FINANCIAL DISTRESS PREDICTION IN TANZANIA: SUITABILITY OF DISCRIMINANT ANALYSIS MODEL

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Abstract

"Any early warning signal of probable failure will enable both management and investors to take preventive measures; operating policy change, reorganisation of financial structure, and even voluntary liquidation will shorten the length of time losses are incurred and thereby improve both private and social resource allocation" [1]

INTRODUCTION

Definition of Financial Distress

Distress is a state of danger or necessity. Financial distress is therefore a state of severe liquidity problems that cannot be resolved without a sizeable rescaling of the entity's Operations or structures [2]. Many Studies have been done to seek objective criteria to categorise firms (as either financially distressed or non-financially distressed). Most studies seem to use filing for bankruptcy as the criterion "Since this event is a legal one that can be heavily influenced by the actions of bankers or other creditors"[3]. Beaver[4] in his univariate model (1960) classified a firm as failed if one of the following events occurred in the 1954 - 1964 research period:-

1. Bankruptcy
2. Bond default
3. An overdrawn bank account
4. Non-payment of a preferred stock divide

Deakin [5] in his research defined a firm as failed if it experienced bankruptcy, insolvency, or was otherwise liquidated for the benefit of creditors during the 1964-1970 research period. Research by pinches and Trieschmann [6] defined a firm as insolvent if it experienced involuntary receivership, rehabilitation, conservatorship, or liquidation.

In Tanzania, operationalising financial distress was much more difficult because most business organisations, especially those which are state owned, did not file for bankruptcy. They continue to get support from the Government in the form of subsidies, grants, loans or in the form of additional equity. In this case, classifying firms on the basis of filing for bankruptcy was not feasible. With the introduction of market based economy the trend has changed. We now see many firms being declared bankrupt and many companies liquidated or placed under receivership. The researcher feels that since liquidity is the ability to realise value in money (the most liquidity of assets), working capital or net current assets which is the measure of the liquidity position of the firm should also be considered to be a reasonable criterion for categorising firms in Tanzania. Obviously, a firm with a negative net current assets must be in financial problems. A firm which cannot pay its short term maturing obligations when called upon is said to be technically insolvent.

CAUSES OF FINANCIAL DISTRESS

Causes of Financial distress were discussed by the writer in his article "Application of Financial Ratios in prediction of Business performance:- The IFM Journal of Finance and Management Vol. 3 Number 1 July, 1994". These were

identified by Argenti to include [7]:

Internal factors

Bad Management manifested through:

(a) Lack of responsiveness to change in technology
(b) Bad communication
(c) Fraud
(d) Insufficient consideration for costs factors (research and development costs in particular)
(e) Poor knowledge of financial matters
(f) High leverage position - particularly harmful in an economic downturn.

External factors

(a) Labour unions
Too high wages causing the firm to pay its employees in excess of their marginal product.
(b) Government regulations which impede, in some instances, the functioning of the markets system distorting in the process its signals to the corporate decision makers.
(c) Natural causes:
Natural disasters, demographic charges etc.

Altman [8] was the first person to carry out analytical studies on the general macroeconomic causes of corporate failure. At that time failure was significantly linked to the following:

(1) Prevailing monetary policy: A tight monetary policy increases the probability of failure.
(2) The investors expectations (as measured by the change in standard and poor's index of common stock) about the economic conditions (the more negative the expectations the more likely failures are to occur).
(3) The state of the economy. At the micro level, Altman found that the age of the firm has a significant impact on its chance of failure.

In Tanzania, Rwegasira [9] carried out a study and empirically established that the principal causes of more than 90% of small and medium sized past business failures boil down to some combination of a few key financial variables namely:

1. Faltering cash - flows from operations
2. The debt overburden
3. The volatility of the cash-flows.

This study was carried out using the "index of credit strength" (ICS) derived from a model of financially ailing firm and occasionally supplemented by the use of financial ratio analysis.

The index of credit strength model (ICS) was defined as follows:

$$ICS = \frac{X}{D}\frac{X}{\sigma}$$

where X = cash flows from operations
D = short-term Debt
ó = standard deviation of X

DISCRIMINANT ANALYSIS

Discriminant analysis is a statistical technique used for the prediction or qualitative classification of variables. It involves deriving the linear combination of two (or more) independent variables that will discriminate best between the pre-defined groups. The technique works under a number of assumptions as follows [10]:

1. Multi variate normality of the distributions and unknown (but equal) dispersion and covariance structures for the groups but the means of the variables in each group are different.
2. Equal costs of misclassification, equal a priori group probabilities, and known dispersion and covariation structures. This assumption is made when classification accuracies are determined.

Discriminant models were developed from univariate models of predicting financial distress which involve the use of a single variable in the model. The univariate model works under the following assumptions [11].

1. The distribution of the variables for the distressed firms differs systematically from thedistribution of the variable for the non-distressed firms.
2. This systematic distribution difference can be exploited for the prediction purposes.

Discriminant analysis is capable of handling either two groups or multiple groups (three or more). When two classifications are involved, the technique is referred to as two-group discriminant analysis. When three or more classifications are identified, the technique is referred to as "multiple discriminant analysis (MDA)" [12].

When this technique is applied, the subjects being analysed are first classified into a priori qualitative classes. Data are then collected for independent variable which seem relevant for predicting the classes to which each subject belongs. Discriminant analysis technique is then applied to determine, from past data "a linear combination of the independent variables that best discriminates between the qualitative classes" [13] The discriminant function developed takes the form:

$$Z_i = W_1 X_1 + W_2 X_2 + X_3 W_3 = W_i X_I = + — + W_n X_n$$

Where:
Z = the discriminant score
W_i = the discriminant weight or coefficient
X_i = the independent predictor variable
i = 1, 2, 3, ...n.

Thus, discriminant analysis transforms the independent variables into a single discriminate score. According to Foster [14], the coefficients of a two groups two-variables discriminant function are calculated as follows:

$$a = \frac{\sigma_y^2 d_x - \sigma_{xy} d_y}{\sigma_x^2 \sigma_y^2 - \sigma_{xy} \sigma_{xy}}$$

$$b = \frac{\sigma_x^2 d_y - \sigma_{xy} d_x}{\sigma_x^2 \sigma_y^2 - \sigma_{xy} \sigma_{xy}}$$

where:

$\delta^2 y$ = variance of Y_i
δ_x^2 = variance of X_i
δ_{xy} = covariance of X_i with Y_i
d_x = difference between the mean X_i for group 1 and the mean X_i for group 2
d_y = difference between the mean Y_i for group 1 and the mean Yi for group 2 and X_i and Yi are the independent variables.
i = (1, 2, ...n)

$$\delta^2_x = \frac{1\Sigma (Xi - X)^2}{N-1}$$

$$\delta^2_y = \frac{1\Sigma (Yi - Y)^2}{N-1}$$

$$\delta_{xy} = \frac{1\Sigma (Xi - X)\ (Yi - Y)}{N-1}$$

Where:
N = Total number of observations.

The application and interpretation of discriminant analysis is similar to regression analysis. Both use a linear combination of metric measurements for two or more independent variables to describe or predict the behaviour of a single dependent variable. The key difference is that in discriminant analysis observations come from different populations and that the technique is appropriate for research problems in which the dependent variable is categorical (nominal or non metric) whereas in regression the dependent variable is metric.

Discriminant analysis can also be compared with Analysis of Variance (ANOVA) in that while in discriminant analysis the single independent variable is categorical and the independent variables are metric, ANOVA involves metric dependent variables and a single categorical independent variable.

The objectives for applying discriminant analysis includes [15]:

1. Determining if statistically significant difference exist between the average score profiles of the two (or more) a priori defined groups.
2. Establishing procedures for classifying

statistical units (individuals or objects) into groups on the basis of their scores on several variables.

3. Determine which of the independent variables account most for the differences in the average scores profiles of the two or more groups.

The application of discriminant analysis can be divided into three major stages [16].

Derivation

This stage involves determining whether or not a statistically significant function can be derived to separate the two (or more) groups.

This stage consists of the following steps:

(a) Variable Selection

Specification has to be made on which variables are to be independent and which are to be dependent and decision on which should be included in the analysis.

(b) Sample Selection

Since when applying discriminant analysis the analyst wants to test the validity of the discriminant function that has been developed, the most popular procedure involves developing the discriminant function on one group and then testing it on a second group. This eliminate the upward bias in the prediction accuracy of the discriminant function [17].

(c) Computation method

In deriving a discriminant function two computational methods can be utilised [18].

(i) the simultaneous method which involves computingthe discriminant function so that all the independent variable are considered concurrently.

(ii) the step wise method involves entering the independent variables into the discriminant function one at a time.

(d) Statistical significance

After the discriminant function has been computed, its level of significance must be assessed. The conventional criterion is .05 or beyond.

Validation

This stage involves developing a classification matrix to evaluate further the predictive accuracy of the discriminant function. A test is used to determine the level of significance for the classification accuracy. If the percentage of correct classification is significantly larger than would be expected by chance, an attempt can be made to interpret the discriminant functions in the hope of developing group profiles. Otherwise no need for interpretation is required.

Interpretation

This stage involves determining which of the independent variables contribute the most to discriminating between groups. The process of interpretation involves examining the discriminant functions to determine the relative importance of each independent variable using standardised discriminant weights or discriminant structure correlations or partial F-values. Interpretation also involves examining the group means for each important variable to profile the differences in the groups.

DEVELOPMENT DISCRIMINANT ANALYSIS MODEL

Walter [19] in his classic article explored a priori link between ratios and the probability of failure. He developed a cash flow model of the firm and demonstrated what elements in that model influence the solvency of the firm.

A slight extension of this analysis can show that may ratios are directly related to the probability of business failure. According to Johnson [20], the properties and characteristics of financial ratios started receiving considerable attention in the 1960's and 1970's with interest primarily focused on determining the predictive ability of financial data. The principal areas cited included the prediction of corporate bond ratings

and the anticipation of financial impairment. A lot of studies have been made in these areas with specific emphasis to the following:-

1. Characteristics of merger firms
2. The difference in financial ratio averages among industries.
3. The relationship between accounting determined and market determined risk measures.
4. Whether firms seek to adjust their financial ratios towards industry averages.
5. The influence of financial ratios on analysts judgement about impending bankruptcy.

Most researchers concluded from the above studies that a number of financial ratios have predictive and descriptive utility when properly employed. It is no wonder, therefore, that most analytical research on failing firms uses ratio analysis as its foundation.

Beaver [21] was among the first to use financial ratios to predict corporate failure. He found overwhelming evidence of difference in the ratios of failed and non failed firms. To test the predictive power of ratios, Beaver used a dichotomous classification technique and found the cash flow to total debt and net income to total assets ratios to be the best predictors of failure five years preceding failure.

Harrigan [22] investigated the ability of ratios to predict bond ratings changes and bond ratings on new issues, where bond ratings is viewed as a surrogate for the probability of default. He found that ratios could correctly predict to a much greater extent than would be possible through random prediction.

There are many financial ratios and other variables examined in distress predictions studies published over the years. Zmijewski [23] classified 75 of these into ten categories and the results of his analysis show that the following four categories of variables show the most consistent difference between bankrupt and non-bankrupt firms.

1. Rate of return - bankrupt firms were less profitable
2. Financial - leverage bankrupt firms were highly leveraged.
3. Fixed payments coverage - bankrupt firms had lower coverage of their fixed payment by their earnings or cash flow.
4. Stock return volatility - bankrupt firms had lower mean stock return and had high stock return variability.

Just like many other research studies, Zmijewski's results showed that the liquidity and activity/ turnover categories of variables showed limited differences between the bankrupt and non bankrupt firms. Significant micro analysis came with the usage of discriminant analysis applied to financial ratios in the prediction of corporate failure.

Altman improved on Beaver's univariate method of analysis by developing a multi ratio prediction model which allows for the simultaneous consideration of several variables in the prediction of financial distress [24]. He thus developed what is known as the "Multiple Discriminant Analysis (MDA)".

Altman's model exhibited excellent discriminatory power in the year before failure but showed marked deteriorations in the second through fifth years before failure. In a later study, Deakin directly compared the performance of the Beaver's univariate model and Altman's Multi variate model on the same set of data and found that the multi ratio model produced lower prediction errors [25]. Moyer later showed that the results of Altman's multiple discriminant analysis model were less suitable under condions different from those used by Altman [26]. He found that a model with the first three parameters in Altman's model explanatory power superior to Altman's. Moyer's results were confirmed by Williams and Picconi using an original sample and a hold out sample [27].

Altman [28] carried out another research and used multiple Discriminant Analysis once again. This time he used both linear and quadratic structures. He came up with new variables and explain financial distress.

This Altman's latest model predicated better than his earlier model. Dambolem and Khoury carried out a study on how to increase the stability of ratios and thereby increase the ability of the discriminant function to predict

failure [29]. The study showed that the degree of instability was substantial in the ratios of firms that went bankrupt when compared with those that did not. They, thus, developed a stability model on corporate failure that uses financial ratios and discriminant analysis as its core.

Zmijewski [30] carried out a study examining Multi variate models based on variables used in prior studies using a common statistical technique known as lobit or probit analysis which was originally developed by Ohlson [31]. He made analysis of how predictive ability varies with different assumptions as to the cost of type I errors (bankrupt predicated to be non bankrupt). Zmijewski's study results which are confirmed by many other studies (e.g. Hamer [32]) concluded that the classification performance of Multi variate models is not highly sensitive to the choice of the statistical technique. Other discriminant analysis studies were conducted by Blum [33], Wilcox [34], Pinches [35] and many others. Researchers still concede that discriminant analysis has the ability to predict corporate distress or failure inspite of the limitations inherent in the models.

In Tanzania, the ratios considered very important by bankers in short-term lending are [36]:

1. Current ratio
2. Quick ratio
3. Earnings/interest ratio
4. Debt/equity ratio
5. Net income/sales ratio

ABC CORPORATION

DEBT/EQUITY AND CURRENT RATIOS OF SELECTED COMPANIES

	Company	X_1 Debt/Equity Ratio	X_2 Current Ratio
	(a) Financially Distressed Firms		
1.	A	1.451	1.390
2.	B	0.746	0.813
3.	C	0.848	0.789
4.	D	1.048	0.520
5.	E	0.628	1.309
6.	F	1.682	1.910
7.	G	0.958	1.426
8.	H	0.090	1.000
	(b) Non-Financially Distressed Firms		
9.	I	0.059	1.310
10.	J	0.0	1.040
11.	K	0.0	1.260
12.	L	1.481	1.756
13.	M	0.0	2.194
14.	N	0.093	1.551
15.	O	0.0	1.628
16.	P	0.0	1.291

Source: *Calculated from the figures from the Annual Reports of ABC companies (1979 - 1989). The real names of companies are not hereby disclosed.*

Although none of these is consistently and empirically supported in the literature as an effective index of business failure or default, the writer find them appropriate in the Tanzanian environment. The reason behind their adoption is that they are the widely accepted and mostly used in Tanzania business cycles as indicators of liquidity and risk.

THE SUITABILITY OF THE MODEL IN TANZANIA

Since conventional ratios have been used quite often by a number of Financial analysts in Tanzania to predict the likelyhood of loan default or likehood of financial problems, the debt/equity ratio and current ratio (which are commonly used in Tanzania) were applied by the writer to analyse the companies falling under one of the biggest corporations in the country [37]. The discriminant function used in this analysis combined the information contained in the debt/equity and current ratios into a single multivariate prediction model. The independent variables were therefore the debt/equity ratio (X_1) and the current ratio (X_2) as presented in a table in the previous page.

Using the two variables in the table above the mean ratios were calculated to profile differences between financially distressed and non-financially distressed firms. It was found out that the mean debt/equity ratio of 0.931 for the financially distressed firms was higher than that of the non-financially distressed firms which was 0.204. Thus, a profile of the characteristics of these two groups shows that the distressed firms have higher debt burden than non-financially distressed firms. On the other hand, the mean current ratio of the financially distressed firms (1.145) was lower than the mean current ratio of non-financially distressed firms (1.504). This shows that the financially distressed firms have more liquidity problems than the non-financially distressed firms.

The independent variables (debt/equity ratio and current ratio) presented in the table above were used to calculate the discriminant coefficients and to formulate the discriminant function.

The discriminant function formulated was as follows:

$$Z_i = -0.99862X_1 + 0.81460X_2$$

where

Z_i = credit index (discriminant score)
X_1 = Debt/equity ratio
X_2 = current ratio
0.99862 = Discriminant coefficient for variable X_1
0.81460 = Discriminant coefficient for variable X_2

The discriminant coefficients are the standardised values produced by the statgraphis package.

The discriminant function indicates that the debt/equity ratio has negative correlation with the discriminant score while the current ratio has positive correlation with the discriminant score. Also the discriminant function indicates that the debt/equity ratio has a higher discriminant weight or coefficient (0.99862) than the current ratio (0.81460). This means that the debt/equity ratio contributes more to the discriminating power of the discriminant function.

The discriminant function developed above was then used to compute the Z_i - scores for the companies under the study. The results indicated that generally, financially distressed firms have negative Z_i - scores while the non-financially distressed firms have positive scores. This was inline with the higher contribution of the debt/equity ratio than the current ratio to the discriminant function.

The Z_i - scores were then used to calculate the mean (centroids) scores of the financially distressed and non-financially distressed firms to determine if there was any difference in the way the Z_i - scores of the two groups were distributed. Results indicated that the standardised mean scores of financially distressed firms was (-1.07971) while that of the non-financially distressed firms was (1.07971). This confirms that the financially distressed firms have lower scores than the non-financially distressed firms.

CONCLUDING REMARKS

Analysis of the financial performance of ABC group of companies had indicated that the following factors characterize the liquidity position of the firms:

(1) Eight companies were technically insolvent while the other eight companies were financially healthy during the ten year period of 1980 - 1989.

(2) The financially distressed firms had higher debt-burden (debt/equity) than the non-financially distressed firms.

(3) The financially distressed firms had more liquidity (current ratio) problems than the non-financially distressed firms.

(4) The mean debt/equity ratio of the financially distressed firms was higher than the mean debt/equity ratio of non-financially distressed firms.

(5) The mean current ratio of financially distressed firms was lower than the mean current ratio of non-financially distressed firms.

(6) The debt/equity ratio had negative correlation with the discriminant score.

(7) The current ratio had positive correlation with the discriminant score.

(8) The debt/equity ratio had higher discriminant weight (coefficient) than the current ratio. This means the debt/equity ratio contributed more to the discriminating power of the discriminant function than the current ratio.

(9) Financially distressed firms had lower Z_i - scores than the non-financially distressed firms. This was because of the influence of the debt/equity ratio.

(10) The standardised mean scores of the financially distressed firms was lower than the standardized mean scores of the non-financially distressed firms.

(11) The Z_i - scores discriminated better between the financially distressed firms than the debt/equity ratio and the current ratio used independently.

The hypotheses tested by the writer in the study were related to four issues listed below:

(a) The mean debt/equity ratios of financially distressed and non-financially distressed ABC corporation firms.

(b) The mean current ratios of financially distressed and non-financially distressed ABC firms.

(c) The discriminatory power of the debt/equity and current ratios.

(d) The discriminatory ability of the discriminant analysis.

The study came out with the following conclusions:-

(a) That the mean debt/equity ratio of financially distressed firms was higher than that of the non-financially distressed firms.

(b) That the mean current ratio of financially distressed firms was lower than the mean current ratio of non-financially distressed firms.

(c) That the debt/equity ratio contributed more to the discriminating ability of the discriminant function than the current ratio.

(d) That a linear combination of debt/equity and current ratios determined by discriminant analysis has the ability to predict financial distress in Tanzania. The limitations of study included the use of a relatively smaller sample (16 companies) than would otherwise be desirable (50-100 companies).

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