The Applicability of Corporate Failure Models to Emerging Economies: Evidence from Jordan

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Abstract

This study investigated the applicability of corporate failure models to Jordanian manufacturing firms publicly traded on the Amman Stock Exchange during (2005-2012). Altman and Kida models are applied to a matched pair sample of 19 failed and 19 healthy firms. The findings showed that Altman and Kida models are suitable for predicting corporate failure in emerging economies like Jordan. Furthermore, both models work well with recent data. However, Altman model outperforms Kida model in terms of predictive accuracy and type I error produced. This suggests for stakeholders who are interested in early warning systems, that Altman model can be used for predicting potential problems since it considers solvency indicators. However, the model should be used along with nonfinancial models and proxies that reflect the firm's operating environment.

Keywords: Altman model, Kida model, corporate failure, Jordan.

1. Introduction

Corporate failure is a major concern to stakeholders including employees, management, investors, creditors, government etc. It can produce heavy losses and sever costs to the whole society and economy (Ahn, Cho, & Kim, 2000). For example, Lev (1974), argues that corporate failure is a sign of resources misallocation which leads to unwanted social implications. Furthermore, evidence shows that bankruptcy costs incurred by firms can reach up to 17% of the firm value three years prior to bankruptcy (Altman, 1984). The economic cost of business failures are substantial with direct bankruptcy costs amounting to approximately 5% of the market value of the firm (Warner, 1997). Thus, predicting failure as early as possible with sound accuracy enable firms to take action to reduce the costs of bankruptcy, avoid failure to all stakeholders and contribute towards the business and financial environment stability.

Given the financial crisis of 2008, the need for developing corporate failure prediction models has become more vital than ever. Over the last four decades many models focusing on the ability to predict corporate failure have been proposed and, empirically, tested such as Beaver (1966), Altman (1968), Deakin (1972), Kida (1980), Ohlson (1980), Taffler (1983), and Shirata (1998) to name a few. However, the suitability and performance of these models are questionable. The models were developed using data from developed economies. Thus, they may not be suitable to apply in an emerging economy like Jordan because of the differences in business environment and legal system. According to Pereiro (2006) these models lack instructions on how to be applied to emerging economies. Furthermore, the models were developed between the late 60’s and 80’s. Since then, many changes have taken place in the business environment (e.g., corporate law, investment law, accounting standards, financial markets…etc.) (Boritz, Kennedy, & Sun, 2007). Thus, the original coefficients of these models may not perform well with recent set of data (Begley, Ming, & Watts, 1996). Empirical evidence reported by Grice & Ingram (2001) shows that these coefficients should be re-estimated for different time frames.

The purpose of this study is to, empirically, investigate the ability of Altman and Kida models to, successfully, predict corporate failure in three respects: i) to determine whether these models can be successfully applied in an emerging market like Jordan; ii) to determine whether these models can successfully predict corporate failure using recent data from 2000 to 2012; and iii) to identify the difference (if any) in the accuracy level of prediction between the two models.
The current study contributes to the literature on bankruptcy in several ways. Firstly, the majority of previous studies focus on the applicability of Z-score models in developed economies. However, the current study provides empirical evidence from an emerging economy: Jordan. Secondly, prior studies in Jordan are limited and based on data from the 1980s and/or 1990s (see for example: Gharaibeh & Abdullateef, 1987; Khamees & Gharaibeh, 1989; Ateyeh, 1995; Khasharmeh, 2000; Jahmani & Dawood, 2004). The current study uses recent set of data. These data reflect the major changes that have taken place in Jordan economy at both the macro and micro levels. Finally, the findings expected to be obtained from the current study could be of great interest to authoritative organizations such as the companies control department who formulates appropriate policies and procedures to monitor the performance of Jordanian firms.

The remainder of this paper includes the following sections: Review of related literature is followed by research hypotheses, research method, and data analysis and hypotheses testing. Summary, concluding remarks, & limitations are presented in the last section.

2. Review of Related Literature

The literature on corporate failure prediction has drawn considerable interest since the work of Fitzpatrick (1932) who used financial ratios to compare successful firms with failed firms. Beaver (1966) used univariate analysis on 30 financial ratios and 79 pairs of companies (failure/non-failure). He presented empirical evidence that certain financial ratios can correctly identify failed firms one year prior to failure (most notably, working capital/debt ratio, and net income/total assets ratio) with accuracy rates of 90% and 88% respectively. Altman (1968) expanded on the work of Beaver (1966) and used multivariate analysis to develop a discriminant function composed of five ratios. His model outperformed Beaver’s (1966) in discriminating failed from nonfailed firms.

Since the introduction of Altman’s model, a variety of failure prediction models have been proposed using different techniques such as multiple discriminant analysis (e.g.: Deakin (1972); Kida, 1980; Taffler, 1983), logit and probit analyses (e.g.: Ohlson, 1980; Zmijewski, 1984), neural networks (e.g.: Odom and Sharda, 1990; Bell, 1997), and hazard models (e.g.: Shumway, 2001). Discussion of these models is well presented in the literature (see for example: Platt, Platt, & Pedersen, 1994; O’leary, 1998; Charalambous, Neophytou, & Charitou, 2004; Agarwal & Taffler, 2007; Boritz, Kennedy, & Sun, 2007; du Jardin, 2010; Gepp & Kumar, 2012).

However, the Z-score model developed by Altman (1968) is the most widely recognized and used model for predicting the probability of financial failure by researchers, auditors, financial analysts, corporates' managements etc. (Bemmann, 2005). Abundant number of studies has documented evidence on the performance of Altman's model. Following is a review of some of the most recent studies.

Grice and Ingram (2001) examined the predictive accuracy of Altman's original model and a re-estimated model on a sample of 148 distressed and 854 non-distressed firms during 1988-1994. They concluded that Altman’s model is not as useful for predicting financial distress in recent periods as it was in the 1960s. Furthermore, the model is more useful for predicting financial distress of manufacturing firms than for predicting financial distress of non-manufacturing firms. Pongsattat, Ramage, & Lawrence (2004) explored the comparative ability of Ohlson’s Logit model and Altman’s model for predicting bankruptcy of large and small firms in Thailand over the years 1998-2003. They concluded that neither of the two models could be considered superior to the other for predicting bankruptcy of large and small Thai firms. Chung, Tan, & Holdsworth (2008) compared the performance of Altman model with other models for 10 failed finance firms in New Zealand during 2006-2007. They found that Altman model outperformed other models in predicting corporate insolvency one year prior to failure. Gerantonis, Vergos, & Christopoulos, (2009) examined the predictive accuracy of Altman Z-score model to firms listed on Athens Stock Exchange during the period 2002-2008. They found that the z-score gives a good indication of problems (accuracy rate of 66%) one year before the firm will exhibit financial problems.

The accuracy rate gradually diminishes to 52%, 39% and 20%, two years, three years, and four years to failure respectively. Wang & Campbell, (2010) used data from Chinese publicly listed companies for the period 2000-
2008 to test the accuracy of Altman's original model, a variation of the original model for which the coefficients were recalculated, and a revised model which used different variables. The results demonstrated that at the aggregate level, the revised Z-score model has a higher prediction accuracy compared with both Altman's original model and the re-estimated model. At the failed firms' level, Altman's model has the highest prediction accuracy with the lowest type I error rate of 3.7%. However, the model tends to misclassify non-failed firms as failed (type II error rate of 48.9 %.) higher than the other two models. Pitrova, (2011) analysed the predictive ability of Altman model when applied to Czech firms four years prior to failure. The results showed that Altman model performs well (accuracy rate of 84%) when predicting non-failed firms. However, the model can predict financial difficulties only one year prior to failure. Ray (2011) examined the ability of the Z-score model developed by Altman, to predict bankruptcy in Indian fertilizer firms using data from 2000-2007. The study found that the Z-score model can identify financially troubled firms that may bankrupt. In addition, the individual ratios of the model have depicted inefficiencies within the firms that may threaten their financial health. Diakomihalis (2012) evaluated the three versions of Altman model (2000) on 146 private hotels in Greece in the year 2007. The result indicated that Altman models yield a high degree of reliability and accuracy in forecasting the bankruptcy of hotel enterprises. The original model reported the highest accuracy rate of 88.2%. The third model that was developed to be applied in the service firms reported the lowest accuracy rate of 80%. Li (2012) tested the predictive accuracy of Altman's original model and two re-estimated versions of the original model on a sample of 70 manufacturing and non-manufacturing US firms from 2005-2012. The result indicated that all three models perform well in predicting failed firms. The accuracy rates ranged between 75% and 100% with an average of 91.7%. In addition, the re-estimated model with one variable (Market value of equity/Total liabilities) appears to be superior to Altman’s original model and the re-estimated model with two variables. However, the three models fall short on classifying non-failed firms as failed with type II error ranging from 55% to 80%. Mohammed & Kim-Soon (2012) compared the performance of Altman’s model and current ratio in assessing the financial status of firms listed on Malaysian stock Exchange. The result of the study revealed that both approaches are successful in differentiating financial failure and non-failure firms. However, significant differences are found between the two approaches one year prior to failure. Onofrei & Lupu (2012) tested the applicability of Altman model to the Romanian market during 2006-2010. The study presented empirical evidence that Romanian firms cannot use, with acceptable risk of error predictability, Altman model because it was developed under a stable economy that differs from the Romanian economy that is characterized by a sharp economic instability.

Notably, the review of the literature reveals a lack of studies replicating and/or testing the performance of Kida's model. Therefore, it would provide valuable insights to the current study as well as to the literature on corporate failure to test the accuracy of this model in a developing economy like Jordan.

3. Research Hypotheses

Based on the review of the related literature and to achieve the objectives of the study, the following hypotheses will be tested:

**H1**: Altman Model accurately predicts corporate failure when applied to data from an emerging market; Jordan.

**H2**: Kida Model accurately predicts corporate failure when applied to data from an emerging market; Jordan.

**H3**: Altman Model, accurately, predicts corporate failure when applied to data from recent time frame (2005-2012).

**H4**: Kida Model, accurately, predicts corporate failure when applied to data from recent time frame (2005-2012).

**H5**: There are no significant differences in the accuracy level of prediction between Altman model and Kida model when both models are applied to Jordanian firms.

4. Research Method

4.1. Sample

The population of the study includes all publicly traded manufacturing firms on the Amman Stock Exchange during the period 2005-2012. Two samples are selected from this population. The first sample includes failed firms (note 2). After excluding firms less than 5 years old, and firms with incomplete or missing data the final
sample size is 19 firms. The second sample includes non-failed (healthy) firms. To select the elements of this sample, a matched pair process is used. For each failed firm, a healthy firm in the same industry and of the closest asset size and age is identified.

4.2. Source of Data

The required financial data for the failed and healthy firms were collected from the Database of Amman Stock Exchange available online, and the annual reports of the investigated firms. For each failed and matching healthy firms, the data were collected one, two, and three years prior to failure. With the use of Microsoft’s Excel spread sheet the financial ratios required by Altman and Kida models were calculated. Based on these ratios the Altman and the Kida Z scores were calculated.

4.3. Models used

4.3.1. Altman Model

Following the seminal work of Beaver (1966), Edward Altman (1968) applied a Multivariate Discriminant Analysis to identify the discriminating variables for bankruptcy prediction. A total of 22 potential financial ratios were calculated for a sample of 33 bankrupted firms and a control sample of 33 matching non-bankrupted firms, during the period 1946-1965. Of the original 22 ratios, 5 were chosen as the most relevant in predicting bankruptcy. The final discriminant function developed by Altman is as follows:

\[ Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \]

where:

- \( X_1 \) = working capital/total assets,
- \( X_2 \) = retained earnings/total assets,
- \( X_3 \) = earnings before interest and tax/total assets,
- \( X_4 \) = market value of equity/book value of total debt, and
- \( X_5 \) = sales/total assets.

The data of a firm is entered into the model and its Z-score is calculated. Z-score value below 1.81 would imply a high probability of bankruptcy, Z-score above 2.99 would imply a low probability of bankruptcy. Scores between 1.81 and 2.99 are inconclusive about bankruptcy risk. Firms in this range are considered marginal cases and need to be watched with attention. Altman model provided a high predictive accuracy of 95% one year prior to bankruptcy. However, the level of accuracy deteriorated to 72%, 48%, 29%, and 36% two-year, three-year, four-year, and five-year prior to bankruptcy.

To expand the applicability of the model, Altman introduced a second version of his Z-score model for privately held firms. The second version substitutes the book value of equity for the market value in \( X_4 \). In addition, new coefficients are calculated. To minimize the industry effect, Altman proposed a third version of his model where \( X_5 \) is eliminated and new coefficients are re-estimated (Altman, 2000). Table 1 presents a comparison of the three versions of Altman's Z-score model.

****Table 1: The three versions of Altman's Z-score model****

4.3.2. Kida Model

Kida (1980) applied stepwise discriminant analysis and factor analysis to 20 financial ratios related to 40 firms (20 problem and 20 non-problem) during the period 1974-1975. A set consisting of five ratios was selected as they accurately distinguished problem from non-problem firms. The Discriminant function developed by Kida is as follows:

\[ Z = -1.042X_1 - 0.427X_2 - 0.461X_3 - 0.463X_4 + 0.271X_5 \]
where:

\[ X_1 = \frac{\text{net income}}{\text{total assets}}, \]
\[ X_2 = \frac{\text{net worth}}{\text{total debt}}, \]
\[ X_3 = \frac{\text{quick assets}}{\text{current liabilities}}, \]
\[ X_4 = \frac{\text{sales}}{\text{total assets}}, \]
\[ X_5 = \frac{\text{cash}}{\text{total assets}}. \]

A negative Z-score implies a problem firm, where as a positive Z-score implies a non-problem firm. Although the model achieved an overall accuracy rate of 90%. Nevertheless, type I error rate (15%) was significantly higher than type II error rate (5%) implying that the model performs better in predicting non-problem firms.

5. Data Analysis and Hypotheses Testing

The predictive accuracy of each model is tested by examining the percentage of correctly classified firms (failed and healthy). However, two types of classification error can be made when using corporate failure models: type I error, and type II error (see Table 2). Type I error is made when a failed firm is classified as a healthy firm. Therefore it is often known as "credit risk". Type II error is made when a healthy firm is classified as a failed firm. Therefore it is often known as "commercial risk". Both errors are costly. For example, creditors lose the due interest and principal when granting credit for a failed firm that is misclassified as a healthy firm. Investors may lose part or all of their investments. Auditors may lose their fees and professional reputation and face the probability of litigation by shareholders (Geiger, Raghunandan, & Rama, 2005). However, type I error is more costly than type II error. This cost is estimated to be 25 times the cost of type II error (Weiss, 1996).

Table 2 shows that Altman's model is able to correctly classify the majority (69.3%) of failed firms and healthy firms. The percentages of correctly classified failed firms and healthy firms are 94.7% and 84.2% respectively in year 1. However, these percentages gradually declines to 73.9% in year 2, and 57.9% in year 3 for failed firms, where they decline to 57.9% in year 2, and 47.4% in year 3 for healthy firms. It is also interesting to note that, in all three years, the level of accuracy in predicting failed firms is much higher than the level of accuracy in predicting healthy firms. Furthermore, the highest correct classification percentage is attained in year 1. These results are consistent to what has been reported in prior research about Altman's model (for example: Chung, Tan, & Holdsworth, 2008; Gerantonis, Vergos, & Christopoulos, 2009).

Table 4 shows that type I error rate for Altman model is lower than type II error rate in all three years. This is important since type I error is more costly than type II error. Also, the table shows the small values of the misclassification cost calculated at various cost ratios (note 2), with the smallest total misclassification cost attained in year 1. This is considered to be a merit of Altman model since corporate failure models that minimize type I error and thus the total misclassification cost are more preferable (Charalambous, Neophytou, & Charitou, 2004).
The results of Kida's model (shown in table 5) indicate that the model has an overall accuracy rate of 57.9%. The success rate for classifying failed firms varies from 84.2% in year 1 to 52.7% in year 3. On the other hand, the model is able to correctly classify 68.4% of healthy firms in year 1. Nevertheless, the model performs poorly when prediction time horizon increases. Table 6 shows that the model has an average type I and type II error rates of 35.07% and 49.13% respectively. The table also shows the misclassification cost calculated at various cost ratios, with the smallest total misclassification cost attained in year 1. Unlike what has been reported by Kida (1980), these results imply that the model performs poorly in predicting healthy firms.

*****Table 4: Kida's Z-scores prediction statistics for failed & healthy firms*****

*****Table 5: Type I & type II errors and total misclassification costs of Kida's model*****

Based on the previous analysis, Altman's and Kida's models prove to be suitable for predicting corporate failure, not only in developed economies but also in developing economies like Jordan. Furthermore, both models work well with recent data (2005-2012) even though they were developed between the late 60's and early 80's. Accordingly, hypotheses one, two, three, and four can be accepted.

Hypothesis five relates to the differences in the accuracy level of prediction between Altman model and Kida model. A comparison of the classification accuracy between the two models is presented in Table 7.

*****Table 7: Comparison of the accuracy level of Altman Z-score and Kida Z-score*****

Table 7 shows that for failed firms, the Altman model has a higher predictive accuracy than Kida model. The predictive accuracy of Altman model and Kida model in year 1, year 2, and year 3, is 94.7 to 84.2%, 73.9% to 57.9%, and 57.9% to 52.7% respectively. Similarly, Altman model has a higher level of predictive accuracy than Kida model at the healthy firm level. The predictive accuracy of Altman model and Kida model in year 1, year 2, and year 3 is 84.2% to 68.4%, 57.9% to 47.4%, and 47.4% to 36.8% respectively. The table also shows that the classification accuracy of Altman model is higher than Kida model in all three years at the aggregate data level (all firms: failed and healthy). The overall difference between Altman model and Kida model respectively is 89.5% to 76.3% for year 1, 65.8% and 52.6% for year 2, and 52.6% to 44.7% for year 3. It is also interesting to note that Altman model produces lower rates of type I error and type II error than Kida model. More specifically, the average type I error and type II error rates for Altman and Kida models are 24.6% to 35.1% and 36.8% to 49.1% respectively (see tables 3 and 5). However, both models tend to have high type II error of misclassifying healthy firms as failed.

To investigate whether these differences are statistically significant, the Wilcoxon Signed-Rank Test is used. The hypotheses for testing the significance of differences between the two models at the 0.05 level are:

\[ H_0: P_{F,A} - P_{F,K} = 0, \]
\[ H_1: P_{F,A} - P_{F,K} \neq 0, \]

\[ H_0: P_{H,A} - P_{H,K} = 0, \]
\[ H_1: P_{H,A} - P_{H,K} \neq 0, \]

\[ H_0: P_{FH,A} - P_{FH,K} = 0, \]
\[ H_1: P_{FH,A} - P_{FH,K} \neq 0, \]
Where:
P Predictive accuracy level
F Failed
H Healthy
FH Failed & Healthy Firms (All firms)
A Altman model
K Kida model

The results presented in table 7 shows statistically significant differences in the predictive accuracy of failed firms between the two models for year 1 ($\rho=0.008$) and year 2 ($\rho=0.014$). The differences in year 3 are statistically insignificant ($\rho=0.256$). Therefore, the null hypothesis can be accepted for years 1 & 2 only.

On the other hand, the differences in the predictive accuracy of healthy firms are found to be statistically significant, only, for year 1. The differences for Year 2 and 3 are statistically insignificant at the 0.05 level ($\rho=0.086$) and ($\rho=0.138$) respectively. Therefore, the null hypothesis can be accepted for year 1 only.

Table 7 also shows that the differences of the overall predictive accuracy between the two models are statistically significant for year 1 only. For years 2 and 3 these differences are found to be statistically insignificant ($\rho=0.075$) and ($\rho=0.122$) respectively. Thus, the null hypothesis can be accepted for year 1 only.

Overall, Altman model outperforms Kida model in the predictive accuracy at the failed firm level, the healthy firm level, and the aggregate firm level for years 1, 2, & 3. However, the differences in predictive accuracy between the two models are found to be statistically significant for year 1 only. Therefore, hypothesis 5 can be accepted for year 1, indicating that Altman model is better in predicting the chance of failure within a year compared to Kida model.

6. Summary, Concluding Remarks, and Limitations

This study investigated the applicability of Altman and Kida models to Jordan using a recent set of data. Contrary to what has been proposed by Agrawal & Taffler (2007) that each country requires its own model, the empirical evidence provided by the current study showed that Altman and Kida models are suitable for predicting corporate failure, not only in developed economies but also in emerging economies like Jordan. Furthermore, both models work well with recent data even though they were developed between the late 60’s and early 80’s. However, the models achieve the highest correct classification rate one year prior to failure. As the prediction time horizon increases, their performance deteriorates. This is consistent with prior empirical evidence that corporate failure models cannot predict failure, with high reliability, earlier than one year ahead. According to Mensah (1984) this can be attributed to the changes in the distribution of the accounting ratios making up these models over time. Thus, he contends that the coefficients of these models should to be re-estimated on a regular basis.

In addition, the findings the study lends support for the assertions from prior research on the superiority of Altman model in terms of predictive accuracy. The model outperforms Kida model one year, two years, and three years prior to failure. However, the differences in predictive accuracy between the two models are found to be statistically significant, only, for year 1.

Another merit of Altman model is low type I error rates produced by this model. This is important since type I error is more costly than type II error. Thus, corporate failure models that minimize type I error and thus the total misclassification cost are more preferable. On the other hand, Altman model as well as Kida model tends to yield high type II error of misclassifying healthy firms as failed. This implies that both models are less suitable for predicting healthy firms. There appears to be a need for developing special model for predicting healthy firms only.
The findings reported here have a major implication for all stakeholders interested in predicting the probability of corporate failure. The Altman Z-score model can be used for predicting potential problems since it considers solvency indicators. However, the model should not be used alone rather it should be used along with nonfinancial models and proxies that reflect the firm's operating environment. The warning signals provided by both models assist interested stakeholders in portraying a clear picture of the firm's performance, and thus, predicting corporate problems early enough to avoid difficulties.

In spite of these findings, the study has some limitations that should be considered when interpreting the results. For example, the definition of failure used, the small sample size, the number of models tested, confining the sample to the publicly traded manufacturing firms, and focusing on Jordanian firms only can limit the generalizability of the findings and conclusions drawn from the study. On the other hand, these limitations provide some future research opportunities. For example, other definitions for failed firms can be adopted. Larger samples can be investigated. The performance of other models such as Ohlson (1980), Taffler (1983), and Shirata (1998) to name a few, can be tested and compared. Such comparative studies can be conducting using Jordanian firms' data. In Addition, it can be expanded to include data from other emerging economies. Finally, new models for predicting healthy firms only can be attempted.
References


**Endnotes**

Note 1 For the purpose of this study, a firm is classified as "failed" if it incurs losses for three consecutive years (Companies Control Department, 2013)

Note 2 The total misclassification cost at a cost ratio of 10:1 = (Type I error *10) + (Type II error*1). A cost ratio (10:1) means that the cost of type I error is ten times as large as the cost of type II Error (Anandarajan, Lee, & Anandarajan, 2001).
Annexure

Table 1: The three versions of Altman's Z-score model

<table>
<thead>
<tr>
<th>Version</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>Cut off scores</th>
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<td>1</td>
<td>1.21</td>
<td>1.41</td>
<td>3.3</td>
<td>0.6</td>
<td>0.999</td>
<td>Bankrupted: Z&lt;1.81</td>
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<td></td>
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<td>Gray: 1.81&lt;Z&lt;2.99</td>
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<td></td>
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<td></td>
<td>Distress: Z&gt;2.99</td>
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<tr>
<td>2</td>
<td>0.717</td>
<td>0.847</td>
<td>3.107</td>
<td>0.420</td>
<td>0.998</td>
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<td>6.72</td>
<td>1.05</td>
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Table 2: Possible classification outcomes

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<tr>
<td>Failed (F)</td>
<td>FH</td>
<td>(type I error)</td>
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<tr>
<td>Healthy (H)</td>
<td>HF</td>
<td>(type II error)</td>
</tr>
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<td>HH</td>
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Table 3: Altman's Z-scores prediction statistics for failed & healthy firms

<table>
<thead>
<tr>
<th>Years prior to failure</th>
<th>Failed firms</th>
<th>Healthy firms</th>
<th>All firms</th>
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<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>57.9%</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>73.9%</td>
<td>11</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>94.7%</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>75.4%</td>
<td>36</td>
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Table 4: Type I & type II errors and total misclassification costs of Altman model

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<thead>
<tr>
<th>Year</th>
<th>Type I error</th>
<th>Type II error</th>
<th>Cost Ratio (Type I : Type II error)</th>
<th>10:1</th>
<th>20:2</th>
<th>30:1</th>
<th>40:1</th>
<th>50:1</th>
<th>60:1</th>
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<tr>
<td>3</td>
<td>42.1%</td>
<td>52.6%</td>
<td>4.74</td>
<td>8.95</td>
<td>13.2</td>
<td>17.4</td>
<td>21.6</td>
<td>30</td>
<td></td>
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<tr>
<td>2</td>
<td>26.1%</td>
<td>42.1%</td>
<td>3.03</td>
<td>5.64</td>
<td>8.25</td>
<td>10.9</td>
<td>13.5</td>
<td>16.1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5.3%</td>
<td>15.8%</td>
<td>0.69</td>
<td>1.22</td>
<td>1.75</td>
<td>2.28</td>
<td>2.81</td>
<td>3.34</td>
<td></td>
</tr>
</tbody>
</table>
Table 5: Kida's Z-scores prediction statistics for failed & healthy firms

<table>
<thead>
<tr>
<th>Years prior to failure</th>
<th>Failed firms</th>
<th>Healthy firms</th>
<th>All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>52.7%</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>57.9%</td>
<td>9</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>84.2%</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>64.9%</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 6: Type I error, Type II errors and total misclassification costs of Kida model

<table>
<thead>
<tr>
<th>Year</th>
<th>Type I error</th>
<th>Type II error</th>
<th>Cost Ratio (Type I : Type II error)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10:1</td>
</tr>
<tr>
<td>3</td>
<td>47.3%</td>
<td>63.2%</td>
<td>5.26</td>
</tr>
<tr>
<td>2</td>
<td>42.1%</td>
<td>52.6%</td>
<td>4.74</td>
</tr>
<tr>
<td>1</td>
<td>15.8%</td>
<td>31.6%</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Table 7: Comparison of the accuracy level of Altman's Z-score and Kida's Z-score

<table>
<thead>
<tr>
<th>Years prior to failure</th>
<th>Classification accuracy for failed firms</th>
<th>Classification accuracy for healthy firms</th>
<th>Classification accuracy for all firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Altman</td>
<td>Kida</td>
<td>Sig (p)</td>
</tr>
<tr>
<td>3</td>
<td>57.9%</td>
<td>52.7%</td>
<td>0.256</td>
</tr>
<tr>
<td>2</td>
<td>73.9%</td>
<td>57.9%</td>
<td>0.014</td>
</tr>
<tr>
<td>1</td>
<td>94.7%</td>
<td>84.2%</td>
<td>0.008</td>
</tr>
</tbody>
</table>