Altman's Z-Score Models of Predicting Corporate Distress: Evidence from the Emerging Sri Lankan Stock Market

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Abstract

This study investigates the ability of three versions of Altman's Z-Score model (Z, Z', and Z") of distress prediction developed in the U.S. to predict the corporate distress in the emerging market of Sri Lanka. The results show that these models have a remarkable degree of accuracy in predicting distress using financial ratios computed from financial statements in the year prior to distress. The overall success rate of 81% is observed using the Z"-Score. The out-of-sample evidence provided in this paper means that the Z-Score models seem to have a very good potential in evaluating the risk of corporate distress in smaller emerging markets as well.

Introduction

One of the best-known models for predicting corporate financial distress is the Altman's Z-Score model (Altman, 1968, 1983, 1993). Altman's work has shown that the Z-Score and its variants have a very high degree of accuracy in predicting corporate financial distress in the U.S. as well as in the emerging markets (Altman, Hatzell and Peck, 1995). The purpose of this paper is to provide an out-of-sample test of the Z-score model and its variants by applying them to a sample of firms in the emerging Sri Lankan stock market. This application is particularly important for the emerging market investors. Understanding the potential for corporate distress has become ever more important in light of corporate distress and bankruptcies in developing stock markets, particularly in the aftermath of the Asian crisis. This paper contributes to the literature by applying the well-known Z-Score distress prediction model to an emerging market. The results provide us with evidence of the validity of a set of financial ratios, identified with reference to the U.S. companies, in predicting financial distress in an emerging market.

Description of the Sri Lankan Stock Market

The Sri Lankan stock market, in its present form, was established in 1984 with the formation of the Colombo Stock Exchange (CSE). It is the smallest of the three emerging markets in South Asia, the other two being India and Pakistan. Table 1 shows the basic statistics on the size, liquidity, return performance, and number of listed firms during the period of 1990 to 1997. The market capitalization of the CSE at the end of 1997 was just over 2 billion dollars while the turnover was almost 300 million dollars. In 1997, the turnover was 14.2% of the market capitalization, while the market capitalization was 14.5% of the GDP. The broadest measure of the market is the All Share Price Index, a value-weighted index of all the shares listed on the CSE. As of the end of 1997, the number of listed firms stood at 239. These companies represent 18 industry sectors and the major sectors are the bank, finance and insurance,

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diversified, hotels and travels, manufacturing, and plantations. The return performance of the market has been very volatile with 118% return in 1991 and -32.7% in 1995.

There are 15 stock brokering companies in the market. The brokers act as intermediaries to transactions, and they do not engage in market making. The trading in the Colombo Stock Exchange takes place through an automated trading system whereby brokers are electronically connected to a central computer, located at the CSE, which automatically executes orders on the basis of the specified order-matching rules. The settlement period is t+5 for buy and t+6 for sell transactions, where t is the date of the trade. Transactions cost is 1.4% for transactions up to 1 million rupees and 1.15% for transactions exceeding that amount.

Foreign investment in equity is permitted without restriction in all listed companies up to 100% of the equity of each company except for 42 companies where foreign investment is restricted. There is no tax on capital gains for both foreign and local investors.

Z-Score Models

The Z-Score models tested in this study include the following three models (Altman, 1968, 1983, 1993).

Z-Model (Original Model): $Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$

Z'-Model (Private Firm Model): $Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_{4*} + 0.998X_5$

Z"-Model: $Z = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_{4*}$

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 liabilities,
X_{4*} = book value equity/book value of total liabilities, and
X_5 = sales/total assets.

X_1 measures the net working capital relative to the size of the assets used in the business. It is used as a measure of liquidity standardized by the size of the firm.

X_2 relates the total retained earnings of the firm to the total assets employed. It is able to capture the cumulative profitability of the firm since inception. Also, since young firms tend to have low RE/TA ratios, this variable may capture the age of the firm as well.

X_3 measures the productivity of the assets or the earning power.

X_4 measures the extent to which total assets can decline in value before total liabilities exceed book value of equity. In other words, this indicates the asset cushion of the firm.

X_{4*} differs from X_4 in that it uses the book value rather than the market value of equity. This ratio is appropriate for a firm that is not publicly traded, and hence the Z-model with this variable definition is called the Z'-model or the private firm model. While we examine publicly traded firms in the current study, this private firm model may be appropriate in a smaller, less liquid and (informationaly) less efficient market such as Sri Lanka.

X_5 is intended to capture the sales generating ability of the assets. Altman found this to be industry sensitive and least discriminating between the bankrupt and non-bankrupt companies. As a result, Altman proposed a variant of the Z'-model called the Z"-model which excludes S/TA.

We apply all three models described above to a sample of distressed firms and to a sample of non-distressed firms in the Sri Lankan stock market.

Data and Methodology

We examine the firms listed in the Colombo Stock Exchange during the period 1986 to 1997 to identify a sample of distressed firms and a paired control sample of non-distressed firms. We include firms, which have been delisted due to liquidation, litigation or losses as well as those with a negative net worth as distressed firms. This results in sample of 13 distressed companies from eight industry sectors. The industry sectors include trading, beverages food and tobacco, chemicals and pharmaceuticals, manufacturing, diversified, footwear and textiles, hotel and travels, and motors. Then, we match each distressed firm by another non-distressed firm in the same industry and similar size. This produces a matched paired sample of 13 firms. For each firm in the distressed sample, we compute the financial ratios that are used in determining the Z-Scores for each of the two years before distress. Then, the same financial ratios for the same years are computed for the control sample firms as well.

The test methodology involves computing the Z-Scores for both the distressed and non-distressed samples and then examining the accuracy in classifying the distressed firms as distressed and non-distressed firms as non-distressed. As a prelude to our tests, we also compute the means of each of the variables and test for the difference between the means of the variables between the two samples using the non-parametric paired t-test for related samples. This test has the ability to show the significance of the difference in means of variables between the two samples.

The classification involves placing each firm into three zones, namely safe, gray and distress, on the basis of the cut-off points for each zone provided by Altman (1993). The cut-off points for each of the three models are given in Table 2.

Results

Table 3 shows the mean values of variables using the financial statements in the year before distress. The means of variables in the distressed sample are vastly lower than the means in the non-distressed sample. The results of the paired t-test show that the mean differences in variables between the two groups are extremely significant. p-values for variables X_1, X_2, X_3, and X_{4*} are below 1% while the p-values for X_4 and X_5 are below 2% level of significance. Table 4 provides the mean values and the paired t-test results for the two groups using financials in two years prior to distress. We observe significant difference in means for X_3 at 1% and for X_{4*} and X_5 at 5% level. Other variables are significant at 10% level. The means in the distressed sample are lower than those in the non-distressed sample. Overall these tests provide convincing evidence that on a univariate basis the specified variables are able to discriminate between distressed and non-distressed firms using financial statements prior to distress.

The classification results using the prior-year financials are given in Table 5. Using the prior year variables, the Z-Score classifies 90% of the distressed firms and 60% of the non-distressed firm accurately. The Z'-Score and Z"-Score do a slightly better job of classifying the distressed firms correctly in that their success rate is 92% for distressed firms. Z"-model, which uses the book value based asset cushion and excludes the industry-sensitive asset turnover ratio, seems to be the best model for non-distressed firms with a level of accuracy of 69%. The overall classification accuracy of the Z"-model is 81% and it is found to be the best model to predict the financial distress of Sri Lankan firms.

When we use ratios based on the financials of two consecutive years before distress, the classification accuracy declines dramatically for distressed firms (see Table 6). The highest success rate for that group is 64%, once again using the Z"-model. Interestingly, the success rate of the non-distressed sample increases in each of the three models, and the highest accuracy of 73% is found using the Z''-model. However, the overall classification accuracy using the financials of two consecutive years prior to distress is less strong.

Conclusion

This study investigates the ability of three versions of Altman's Z-Score model (Z, Z', and Z") of distress prediction developed in the U.S. to predict the corporate distress in the emerging market of Sri Lanka. The results show that these models have a remarkable degree of accuracy in predicting distress using financial ratios computed from financial statements in the year prior to distress. The overall success rate of 81% is observed using the Z"-Score. Not surprisingly, the classification accuracy declines when the financials in the two consecutive years prior to distress is used. The out-of-sample evidence provided in this paper means that the Z-Score models seem to have a very good potential in evaluating the risk of corporate distress in smaller emerging markets as well.

Table 1
Market Statistics

This table shows the market statistics of the Colombo Stock Exchange (CSE) during from 1990 to 1997. The market cap is the local-currency value of the year-end market capitalization converted by the year-end exchange rate. Turnover is the sum of the local currency value of annual turnover converted using the year-end exchange rate. GDP is the gross domestic product at current local currency market prices converted using the year-end exchange rate. Local currency market return represents the change in the All Share Price Index of the CSE. Currency return is the rate of depreciation (-) or appreciation (+) of the value of the rupee with respect to the U.S. dollar. USD market return reflects the annual return to a U.S. investor after adjusting the local currency return for currency return. Number of listed firms is as of the end of the year.

Year	Market Cap (USD Mn.)[1]	Turnover (USD Mn.)	GDP (USD Mn.)[2]	Turnover/ Market Cap (%)	Market Cap/ GDP (%)	Market Return (%) (Local Currency)	Currency Return (%)	Market Return (%) (USD)	No. of Listed Firms[1]
1990	916	39	7,997	4.2	11.5	114.2	-0.6	112.9	175
1991	1,974	134	8,983	6.8	22.0	118.0	-2.9	111.6	178
1,992	1,486	138	9,546	9.3	15.6	-27.8	-7.0	-32.8	190
1993	2,572	459	10,354	17.8	24.8	61.7	-7.7	49.3	201
1994	2,893	695	11,659	24.0	24.8	0.8	-2.9	-2.1	215
1995	2,003	211	12,512	10.5	16.0	-32.7	-6.9	-37.4	226
1996	1,841	131	13,571	7.1	13.6	-9.2	-5.7	-14.3	235
1997	2,101	297	14,452	14.2	14.5	16.5	-8.1	7.0	239

1. Annual Reports of the Colombo Stock Exchange, 2. Annual Reports of the Central Bank of Sri Lanka.

Table 2
Classification Cut-off Points

Zone	Model		
	Z	Z'	Z"
Safe	>2.99	>2.90	>2.60
Gray	1.80 – 2.99	1.23 – 2.90	1.10 – 2.60
Distress	<1.80	<1.23	<1.10

Source: Altman (1963)

Table 3
Mean Values of Variables in the Year before Distress (t-1)

Variable	Distressed Group Mean %	Non-Distressed Group Mean %	t	p-value
X_1	-21.3	21.3	3.79	0.0026
X_2	-30.6	2.7	3.15	0.0083
X_3	-8.0	15.2	3.91	0.0021
X_4	49.4	134.7	2.97	0.0158
X_{4*}	24.6	127.6	4.22	0.0012
X_5	73.8	130.5	3.05	0.0111

Table 4
Mean Values of Variables in two Years before Distress (t-2)

Variable	Distressed Group Mean %	Non-Distressed Group Mean %	t	p-value
X_1	3.9	24.5	1.92	0.0840
X_2	-6.7	1.9	1.92	0.0841
X_3	0.8	17.7	4.50	0.0011
X_4	89.7	187.4	2.26	0.0540
X_{4*}	55.3	155.6	2.62	0.0255
X_5	88.9	143.1	2.80	0.0206

Table 5
Classification results Previous Year's Financials (t-1)

Sample	Z		Z'		Z"	
	% Correct	% Error	% Correct	% Error	% Correct	% Error
Distressed	90	10	92	8	92	8
Non-Distressed	60	40	33	67	69	31
Total	75	25	63	37	81	19

Table 6
Classification results from Financials two Years Before (t-2)

Sample	Z		Z'		Z"	
	% Correct	% Error	% Correct	% Error	% Correct	% Error
Distressed	63	37	60	40	64	36
Non-Distressed	63	37	50	50	73	27
Total	63	37	55	45	68	32

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