Corporate financial distress prediction: An application of Multiple Discriminant analysis

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Abstract

Recent failures of large corporations at the international level and instability of securities in Sri Lanka have emphasized the importance of evaluating the companies' financial distress. One of the methods of evaluating financial distress is bankruptcy prediction models. They are the tools for measuring the financial healthiness of companies in the future. This research aims to bring out the theoretical foundations and make a deep study about the results of Altman's model (1968) in the Colombo Stock Exchange through statistical techniques of Multiple Discriminant Analysis and Logistic Regression Model. The data was gathered from 2013 to 2018. The results obtained from the Multiple Discriminant Analysis identified that Altman's model could predict bankruptcy within one year before with an accuracy rate of 72.10%. According to the logistic regression analysis, Altman's model has a higher predictability power. This research's findings can be applied by potential investors when designing their investment strategies in healthy financial companies.

Keywords: bankruptcy prediction models, financial distress and multiple discriminant analysis

Introduction

A distressed financial situation means that a company cannot settle its obligations and trade liabilities from the operating cash flows or the value of the total assets is lower than the aggregate value of the total liabilities and equity. Predicting corporate distress or bankruptcy has become essential for reducing its' harmful effects like huge bankruptcy costs. The stakeholders always try to find an appropriate method to forecast bankruptcy. Up to now, various types of bankruptcy prediction models were generated. Examples: Beaver Model, Altman's model, Zmijewski model, Springate model, Fulmer model, etc. Among them, Altman's Z score model is the popular model. Most researches have been done on the accuracy of those models within a different context. In this research, the selected sample of the Colombo Stock Exchange's financial data will be evaluated to do a study regarding the applicability of financial distress prediction models by using Multivariate Discriminant Analysis. The reason for selecting the Colombo Stock Exchange is there are many bankruptcy and de-listing cases recently. E.g.: Ceylon Leather Products PLC, Kalpitiya Beach Resort PLC, Chilaw Finance PLC etc. Therefore, the research is is how can accounting-based bankruptcy

prediction models of Altman (1968) apply to Public Listed Companies of Colombo Stock Exchange during 2013-2018 and compare the results with actual financial healthiness of them to prevent those bankruptcy and de-listing cases? Other research questions are as follows.

- Are the existing models of predicting bankruptcy applicable in Listed Companies of Sri Lanka?
- Which prediction models of financial distress are the most reliable in predicting financial distress in companies in the Sri Lankan context.?

The main research objective is to examine the applicability of selected financial distress prediction models and identify the most accurate model within the Sri Lankan Context.

Literature Review

The most popular model used for forecasting financial distress in the world is Altman's Z core model (1968). Altman introduced multivariate Discriminant Analysis in 1968 by extending the Beavers Univariate Analysis. Altman used a mix of accounting ratios to find the most suitable financial ratio which can forecast the bankruptcy level at the best level. After finding the essential ratios, Altman used various types of tests to ensure that the Z score model can accurately categorize companies as bankrupt or not (Altman, 1968). Many researchers have been involved in analyzing the efficiency of Altman's models to forecast financial distress by comparing results of other models like the Springate model and Grover model etc. But most of the time, other models' accuracy is lower than Altman's model. Altman's Z score model can accurately forecast bankruptcy three years before bankruptcy (Gerantonis, 2009). Gunathilake (2014) expressed that Altman's and Springate's Z core models have similar predictive ability. Altman's Z core model has a higher discriminant power to identify distressed firms at least 1 year before (Gunathilaka, 2014). In the international context, Altman's model can predict distress in terms of percentage for four years before the bankruptcy (Mahalakshmi, 2015). In this case, Altman's model gives moderate support to predict the financial distress of the selected sample of sick and non-sick companies in India. The research findings suggested that recent studies that have used Altman's model to estimate the financial distress of sample firms should be interpreted cautiously because the results are largely affected by the economic characteristics of the selected country.

Methodology

In the quantitative research study, research variables are categorized into two parts, which are independent and dependent variables. The companies' financial healthiness is the dependent variable and has two aspects that are distressed or non-distressed. The predictors of Altman's model (1968) are identified as independent variables.

Altman's Z Score model (1968)

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \quad ……. \quad \text{Equation 01}$$

Where,

X_1 = Working Capital / Total Assets

X_2 = Retained Earnings / Total Assets

X_3 = Earnings before Interest and Taxes / Total Assets

X_4 = Market value equity / Book value of Total debt

X_5 = Sales / Total Assets

The cut-off mark is 2.99. If the value Z is greater than 2.99, that firm is treated as a non-distressed firm, and if the Z value is smaller than 1.8, they are treated as distressed firms and among the area of .2.99 and 1.8, treated as a grey area. In identifying the sample, Banking, Finance, and Insurance industry have to be neglected since it has different characteristics and different capital structures from the 20 industries of CSE. Finally, this research study uses a sample of 122 companies listed in CSE, 61 distressed 61 non-distressed as the matched sample through the non -random sampling technique. Here corporate distress is decided on the companies that are suffering losses continuously for three years or more, having a negative cash flow position continuously for three years or more or having a negative net worth continuously for three years or more. The data are collected from the Colombo Stock Exchange. The accounting ratios are collected from the annual reports of the firms. Since the bankruptcy process might take several years to happen, the data collection period was identified as the period of 2015 to 2019. Multivariate Discriminant Analysis is used in this research study via the Mini Tab 2019 software. Multivariate discriminant analysis (MDA) is a technique used by financial predictors to evaluate potential investment opportunities when several variables must be considered. It is the primary method of analysis of this study. To confirm the validity of Altman's model, regression analysis is performed. Since there are three possible outcomes, the ordinal logistic regression model is used. The ordinal logistic regression model is used to analyze the relationship of the selected ratios as independent variables and the selected sample's financial status as the dependent variable. The general logistic regression model is as follows.

$$(p) = \alpha_k + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n \quad …….. \quad \text{Equation 02}$$

Where,

p = Financial Status Coefficient

β =

x = Independent variables Constatnt

α =

Results and Discussions

The findings and analysis of this research study bring the following results.

Table 1. Prediction Accuracy

Status	Non -distressed sample	Distressed sample
Non-Distress	75.54%	24.59%
Distress	2.29%	48.52%
Grey	21.97%	26.89%

Table 2. Predictability Power

	Within 1 Year	Within 2 Years	Within 3 Years
Altman's Model	72.10%	69.30%	64.80%

The Altman's Z Score model can accurately categorize 75.74% of the observed non-distress listed companies, 2.29% were classified in the distress Zone while 21.97 were classified in the grey zone. It can be highlighted that 48.52% of the observed distressed corporations were accurately classified while 24.59% were classified as non-distressed, and 26.89% were challenging to analyze.

Coming to the overall measures of Multivariate Discriminant Analysis, the estimation model 1 (within 1 year) performs with an accuracy rate of 72.10%. The estimation model 2 (within 2 years) reveals that Altman's model can forecast bankruptcy before two years to bankruptcy with an accuracy rate of 69.30%. The estimation model 3 reveals that Altman's model can forecast bankruptcy three years before with a 64.80% accuracy rate. It means that Altman's model can give a higher prediction ability within one year before to the bankrupt. The result of regression analysis is as follows:

Table 3. Regression Results

Predictor	Coefficient	SE	Z	P	Ratio	95% CI Lower	95% CI Upper
Constant (1)	-3.00	0.24	-12.72	0.00			
Constant (2)	-0.95	0.19	-4.90	0.00			
X1	0.50	0.46	1.08	0.04	1.64	0.67	4.06
X2	0.42	0.36	-1.19	0.04	0.66	0.33	1.32
X3	0.41	0.68	1.61	0.04	1.51	0.40	5.71

| X4 | 0.67 | 0.07 | 10.23 | 0.00 | 1.96 | 1.72 | 2.23 |
| X5 | 1.51 | 0.21 | 7.05 | 0.00 | 4.52 | 2.97 | 6.87 |

$$(p_1) = -3.00 + 0.49X_1 + 0.42X_2 + 0.41X_3 + 0.67X_4 + 1.50X_5$$
..…   Equation 03

$$(p_2) = -0.95 + 0.49X_1 + 0.42X_2 + 0.41X_3 + 0.67X_4 + 1.50X_5$$
……   Equation 04

The coefficients reflect that the probability of an outcome changes when the independent variables change. All independent variables have positive coefficients. It means that it makes the non-distress and Grey status are more likely as those variables are increased. It means that it makes the non-distress and Grey status are more likely as those variables are increased.

The standard error of coefficients measures the variability among coefficient estimations obtained from the samples from the same population again and again. The standard error of coefficients for all predictors are less than 1. It reveals that the estimations are precise. Z value, which is away from 0, highlights that the coefficient estimate is both large and precise and statistically different from 0. Z-value that is near to 0 represents that coefficient estimates are too small and imprecise, and that term has an effect on the response. The Z values for all predictors are far from 0, which indicates that the coefficient estimates are both large and precise. The relationships among the dependent and independent variables are statistically significant since the p-value is less than the significant level of 0.05. The odds ratio implies that a company is more likely to go for a non-distress situation when all predictors increase. Under the 95% confidence level, it can be concluded that the confidence interval includes all the values of the odds ratio for the population. The results are similar to the findings of the research done by Gunathilake (2014), which mentioned as Altman's Z score model has a higher degree of discriminant power in forecasting financial distress at least one year before. The reason for this similarity is the nature of the financial characteristics of Sri Lanka Listed companies.

Conclusions and Recommendations

The study analyses Altman's Z score model (1968) on bankruptcy prediction within the Sri Lankan Context with the use of data obtained from the Colombo Stock Exchange. The results show that this model has a higher degree of accuracy in forecasting distress using the selected independent variables within one year before the bankruptcy. The overall accuracy rate is 72.1%. Therefore, as the sample evidence proves, Altman's Z score model seems to have a better ability in forecasting financial distress in Listed Companies in
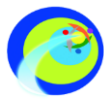
Sri Lanka. The results may be necessary for both investment managers and company management. Even though the companies can develop their position during improving periods of capital markets, it may not happen in the long run. Altman's model can be useful in such situations to decide whether they want to go for a merger or another solution to prevent bankruptcy by forecasting the distress of the companies as well as potential investors can rationally choose their investment decision by using this model. On the other hand, Prediction models may not forecast distress at 100% since it will be affected by economic failure, management failure and weaknesses in strategies. Highly developed methods through these prediction models should be wanted to face those situations efficiently.

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