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PREDICTIVENESS OF CORPORATE FAILURE PREDICTION MODELS: A METHODOLOGICAL COMPARISON

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Supervisor

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DR. AZMI OMAR

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Abstract

This paper analyses the sensitiveness of the multiple discriminant analysis (MDA) to the normality of the predictor variables. Normality test is conducted to predictor variables used in the study and several transformation techniques are applied to the predictor variables to induced normality. Prediction functions are obtained for both the transformed and untransformed data and the results are compared. It is the requirement of the multiple discriminant analysis that the predictor variables are multivariate normal. Many earlier researchers have adopted MDA in their study but failed to test normality of the predictor variables.

For the purpose of comparison, another statistical tools of prediction are introduced in the study namely, the logistic regression techniques. This technique does not require multivariate normality of the predictor variables to obtain the prediction function. Similar methodology will be adopted with these techniques as it is with the MDA. The results are then compared whether one can outperform the other.

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CHAPTER 1

OVERVIEW

1.1 INTRODUCTION

Over the years, the corporate distress analysis has attracted a lot of attention from researchers due to the increasing number business failures especially during the economic crisis. There are various reasons given for the failure of the business from high economic cost related to high interest rates, recession or high gearing level which ultimately put the corporation in the most vulnerable state.

As such, for the past 40 years studies on the developing effective predictive corporate distress model have taken place. These models play important roles in providing early warning system to many interested parties. The ability to make predictions regarding potential distress by analyzing financial distress has always been important and will continue to remain so in the future. Bankers, for instance, have been relying on corporate distress prediction model as a tool for loan granting decisions. This is to avoid or minimized any potential loan default, as these incidents are extremely costly to them. Equity analysts may also find that these models are important as financial stability plays an integral part of investment decision making. Strategic planner also should find these models are particularly important to them where an early detection of corporate distress would allow them to formulate an effective action plan.

1.2 THE DEFINITION OF CORPORATE DISTRESS

There are various definitions of corporate distress or failure that have been used by researchers in their studies. Generally, corporate distress can be defined, as a situation in which there is insufficient income to recover cost of investment. In legal term, corporate distress is associated with the term "bankruptcy", "liquidation" or "receivership". In the past, there were inconsistencies among the researchers in defining or using the term financial distress, bankruptcy or failure. On various occasions, the term financial distress and bankruptcy have been used interchangeably in reference to corporate distress. Beaver (1966) used the term corporate failure to surrogate the term corporate distress. It defined failure as *the inability of a firm to pay its financial obligations as they mature. Operationally, a firm is said to have failed when any of the following events have occurred: bankruptcy, bond defaults, an overdrawn bank account or nonpayment of a preferred stock dividend.* Altman (1968) used the legal term bankruptcy in their research on failure prediction model. The definition covers the firms that are legally bankrupt, under receivership or those that have filed bankruptcy petition. In general, most of the early works concerning corporate distress have narrowly used the term's failure or bankruptcy that relate to the legal term of bankruptcy.

In more recent studies of corporate distress, however, a broader definition of corporate distress or corporate failure has been used. Pacey and Pham (1990) used the term failure to denote distress companies by which firms are considered fail upon the appointment of a receiver or liquidator to that firm either compulsorily by the court order or voluntarily by creditors. In broader terms Coats and Fants (1993) used the term financial distress in

their studies in reference to the firms that have been issued with a "going concern opinion" by the auditors and subsequently cease operation after such opinion. It includes firms that are acquired or merged, liquidated, privatized or other re-structuring exercises. The other broad definition of failure that are being used by various authors include the firms that experienced the following events: defaulting on the payment of principal or interest, suspending preferred stock dividends, bond defaults, nonpayment of creditors, negative net worth or overdrawn bank accounts.

Understanding the various definitions of corporate distress is important as these definitions affect the sample size used in the studies. Generally, the broader the definitions, the greater the sample size are. For instance, Altman (1968) which used a strict definition of bankruptcy relied on a sample size of 33 whereas the recent studies by Pacey and Pham (1990) which used the broader definition of corporate distress used a bigger sample size of 55.

1.3 CORPORATE DISTRESS IN MALAYSIA

In Malaysia, corporate collapse has become an issue during the economic crisis that currently hit the country. Prior to that, corporate failure was normally associated with private firm, small or newly set up businesses. Over the years, there were very limited numbers of bankruptcy in the public listed firms in Malaysia as the public listed that were bound to be in distress were normally merged, re-structured or bailed-out. This is especially true to the government-related companies due to the fact that some of these businesses are of national interest. The term corporate distress in Malaysia is associated

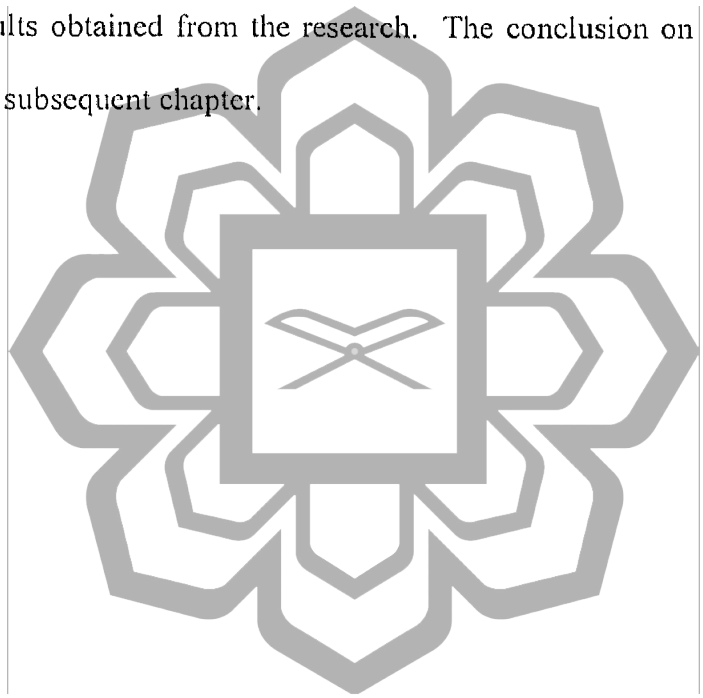
with companies that are under receivership, liquidation or those that cease operations. In Malaysia, there is provision in the Companies Act 1965 that allow companies to seek court protection from creditors in the event of default. Section 176 of the Companies Act 1965 provides for the refrain of further, continuing or intended actions and proceeding against a company for a period of six months. The protection is given for companies that have a re-structuring scheme or those companies that are still formulating the scheme. It is equivalent to Chapter 11 of the US National Bankruptcy Act. In the recent economic crisis, many public listed firms in Malaysia had sought such protection to avoid winding up order (*The Star*, August 26, 1998).

To my knowledge, there was only one study being done by Dr. Abdul Rahim Bidin (1988) to formulate financial distress prediction model. He employed multivariate approach to develop such model. This model, however, is not widely used by related parties as they are relying on the model developed by Altman (1968). In Malaysia, financial distress model is widely used by equity analysts as the tools for their analysis.

The objective of this study is to extend the study by Dr. Abdul Rahim Bidin to incorporate the requirements of the multiple discriminant analysis especially the requirement of normality of the predictor variables. It will analyze the sensitiveness of the MDA to the normality of the predictor variables. To induce normality of the predictor variables, several transformation techniques are applied to the predictor variables whereby the predictiveness of the predictor variables is compared. For the purpose of comparison, another statistical tool is introduced in the study namely, the

logistic regression technique as this technique does not require multivariate normality of predictor variables. The results of both techniques are then compared.

In this chapter, the concept of corporate distress is introduced whereby various definitions of corporate distress by earlier researchers were presented. Chapter 2 will review the main research papers in the area of corporate distress analysis. Chapter 3 will explain the data and research methodology used in this paper while Chapter 4 will analyze the results obtained from the research. The conclusion on the findings will be presented in the subsequent chapter.



CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

For the past 30 years, various literatures have emerged concerning the statistical models that are designed to predict any potential corporate distress or corporate failure. The univariate study by Beaver (1966) was the starting point for the development of the statistical techniques to predict the likelihood of corporate distress. Thereon, various studies have attempted to improve the predictiveness or the accuracy of such models using a further refined or more advanced statistical tools. The interest was very much induced by the strong interest by various parties on the potential benefit of such models for their business decision making.

Realizing the importance of corporate distress models to many parties, many studies have been done in developing these models or to improve the predictiveness of a model developed by early researchers. The early studies by Beaver (1966) marked a milestone in the corporate distress analysis as it initiated the use of financial ratios to predict bankruptcy. Thereon, substantial volume of bankruptcy prediction studies has been published while research interest has continued unabated.

In this chapter, various concepts of corporate distress by previous researchers will be introduced and how this definition shapes the sample size of the studies. This is followed by a review of relevant literature of financial distress categorized by methodological approaches of studies. It will analyze behavioral aspects of the studies and the shortfall of such studies. Summarizing issue relating the methodological approaches arising from the studies will conclude the chapter.

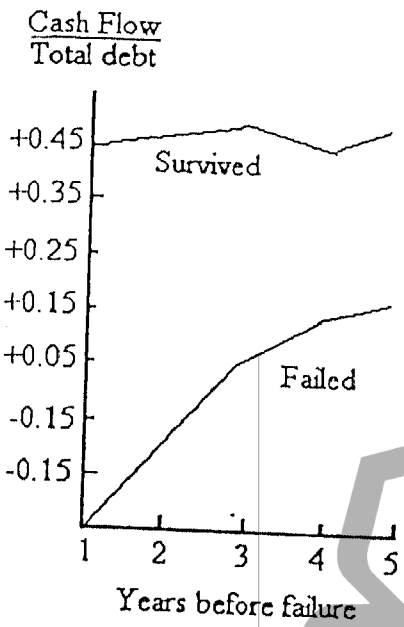
2.2 EARLIER STUDIES

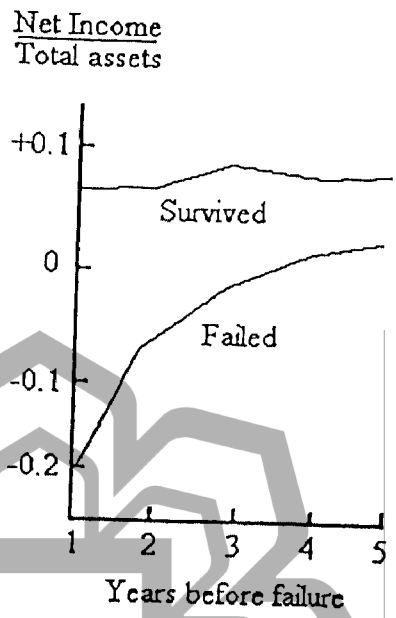
2.2.1 BEAVER (1966)

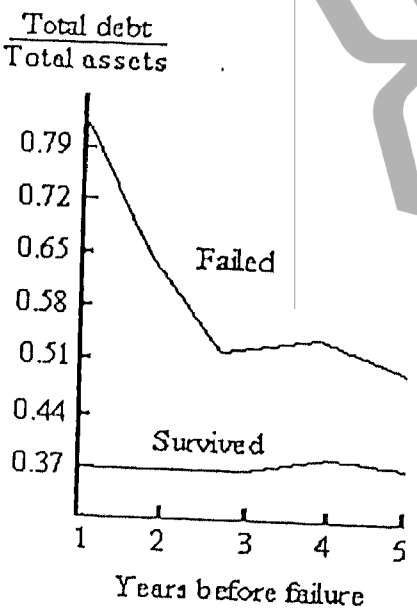
As one of the early researcher that used financial ratios to predict corporate failure, Beaver developed and tested a univariate distress prediction model in which the predictive ability of 30 financial ratios was analyzed on a one-by-one basis. Financial statements of 79 sample of industrial firms over 38 different were chosen for the period between 1954 to 1964. Beaver defined "failure" as the condition when any of the following events have occurred: bankruptcy, bond default, an overdrawn bank account or nonpayment of a preferred stock dividend. The sample that were classified according to the industry and asset size were then paired with an equal number of non-failed firms of the same industry and asset size. Data was collected up to 5 years before failure. This was to provide a control over factors that otherwise affect the relationship between ratios and failure. Beaver, however, noted that the shortcoming of a paired sample was that it masked the predictive power of the controlled variables, which may be important predictors of failure.

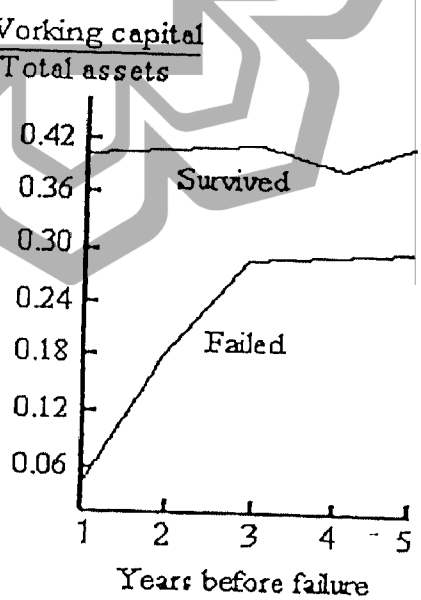
Thirty ratios were selected based on three criteria namely, the popularity of such ratios in the literature, the previous performance of such ratios and the ability of such ratios to be explained in terms of a cash flow concept. Using this cash flow concept, Beaver attempted to justify the use of cash flow concept by describing the theory of ratio analysis. These ratios were then classified into 6 elements namely, cash flow ratios, net income ratios, debt to total assets ratios, liquid assets to total assets ratios, liquid assets to current debt ratios and turnover ratios. Three types of statistical test were conducted: a comparison of mean values, a dichotomous classification test and an analysis of likelihood ratios. In the first test, Beaver compared the mean values of the ratios for the failed and non-failed groups while in the second test Beaver determined the cutoff points for each ratio and then predicted the failure status of each firm.

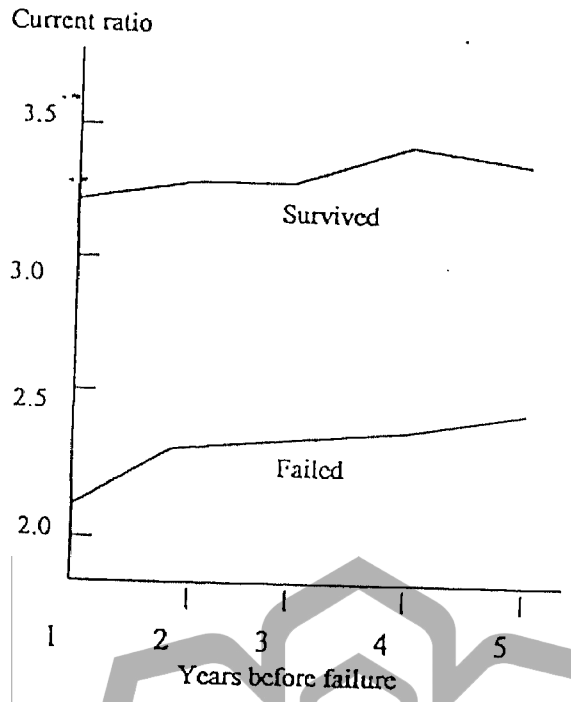
From the mean value comparison, Beaver found out that there were persistent differences between failed and non-failed groups whereby the trend for the non-failed group were constant as compared with the deteriorating trend of the non-failed group over the 5 year period. The ratios that were found to predict accurately were cash flow/total debt, net income/total debt, working capital/total assets, current assets/current liabilities and no credit interval. Figure 1.1 below shows the trend of such ratios:


Cash Flow
Total debt
+0.45
+0.35
+0.25
+0.15
+0.05
-0.15
-0.15
Survived
Failed
1
2
3
4
5
Years before failure


Net Income
Total assets
+0.1
0
-0.1
-0.2
Survived
Failed
1
2
3
4
5
Years before failure


Total debt
Total assets
0.79
0.72
0.65
0.58
0.51
0.44
0.37
Failed
Survived
1
2
3
4
5
Years before failure


Working capital
Total assets
0.42
0.36
0.30
0.24
0.18
0.12
0.06
Survived
Failed
1
2
3
4
5
Years before failure



(*Source* : W.H. Beaver, "Financial Ratios and Predictors of Failure, *"Empirical Research in Accounting : Selected Studies Supplement to Journal of Accounting Research*, 1966, pp. 77-111, fig. 1, p 82.)

The result also indicated that some ratios were better predictors than others were and all the ratios predicted failure better than non-failure. In his studies, Beaver prepared histogram to select likelihood ratios to show the probability of failure and non-failure and the asymmetrical loss function of Type 1 and Type 2 errors. Type I error is an error in classifying a group I subject as group II such as misclassifying a failed firm as non failed while Type II error is an error in classifying a group II subject as group I such as misclassifying a non failed as failed. It showed that Type I error increased substantially as the number of years prior to failure increased. The Type I error was 22% one year prior to failure while Type 2 error was only 5%. Generally, Type 1 error increased substantially as the number of years prior to failure increased. Type 2 error, however, was stable and substantially lower of between 3% to 5% over the five years period.

Beaver, however, found out that cash flow/total debt ratio was the best predictor of failure 5 years preceding the failure.

From the study by Beaver, it can be concluded that not all ratios predict with the same accuracy. Ratios also have greater success in predicting non-failed group than that of failed group. For decision-making purposes, ratios should be used in complimentary with frequency distribution and likelihood ratios. The univariate approach used by Beaver, however, is subject to limitation as single ratio may only represent single dimension of the financial state of a firm. As such, many researchers shifted their approach from univariate model to multivariate models to predict corporate financial distress.

2.2.2 ALTMAN (1968)

Altman (1968) improved on the univariate approach by Beaver by pioneering the use of multiple discriminant analysis (MDA) which enables several ratios to be simultaneously used in predicting financial distress. The study by Altman marked a new development in the financial modeling of financial distress although the purpose of the study was still to assess the quality of ratios as indicators of prediction. Altman used a sample size of 66 firms that were divided equally between failed and non-failed groups. The sample were derived from medium sized manufacturing companies that were matched with the same industry, size and time period using a paired sample design. Altman used the legal term "bankrupt" to denote financial distress and his samples were obtained from those that applied petition for bankruptcy under Chapter X of the US National Bankruptcy Act. Financial statement was collected for up to 5 years prior to bankruptcy and the average

lead-time for the financial statement one year prior to bankruptcy was approximately 71/2 months. A total of 22 ratios were chosen from 5 categories of ratios namely, profitability, liquidity, leverage, solvency and activity based on popularity in the literature and potential relevancy to the study. From his study, Altman selected five ratios that provided the most efficient discriminant function. MDA approach excludes ratios that singularly contributed the most discriminating power. It was found that financial distress or bankruptcy could be explained by the combinations of 5 different ratios that were working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, market value of equity/total assets and sales/total assets. The discriminant function selected by Altman that was found to be the best predictor was:

$$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1.0\ X5$$

where :

X1 = Working Capital/Total Assets

X2 = Retained Earnings/Total Assets

X3 = Earnings before Interest and Taxes/Total Assets

X4 = Market Value of Equity/Total Assets

X5 = Sales/Total Assets

The cut-off score, which minimized the overall misclassification, was 2.675. From the function, Altman concluded that if the z score was below 1.81, the firms were classified as failed or bankrupt whereas a z score of above 2.99 as non-failed. The z score between 1.81 and 2.99 were considered "grey area". The predictive power of the model developed by Altman was accurate up to 2 years prior to bankruptcy whereas the

predictive accuracy from three years onwards decreased significantly. Testing the model on each five years prior to bankruptcy, the predictive accuracy for years 1 to 5 prior to bankruptcy was 95%, 72%, 48%, 29% and 36%, respectively. This was in line with the upward trend in the Type I error of 6%, 28%, 52%, 71% and 64% for year 1 to 5 prior to bankruptcy, respectively. Altman study was considered ex-post whereby the estimation and validation samples used were known to have failed on a set date.

The study done by Altman also suffered the same limitation as that of Beaver (1966) whereby the use of paired sample on a random basis violate the assumption of discriminant analysis leading the estimated parameters to biased while some characteristics to be over-presented (Zavgren, 1983). Using an equal-sized sample of bankrupt and non-bankrupt also did not reflect the actual prior probability of a firm that belong to either group.

Subsequently, the original discriminant analysis of corporate failure prediction was updated by Altman et al into Zeta Analysis in 1977. Using more recent samples, the updated model included retail and large companies while transforming the financial account to reflect the effect of off-balance sheet items. The study also incorporated prior probabilities of group membership and cost of misclassification. Altman et. al also attempted both linear and quadratic models but failed to test for multivariate normality. The results showed that the linear model had a lower classification error rate than quadratic model although the quadratic model was statistically more appropriate. In 1985 Altman developed a computer program to predict corporate failures using Recursive Partitioning Algorithm (Altman and Subrahmanyam, 1985)

2.2.3 DEAKIN (1972)

Deakins (1972) replicated the best of Altman's (1968) and Beaver's (1966) by using empirical results for predictive accuracy while using the multivariate approach. He captured the best of both studies by employing the 14 ratios used by Beaver and used linear combination of these ratios that yielded the greatest predictive accuracy. He studied a sample of 32 companies that failed between 1964 and 1970 and an equal number of non-failed companies at random that were matched on the basis of industry, asset size and year of financial data. The definition of "failure" includes bankruptcy, insolvency or liquidation for the benefit of creditors.

The 14 ratios used by Beaver were computed using the data gathered by Deakin and the dichotomous classification test was employed. The results showed that a linear discriminant function in which all the 14 ratios were found to contribute significantly to the discriminating ability of the function. Unlike Beaver, the result of Deakin study favored the Cash flow/total debt ratio except for the third year prior to failure when the ratio of Total Debt/Total asset was more accurate. Unlike Altman (1968) that developed single discriminant function from one year to failure and testing it on the data from two to five years prior to bankruptcy, Deakin developed a discriminant function for each of the five year prior to bankruptcy. This yielded better results as compared to that of Beaver and Altman whereby Deakin obtained a high degree of predictive accuracy of approximately 94% for the first three year prior to bankruptcy. For the fourth and fifth year prior to bankruptcy, the predictive accuracy dropped significantly. Deakin also used

secondary sample of 11 failed firms and 23 non-failed firms to test its predictive ability. The result showed that the misclassification rates for the first five year prior to bankruptcy was 22%, 6%, 12%, 23% and 15%, respectively. This has indicated that the result might be sample specific. As such, the study by Deakin also suffered the same limitation as that of Altman (1968). Similar to the earlier studies, Deakin did not test for multivariate normality although the method employed by him depends upon such assumption.

2.2.4 BLUM (1974)

The study by Blum (1974) was aimed to develop a failing company model (FCM) which the court would utilize to assess the likelihood of business failure objectively in the application of 'failing company doctrine'. His model had a more limited application namely, to assist in determining the viability of a company prior to a merger that might otherwise violate the US anti-trust laws. Blum used a sample of 115 failed firms from 1954 to 1968 and paired with 115 non-failed firms on the basis of industry, size and fiscal year. Blum defined the term failure based on 3 criteria; inability to pay debt as they fall due, entrance to bankruptcy proceeding or an explicit agreement with creditors to reduce debts. The financial information collected was up to 8 years prior to failure. Like Beaver (1966), Blum adopted a cash flow framework based on the concept of a firm as a reservoir of financial resources with the possibility of failure are expressed in terms of expected cash flow. Blum selected 12 variables that represent 3 common factors namely, profitability, liquidity and variability based on the cash flow concept.

The predictive accuracy of the Failing Company Model was between 93% to 95% at the first year prior to failure, 80% at the second year and 70% at the third to fifth year prior to failure. The study by Blum was found to be more superior to that of Altman (1968). Like Altman (1968) and Deakin (1972), Blum did not test for equality of dispersion matrices for the two groups and also multivariate normality of predictor variables.

2.2.5 OHLSON (1980)

Ohlson adopted a conditional probability technique and among the earliest researchers to have used logit model to predict corporate failure and develop probabilistic estimates of failure. He criticized the use of multiple discriminant model and instead proposed conditional logit analysis since it required no assumption to be made about the prior probability of bankruptcy and the distribution of predictor variable. He argued that there were three major problems of multiple discriminant analysis; the statistical requirement imposed on the distributional properties of the predictor variable, the output from the model which was a score and not a probability of failure and the problems associated with the use of matched sample.

In his study, Ohlson used 9 independent variables with no evocation of theoretical considerations. The study used the sample size of 105 failed firms from the period of 1970 and 1976 selected from Wall Street Journal Index in industrial sector and had been traded on the stock exchange for at least 3 years prior to failure. The fund statements for the entire sample period must also be available. In the non-failed sample, each of 2,000 non-failed industrial firms was allowed to contribute one-year data to the data used in