Z-Score Analysis - A Tool to Predict Financial Health

Dr. Sunil Kumar*
Prof. Pradeep Aggarwal**
Dr. M.K.Gupta***
Dr. Shruti Nagar****

ABSTRACT

This paper analyses whether Altman Z-score models, can predict correctly company failures. The empirical analysis examines all listed in the National Stock Exchange companies, during the period 2003-2009 and discontinuations of operation for these companies during the same period. It is investigated whether Z-score models can predict bankruptcies for a period up to three years earlier. Our study shows that Altman model performs well in predicting failures. This is in line with other findings. The empirical results are interesting since they can be used by company management for financing decisions, by regulatory authorities and by portfolio managers in stock selection.

KEY WORDS : Valuation, Altman, Regulation, Share price, Capital markets, bankruptcy

INTRODUCTION

In the study it is examined whether Z-score alone can predict business failure for the examined companies in the examined period. To examine this it is investigated whether Z-scores one up to four years before bankruptcy can predict business failures or financial problems. The study is interesting for financial analysts and portfolio managers given that in the case that discriminant analysis is useful, they can use it for stock picking and asset allocation. Discriminant analysis can also be a valuable tool for investors. Companies with high probabilities to bankrupt should trade at a discount to their value. If this is correct, then this paper provides an interesting contribution to bankruptcy literature, by linking Z-score with business failure prediction and asset allocation in India.

Objectives of the Study

The objectives of the study are as follows:

- To examine the overall financial performance of companies selected for the study.
- To predict the financial health and viability of companies selected for the study.

Review of literature

Multivariate prediction of bankruptcy as established by using univariate analysis of bankruptcy predictors were initially developed by Beaver (1967, 1968) who found that a number of indicators could discriminate between matched samples of failed and non-failed firms for as long as five years prior to failure. Altman (1968) defines five predicted factors and sets the base for other researchers to examine the validity of multivariate models. Following to the Beaver and Altman research seems to verify the validity of Altman models, but their prediction ability is found gradually lower. Begley et.al (1996) examines the Altman Z-model and concludes that the model performs better in US data during the 1980s than during the period 1990-1995. Similar are the findings of Grice and Ingram (2001), who also find better performance for manufacturing companies. One of the classic works in the area of ratio analysis and bankruptcy classification was performed by Beaver (1967). Beaver found that a number of indicators could discriminate between matched samples of failed and non-failed firms for as long as five years prior to failure. He questioned the use of multivariate analysis, although a discussant recommended attempting this procedure. The Z- score model did just that. A subsequent study by Deakin (1972) utilized the same 14 variables that Beaver analyzed, but he applied them within a series of multivariate discriminant models. The aforementioned studies imply a definite potential of ratios as predictors of bankruptcy. In general, ratios measuring profitability, liquidity, and solvency prevailed as the most significant indicatorsIn almost every case, the methodology was essentially univariate in nature and emphasis was placed on individual signals of impending problems. Ratio analysis presented in this fashion is susceptible to faulty interpretation and is

* Faculty, SOMS, IGNOU, Maidangarhi, New Delhi-110068. (m) 9891693917 ** Deptt. of Management Studies, IILM, NOIDA. (m) 9716103478
*** Deptt. of Commerce, JLN College, Faridabad.(m) 9818634845 ****Faculty, Deptt. of Management Studies, IMS, Dehradun.

potentially confusing. For instance, a firm with a poor profitability and/or solvency record may be regarded as a potential bankrupt. However, because of its above average liquidity, the situation may not be considered serious. The potential ambiguity as to the relative performance of several firms is clearly evident. The crux of the shortcomings inherent in any univariate analysis lies therein. An appropriate extension of the previously cited studies, therefore, is to build upon their findings and to combine several measures into a meaningful predictive model. In so doing, the highlights of ratio analysis as an analytical technique will be emphasized rather than downgraded. The questions are (1) which ratios are most important in detecting bankruptcy potential, (2) what weights should be attached to those selected ratios, and (3) how should the weights be objectively established.

In order to test the credit risk of the construction companies in India, two Z-score models are examined, in particular the Z-score models developed in Altman (1993). The financial data used are annual and cover the period of 1999-2006. To compute the market value used, we take the market value of the company on 31 December of each year. The prices were taken by EFFECT S.A. database and we use the National Stock Exchange daily report to identify when the company share price was suspended. From the sample companies that were listed for less than three years were excluded, and companies that merged. The examined cases of companies that bankrupted or their shares were suspended permanently are the following (Table 1).

Research Methodology and Variable Selection

After the initial groups are defined and firms selected, balance sheet and income statement data are collected. Because of the large number of variables found to be significant indicators of corporate problems in past studies, a list of 22 potentially helpful variables (ratios) was complied for evaluation. The variables are classified into five standard ratio categories, including liquidity, profitability, leverage, solvency, and activity.. The Beaver study (1967) concluded that the cash flow to debt ratio was the best single ratio predictor. This ratio was not considered in my 1968 study because of the lack of consistent and precise depreciation and cash flow data. The results obtained, however, were still superior to the results Beaver attained with his single best ratio. Cash flow measures were included in the ZETA model tests (see later discussion). From the original list of 22 variables, five are selected as doing the best overall job together in the prediction of corporate bankruptcy. The contribution of the entire profile is evaluated and, since this process is essentially iterative, there is no claim regarding the optimality of the resulting discriminant function. The function, however, does the best job among the alternatives which include numerous computer runs analyzing different ratio profiles. In order to arrive at a final profile of variables, the following procedures are utilized: (1) observation of the statistical significance of various alternative functions, including determination of the relative contributions of each independent variable; (2) evaluation of intercorrelations among the relevant variables; (3) observation of the predictive accuracy of the various profiles; and (4) judgment of the analyst.

The final discriminant function is as follows:

$$Z = 0.012X1 + 0.014X2 + 0.033X3 + 0.006X4 + 1.0X5$$

Where

X1 = working capital/ total assets,

X2 = retained earnings/ total assets,

X3 = earnings before interest and taxes/ total assets,

X4 = market value equity/ book value of total liabilities,

X5 = sales/ total assets, and

Z = overall index.

Note that the model does not contain a constant (Y-intercept) term. This is due to the particular software utilized and, as a result, the relevant cut-off score between the two groups is not zero. Other software program, like SAS and SPSS, have a constant term, which standardizes the cut off score at zero if the sample sizes of the two groups are equal.

X1, Working Capital/Total Assets (WC/TA).

The working capital/ total assets ratio, frequently found in studies of corporate problems, is a measure of the net liquid assets of the firm relative to the total capitalization. Working capital is defined as the difference between current assets and current liabilities. Liquidity and size characteristics are explicitly considered. Ordinarily, a firm experiencing consistent operating losses will have shrinking current assets in relation to total assets. Of the three liquidity ratios evaluated, this one proved to be the most valuable. Two other liquidity ratios tested were the current ratio and the quick ratio. There were found to be less helpful and subject to perverse trends for some failing firms.

X2, Retained Earnings/Total Assets (RE/TA).

Retained earnings are the account which reports the total amount of reinvested earnings and/or losses of a firm over its entire life. This measure of cumulative profitability over time is what I referred to earlier as a "new" ratio. The age of a firm is implicitly considered in this ratio. For example, a relatively young firm will probably show a low RE/TA ratio because it has not had time to build up its cumulative profits. Therefore, it may be argued that the young firm is somewhat discriminated against in this analysis, and its chance of being classified as bankrupt is relatively higher than that of another older firm, ceteris paribus. But, this is precisely the situation in the real world. The incidence of failure is much higher in a firm's earlier years. In 1993, approximately 50% of all firms that failed did so in the first five years of their existence (Dun & Bradstreet, 1994). In addition, the RE/TA ratio measures the leverage of a firm. Those firms with high RE, relative to TA, have financed their assets through retention of profits and have not utilized as much debt.

X3, Earnings Before Interest and Taxes/Total Assets (EBIT/TA).

This ratio is a measure of the true productivity of the firm's assets, independent of any tax or leverage factors. Since a firm's ultimate existence is based on the earning power of its assets, this ratio appears to be particularly appropriate for studies dealing with corporate failure. Furthermore, insolvency in a bankrupt sense occurs when the total liabilities exceed a fair valuation of the firm's assets with value determined by the earning power of the assets. As we will show, this ratio continually outperforms other profitability measures, including cash flow.

X4, Market Value of Equity/Book Value of Total Liabilities (MVE/TL).

Equity is measured by the combined market value of all shares of stock, preferred and common, while liabilities include both current and long term. The measure shows how much the firm's assets can decline in value (measured by market value of equity plus debt) before the liabilities exceed the assets and the firm becomes insolvent. The reciprocal of X4 is a slightly modified version of one of the variables used effectively by Fisher (1959) in a study of corporate bond yield-spread differentials. It also appears to be a more effective predictor of bankruptcy than a similar, more commonly used ratio; net worth/ total debt (book values). At a later point, we will substitute the book value of net worth for the market value in order to derive a discriminant function for privately held firms (Z') and for non-manufacturers (Z"). More recent models, such as the KMV approach, are essentially based on the market value of equity and its volatility. The equity market value serves as a proxy for the firm's asset values.

X5, Sales/Total Assets (S/TA).

The capital-turnover ratio is a standard financial ratio illustrating the sales generating ability of the firm's assets. This final ratio is quite important because it is the least significant ratio on an individual basis. In fact, based on the univariate statistical significance test, it would not have appeared at all. Still, there is a wide variation among industries in asset turnover, and we will specify an alternative model (Z"), without X5 at a later point.

Table 1: Companies that their shares were suspended permanently or get bankrupt

Industry	Sector
Reliance Industries	Oil & Gas, Petrochemicals
Oil and Natural Gas Corporation	Oil & Gas Operations
State Bank of India	Banking
Indian Oil Corporation	Oil & Gas Operations
ICICI Bank	Banking
NTPC	Electricity generation
Steel Authority of India Limited	Steel
Tata Steel	Steel
Bharti	Telecommunications Services
Reliance Communications	Telecommunications Services
Tata Consultancy Svcs	Software & Services
HDFC	Banking
Larsen & Toubro	Capital Goods
Bharat Petroleum	Oil & Gas Operations
Bharat Heavy Electricals	Capital Goods
Infosys Technologies	Software & Services
HDFC Bank	Banking
Wipro	Software & Services
Tata Motors	Capital Goods
Hindustan Petroleum	Oil & Gas Operations
NMDC	Materials
ITC Limited	Food Drink & Tobacco
Punjab National Bank	Banking
DLF Universal Limited	Diversified Financials
Hindalco Industries	Materials
GAIL	Utilities
Canara Bank	Banking
Axis Bank	Banking
Bank of India	Banking
Power Grid Corporation of India	Utilities
Bank of Baroda	Banking
National Aluminium Company	Materials
Unitech Group	Construction
Grasim Industries	Construction
Reliance Power	Utilities
Indian Overseas Bank	Banking
IDBI Bank	Banking
Power Finance Corporation	Business Services & Supplies
Union Bank of India	Banking
Mahindra Satyam	Software & Services
Central Bank of India	Banking
Syndicate Bank	Banking
Mahindra & Mahindra	Consumer Durables

The numbers of companies that get bankrupted and/or their shares were suspended permanently are the following (Table 2). Companies belonging in the financial sector (banks, investment companies) were excluded.

Table 2: Number of Companies that get bankrupt and/or their shares were suspended permanently

Year	No of Companies
2005	12
2006	9
2007	9
2008	4
2009	10
Total	**44**

Examined Model

The most well-known quantitative model for predicting bankruptcy is Altman's Z-score, which was developed in 1968 by Edward I. Altman, professor at Stern School of Business. The Z-score is a set of financial ratios in a multivariate context, based on a multiple discriminated model, for the firms where a single measure is unlikely to predict the complexity of their decision making or the scope of their entire activities. Altman examined a list of twenty two possible ratios, and finally has chosen five that had the best results when they were applied together were selected after numerous tests for the discriminant function. Altman defined a "grey area" which is between 1.81 and 2.99. Firms, with z-scores within this range, are considered uncertain about credit risk and considered marginal cases to be watched with attention. Firms with Z scores below 1.81 indicate failed firms. Although, the cut-off point was set at 2.675, Altman advocates using the lower bound of the zone-of-ignorance (1.81) as a more realistic cut-off Z-Score. So if $Z < 1.81$, then the company has a high probability of default. On the other hand, the company is solvent, meaning that it is financial healthy. Some credit analysts,. private underwriting agents, financial analysts, auditors and firms themselves were concerned that since the original model requires stock price data (X5), it was only applicable to publicly traded entities.

Results

The validity of the model is tested by examining the percentage of cases that fall within the predictable range of companies. For example, bankrupted companies must fall within the price range that is expected to be for these companies (e.g. smaller than 1.8), while non-bankrupted companies must fall within the price range that is expected to be for those companies. Cases not predicted correctly are defined as Type 2 error cases. Our results show some support for Altman model.

Findings

Examining the Altman (1993) model we find out that it can predict the majority of companies that will get bankrupt, even when the z-scores of these companies are computed up to six (2) years earlier.

Success rate for failed companies varies from 66% (year -1) and gradually diminishes to 52%, 39% and 20% for year -2, -3 and -4 respectively. Therefore, z-score gives a good indication of problems, at least one year before the company will exhibit financial problems. However, the model performs poorly when prediction time horizon increases. Data for non-bankrupted companies are illustrated on the following table.

The model gives a good indication for companies that will not face problems even in longer span time-horizons. The model has been successful in classifying the majority of non-bankrupted companies in all the examined periods (-1, -2, -3 and -4 years). In particular, 78% of companies are correctly classified for the long times span (4 years) a percentage that gradually diminishes to 54% for a year time span. Overall the model succeeds to identify bankrupted and non-bankrupted companies. Aggregated data are illustrated on the following table.

The model succeeds to identify bankrupted and non-bankrupted companies by 57%-69% depending on the time horizon examined (1-4 years). It is noted that the model takes account of market values. The ability of the

Table 3: Altman Z score prediction statistics, Bankrupted Companies Bankrupted Companies

Year	All	Correctly Classified	Type 2 error	% correct
-4	44	9	35	20%
-3	44	17	27	39%
-2	44	23	21	52%
-1	44	29	15	66%

model to take account of market values, together with redefined beta factors, seems to give it an additional strength. However, the model also has weaknesses, main being its volatile results.

Volatility of Z-scores

The estimated Z-factors vary over time. Z-scores appear higher during bullish markets, while they appear lower during bearish years. As seen on the following graph, average z-scores of both failed and non-failed companies are high in 1999, and then they gradually decrease, to reach by 2005 the lowest levels.

Table 4: Altman Z score prediction statistics, Non Bankrupted Companies
Non Bankrupted Companies

Year	All	Correctly Classified	Type 2 error	% correct
-4	244	190	54	78%
-3	215	149	66	69%
-2	193	121	72	63%
-1	168	91	77	54%

Percentage of Companies below Cut-Off Point

Our results may indicate that bullish markets give even to financially distressed company the ability to survive. It is evidently correct, according to our opinion, since during bullish markets, financially distressed companies can raise capital easier, something that gives them the ability to cover their need in capital for the next 1-2 years. However, as these companies do not generate positive operating cash flows, the capital raised is not a panacea, so financial problems appear again whenever the macroeconomic conditions are bad and the companies can not raise capital. It seems, therefore, that the ability of companies to raise capital does not improve significantly their financial prospects. If companies have the ability to improve their financial position during good years in capital markets, while

Table 5: Altman Z score prediction statistics, All Companies
All Cases

Year	All	Correctly Classified	Type 2 error	% correct
-4	288	199	89	69%
-3	259	166	93	64%
-2	237	144	93	61%
-1	212	120	92	57%

being unable to improve them in the long run, then Altman z-scores are useful tool for the company management, either to proceed in company restructuring, or to proceed to a merger with other companies. At the same time, if Altman z-scores tend to return to historically low levels over a business cycle (6-10 years), then good financial and market years should provide the opportunity to portfolio managers to decrease their position in companies they identify to have low Altman z-scores.

Conclusion

Nearly 15% of the listed companies bankrupt or the trading of their shares was suspended during the examined period. This high percentage of failure makes the investigation and prediction of company failures a useful tool for both financial managers and analysts, since the ability to predict these failures is valuable. For this scope in this paper it is examined whether Z-score model, developed by Altman 1993 can predict bankruptcies. We find evidence that this model is useful in identifying financially troubled companies that may fail up to 2 years before the bankruptcy. The model is useful, probably because it matches both accounting data and market value. Overall model success rate is not statistical significant, but when it comes to failure cases it can predict 54% of them one year before failure. The predictive ability of Altman model is in line with findings by other researchers in India and in the United States. Altman Z-score that are affected by market price of shares, well before the company will declare bankruptcy. In other words, analysts' recommendations, as well as market rumours, that affect the company price may explain why Altman model is more useful than mere traditional financial analysis. The empirical results are interesting for both

portfolio managers and company management. If companies have the ability to improve their financial position during good years in capital markets, while being unable to improve them in the long run, then Altman Z-scores are useful indication to the company management to proceed to a merger with other companies, so as to preserve the company value.

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