuracy of both Ohlson’s model and Altman’s model were compared and are reported in table 1.

Table 1: Classification Comparison of Ohlson's O-score model and Altman’s Z-score model for large asset firms.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ohlson</td>
<td>Altman</td>
<td>Ohlson</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>85.71%</td>
<td>90.48%</td>
<td>85.71%</td>
</tr>
<tr>
<td>Non-bankrupt</td>
<td>60.00%</td>
<td>40.00%</td>
<td>60.00%</td>
</tr>
<tr>
<td>Overall</td>
<td>69.64%</td>
<td>58.93%</td>
<td>69.64%</td>
</tr>
</tbody>
</table>

The Z-test for this research hypothesis was conducted at the 95% confidence level in order to test if there was a significant difference between the predictive accuracy of the two models in predicting bankrupt and nonbankrupt large asset firms.
A comparison of the classification accuracy between the two models affirms that the overall predictive ability of Ohlson’s model is higher in all three years preceding bankruptcy than that of Altman’s four-variable model. The overall difference between Ohlson’s model and Altman’s model respectively was 69.64% to 58.93% for the first year prior to bankruptcy, 69.64% and 62.50% for the second year prior to bankruptcy and 69.64% to 62.50% for the third year to bankruptcy.

An examination of the data shows that for bankrupt firms only, the Altman model had a higher predictive accuracy than Ohlson’s model. For the bankrupt firms, the predictive accuracy of Altman’s model and Ohlson’s model respectively was 90.48% to 85.71% for the first year prior to bankruptcy, 100% and 85.71% for the second year prior to bankruptcy, and 100% and 85.71% for the third year prior to bankruptcy.

For nonbankrupt firms Ohlson’s model had a higher level of predictive accuracy than did Altman’s model. For the nonbankrupt firms, the predictive accuracy of Ohlson’s model and Altman’s model respectively was 60% and 40% for each of the three years prior to bankruptcy. This higher level of predictive accuracy for nonbankrupt firms is the reason why the Ohlson model had a higher overall predictive accuracy.

The hypothesis was tested at a 95 percent level of confidence. The hypothesis for test of significance of a difference between the two models took the following form:

\[ H_0: P_{B,O} - P_{B,A} = 0, \ P_{NB,O} - P_{NB,A} = 0 \]

\[ H_A: P_{B,O} - P_{B,A} \neq 0, \ P_{NB,O} - P_{NB,A} \neq 0 \]

Where \( P \) = The classification accuracy

B = Bankrupt

NB = Nonbankrupt

O = Ohlson’s model

A = Altman’s model

A \( Z \) having a value equal to or greater than \( Z=1.96 \) is considered significant at the 0.05 level (two-tailed test for significance of a difference between two model).

Table 2 shows the results of a comparison of the predictive ability of Ohlson’s and Altman’s models, one, two and three years prior to bankruptcy. The table also shows the \( Z \)-test values and the related level of significance for each comparison. The \( Z \)-tests were conducted to determine whether there is a significant difference between both models in predicting bankruptcy, nonbankruptcy and overall accuracy of the sample of firms.
### Table 2: Z-test Statistical Comparison of Predictive Accuracy of Ohlson's Logit and Altman's Bankruptcy Prediction Models

<table>
<thead>
<tr>
<th>Year Prior to Bankruptcy</th>
<th>Classification</th>
<th>Predictive accuracy %</th>
<th>Z Value</th>
<th>Significant Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ohlson</td>
<td>Altman</td>
<td></td>
</tr>
<tr>
<td>1 Bankrupt</td>
<td></td>
<td>85.71</td>
<td>90.48</td>
<td>-0.176</td>
</tr>
<tr>
<td>2 Bankrupt</td>
<td></td>
<td>85.71</td>
<td>100.00</td>
<td>-0.499</td>
</tr>
<tr>
<td>3 Bankrupt</td>
<td></td>
<td>85.71</td>
<td>100.00</td>
<td>-0.499</td>
</tr>
<tr>
<td>Nonbankrupt</td>
<td></td>
<td>60.00</td>
<td>40.00</td>
<td>1.54</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>69.64</td>
<td>58.93</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>69.64</td>
<td>62.50</td>
<td>0.58</td>
</tr>
</tbody>
</table>

As stated above, significance is demonstrated at a Z of 1.96 or greater. An examination of the table shows that the tests for differences in the prediction of bankruptcy firms in the first, second and third years prior to bankruptcy are not significant at the 0.05 level. Negative Z-values show that Altman’s model performs better in all of the three years examined. The statistical results in predicting bankrupt firms, therefore, are not significant.

An examination of Table 2 shows that the test for differences in the prediction of nonbankrupt firm are also not significant at the 0.05 level in the first, second and third years prior to bankruptcy. The positive Z-tests show that Ohlson’s model performed better in all three years prior to bankruptcy. The statistical results in predicting nonbankruptcy firms are, therefore, also not significant.

A review of Table 2 also shows that for the overall predictive accuracy of the two models, the Z-test for overall accuracy was not statistically significant for years one, two and three prior to bankruptcy. Therefore the null hypothesis was not rejected and support was not found for the alternative hypothesis. The tests for difference in predictive ability between the two models indicate that no model could be considered superior to the other.

The second hypothesis is related to the comparative classification of whether there is a difference in predictive ability between the Ohlson’s and Altman’s four-variable model for small asset firms.

The results of the classification accuracy of both Ohlson’s model and Altman’s model are compared and reported in Tables 9.
Table 3: Percentage Classification Comparison of Ohlson’s model and Altman’s model for small asset firms.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ohlson</td>
<td>Altman</td>
<td>Ohlson</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>71.79%</td>
<td>94.87%</td>
<td>69.23%</td>
</tr>
<tr>
<td>Non-Bankrupt</td>
<td>80.00%</td>
<td>16.00%</td>
<td>68.00%</td>
</tr>
<tr>
<td>Overall</td>
<td>75.00%</td>
<td>64.06%</td>
<td>68.75%</td>
</tr>
</tbody>
</table>

The test for this research hypothesis Z-test statistic was conducted with a 95% confidence level in order to test the significance of the difference between both models in predicting overall, bankrupt and nonbankrupt accuracy of small firms.

Comparing the classification accuracy between the two models affirms that the overall predictive ability of Ohlson’s model is higher than Altman’s model in the first year prior to bankruptcy. The overall prediction percentages for the Ohlson model and the Altman model were 75.00% and 64.06% respectively.

An examination of the tables show that for the second year prior to bankruptcy both models have the same predictive accuracy with an accuracy rate of 68.75% to 68.75%. However, in the third years prior to bankruptcy Altman’s model demonstrates a higher accuracy than Ohlson’s model. The predictive accuracy in the third year prior to bankruptcy for the Altman and Ohlson models was 71.88% and 68.75% respectively.

For bankrupt firms Altman’s model exhibits a higher predictive accuracy than Ohlson’s model in all three years preceding bankruptcy. The predictive accuracy in the three years prior to bankruptcy for the Altman and Ohlson models was 94.87% to 71.79% for the first year prior to bankruptcy, 94.87% to 69.23% for the second year prior to bankruptcy and 94.87% to 71.79% for the third year prior to bankruptcy.

In the case of nonbankrupt firms the Ohlson model preformed with greater accuracy than the Altman in all three year. The predictive accuracy was 80.00% to 16.00% for the first year, 68.00% to 28.00% for the second year and 64.00% to 30.00% for the third year.

The hypothesis was tested at the 95 percent level of confidence. The hypothesis for the test of significance of a difference between two models for small asset firms took the following form:
H₀: \( P_{B,O} - P_{B,A} = 0 \), \( P_{NB,O} - P_{NB,A} = 0 \)

Hₐ: \( P_{B,O} - P_{B,A} \neq 0 \), \( P_{NB,O} - P_{NB,A} \neq 0 \)

Where

\( P \) = The classification accuracy

\( B \) = Bankrupt

\( NB \) = Nonbankrupt

\( O \) = Ohlson’s model

\( A \) = Altman’s model

A \( Z \) having a value equal to or greater than \( Z=1.96 \) is considered significant at the 0.05 level (two-tailed test for significance of a difference between the two models).

Table 4 shows the results of a comparison of the predictive ability of the two models, one, two and three years prior to bankruptcy. \( Z \)-test values and the related level of significance are also reported for each comparison. The \( Z \)-tests were conducted to determine whether there is significant difference between each model in predicting bankruptcy and nonbankruptcy and their overall prediction accuracy for small firms in the first, second and third years prior to bankruptcy.

**Table 4: Comparison of Predictive Accuracy Ohlson's and Altman's (1993)**

Bankruptcy prediction model and \( Z \)-test statistics for Small asset firms.

<table>
<thead>
<tr>
<th>Year Prior to Bankruptcy</th>
<th>Classification</th>
<th>Predictive accuracy %</th>
<th>( Z ) Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ohlson</td>
<td>Altman</td>
<td></td>
</tr>
<tr>
<td>1 Bankrupt</td>
<td>71.79</td>
<td>94.87</td>
<td>1.22</td>
<td>N</td>
</tr>
<tr>
<td>Nonbankrupt</td>
<td>80.00</td>
<td>16.00</td>
<td>3.95</td>
<td>Y</td>
</tr>
<tr>
<td>Overall</td>
<td>75.00</td>
<td>64.06</td>
<td>0.89</td>
<td>N</td>
</tr>
<tr>
<td>2 Bankrupt</td>
<td>69.23</td>
<td>94.87</td>
<td>-1.37</td>
<td>N</td>
</tr>
<tr>
<td>Nonbankrupt</td>
<td>68.00</td>
<td>28.00</td>
<td>2.74</td>
<td>Y</td>
</tr>
<tr>
<td>Overall</td>
<td>68.75</td>
<td>68.75</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>3 Bankrupt</td>
<td>71.79</td>
<td>94.87</td>
<td>1.22</td>
<td>N</td>
</tr>
<tr>
<td>Nonbankrupt</td>
<td>64.00</td>
<td>36.00</td>
<td>1.92</td>
<td>N</td>
</tr>
<tr>
<td>Overall</td>
<td>68.75</td>
<td>71.88</td>
<td>-0.25</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 4 shows that the tests for bankrupt firms were not significant at the 0.05 significance level. While the negative \( Z \)-values show that Altman’s model performs better in all three years of data for these bankrupt firms the statistical results in predicting bankrupt firms are not significant.
Table 4 also shows that the test for difference in the predictive ability for nonbankrupt firm are significant for the first and second year but not in the third year prior to bankruptcy. Again, the positive Z-values show that Ohlson’s model performs better in all three years for nonbankrupt firms but the differences are not significant.

For the overall predictive accuracy of the two models, the Z-test for overall accuracy was not statistically significant for years one, two and three prior to bankruptcy. Therefore the null hypothesis was not rejected and support was not found for the alternative hypothesis. The test for difference in predictive ability between the two models indicates that no model could be considered superior to other. There is no difference in predictive ability between Ohlson’s and Altman’s four-variable model of small asset firms.

Concurrent with classification accuracy between Ohlson’s and Altman’s model, is the classification of errors. Two types of errors can exist. Type α errors will predict a failed firms as a nonfailed firm, while a type β error will predict a nonfailed firm as a failed firm. Ohlson’s model appeared to be higher in type α errors with 23.33% in year one prior to bankruptcy, 25.00% in year two prior to bankruptcy, and 23.33% in year three prior to bankruptcy. Altman’s model showed less type α errors with 6.67% for one year prior to bankruptcy, 3.33% for the second year prior to bankruptcy and 3.33% three years prior to bankruptcy.

The type β error rate coincided with the classification accuracy of the bankrupt firms. There were fewer type β errors in Ohlson’s model than in Altman’s model. Ohlson’s model had 20.00% type β in year one, 21.1% in year two, and 23.33% in year three. At the same time Type β errors for Altman’s (1993) model was 31.67% in year one, 35.00% in year two, and 38.33% in year three.

A type α error would seem to be significantly more costly than a type β from the point of view of bankers and investors. Type β errors would appear to be more costly from the point of view of healthy firms.

Conclusions
Hypothesis one reviews the comparative classification in predictive ability between Ohlson’s model and Altman’s four variable model of large asset firms. Ohlson’s model reflected overall higher predictive accuracy for year one, year two, and year three, with an overall predictive accuracy of 69.64%.

In terms of bankrupt predictive ability of large asset firms Altman’s model achieved higher accuracy for year one with an accuracy rate of 90.48% for year one and a 100% accuracy rate for both year two and year three. However, with regard to nonbankrupt firms, Altman’s model exhibited less predictive accuracy. For each of the three years of data gathered, the Altman model had a predictive accuracy of only
40%. A test for difference of the above results indicated that these differences in hypothesis two were not significant. Thus, there is the implication that neither of the two models could be considered superior to the other for predicting bankruptcy of large asset Thai firms.

Hypothesis two examined the comparative predictive ability between Ohlson’s model and Altman’s model to small asset firms. The results were similar to that found for large asset firms, that is, Ohlson’s model was slightly higher in overall predictive accuracy than Altman’s model.

With regard to small asset bankrupt firms, Altman’s model achieved higher accuracy for year one with a predictive accuracy rate of 94.87%, year two with a predictive accuracy rate of 94.87% and year three with a predictive accuracy rate of 94.87%.

In the case of nonbankrupt predictive ability, Altman’s model demonstrated less accuracy than Ohlson’s model in each of the three years examined, however a test for difference indicated that these differences in hypothesis three were not significant. This implies that neither of the two models could be considered superior to the other for predicting bankruptcy of small asset Thai firms.
References


