C H A P T E R - II

PREDICTION MODELS USING FINANCIAL RATIOS

A ratio is defined as "indicated quotient of two mathematical expressions" and as "the relationship between two or more things"[1]. This relationship can be expressed as a quotient, or as per centum, or interms of 'times' or 'proportions'. Construction of a financial ratio is essentially an attempt to develop meaningful relationship between individual and/or group of items drawn from the financial statements and is of considerable significance in developing insights about the financial condition of the enterprises[2].

"It is inconceivable that accounting data can be analysed without transferring it into ratios, in one way or another..."[3] This remark, made more than two decades ago, is even more important today with the rapid increase in the volume of financial statements. Time available for specific corporate investigation is under increasing pressure. The demand for quick analysis technique that can help detect the financial and economic event of corporations high lights the roles that financial ratios can play in this regard. "The detection of company operation and financial difficulties is a subject which has been particularly susceptible to financial ratio analysis"[4].

The financial ratios have become an accepted evaluative technique to financial analyst. "It is being used to determine

the financial position of a firm since as early as 1890's. It is only recently that researchers have engaged themselves in using empirical techniques to enhance the quality of the ratio analysis"[5]. "Notwithstanding that the credibility of ratios is governed to a large extent by corporate reporting behaviour in discharging relevant and accurate information, it is suggested that when a technique is used extensively in financial statement analysis, it should be used as meaningful a way as possible"[6]. Traditionally, current ratio was popularly used to evaluate the credit worthiness of the business enterprises. At present, ratio analysis involves the use of several ratios by a variety of users including credit lending, credit rating agencies, investors and management people for assessing the financial condition of the firm[7]. "Despite the voluminous literature which has been built up on financial ratio analysis, very little progress has been made in empirical testing of financial ratios with a view to showing which of them really reflect a firm's state of health, its chances of survival or failure"[8]. Recently, researchers have applied sophisticated statistical technique to ratio analysis and proved that statistically derived ratio functions are more accurate and efficient in providing guidelines to the analysis[9].

The studies concerned with warning of business failure were evident in 1930's[10]. These studies concluded that failing firms exhibit significantly different ratio measurements from continuing entities. In other words, financial ratios are a

better measure of prediction of events [11]. At that time, a study was concerned with ratios of large-asset-sized corporations that experienced difficulties in meeting their fixed indebted obligations. The interest of the researchers was created much by the study of W.H. Beaver in 1966, involving the analysis of financial ratios in a bankruptcy-prediction content[12]. He compared a list of ratios individually (in univariate ways) for failed firms and a matched sample of non-failed firms. Additional widespread interest was created by E.I. Altman who applied a sophisticated statistical technique called 'Multiple Discriminant Analysis' to financial ratio analysis[13]. Since then several other researchers have conducted further research works in this area. It is observed that, these studies were mainly concerned with two types of problems - (i) whether it is possible to predict an economic or financial event/condition through ratio analysis, i.e. identification of the financial ratios which reflect better a particular financial or economic event/conditions; and (ii) improving or enhancing the quality of the predictive model based on financial ratios through the analysis and examination of their statistical sensitivity and statistical validity (of both the ratios and the models) to predict a particular financial or economic event/condition and thereby improving the overall quality of the ratio analysis technique. "Univariate and multivariate statistical techniques have been used by the writers who have attempted to identify a relationship between accounting ratios

and corporate failure"[14]. These studies have concluded that the ratios can be used as predictors of economic and financial events like failure, bankruptcy etc., and the ratios commonly used for measuring liquidity, profitability, financial stability, etc., are found to be better indicators of events[15].

Therefore, this study reviews briefly some empirical works on 'financial ratio analysis' with a view to finding areas for further research. Our review is selective in nature, intended more to enlarge our understanding to search the areas of further research than to be a compendium of literature on the subject.

Donald E. Miller : 1966

Miller[16] attempted to present a cause-and-effect ration approach. He studied the relationship of the ratios by dividing them into two categories : (i) causal ratios, and (ii) ratios that measure effect. He found that there exists a cause-and-effect relationship among the ratios. However, the cause-and-effect relationship was traced by him only among ratios inter se, not between a ratio and the ultimate survival of a firm. In his study, there was no clear indication about which ratios have closer bearing on the prospective health and survival of firms. Only tracing the cause-and-effect relationship among the ratios, does not help to build a categorical frame work of the financial health of a firm. Furthermore, "the examples which Miller uses to illustrate his point ignore some of the most important problems that arise in practical analysis in this imperfect world-distortions and incomparabilities resulting from price-level

changes and differences among firms in respect of financial practices"[17].

W.H. Beaver : 1966

Beaver[18] attempted to demonstrate the failure of an enterprise which could be forewarned reliably through combined utilization of quantitative techniques and financial ratio analysis.

Beaver used 'dichotomous classification test' to study the financial ratios of 79 failed and 79 non-failed firms. He defined failure as a business defaulting on interest payments of its debts, overdrawing its bank accounts or declaring bankruptcy. He selected the firms on the basis of industry and asset size and adopted a paired sample design, (i.e., for each failed firm in the sample, a non-failed firm of the sam industry and of similar asset size was selected). H examined the predictive power of 30 different financial ratios which were further divided into six ratio groups, namely, Cash-flow ratios, Net income ratios, Debt to total assets ratios, Liquid assets to total assets ratios and Turnover ratios. He, "for the first time, threw interesting light on the relative efficiency of the various ratios to predict failure upto 5 years prior to failure"[19]. His approach involved ranking the firms by the values of particular financial ratios, and then visually inspecting the data to determine an 'optimal' cut-off point for classifying a firm as 'failed' or 'non-failed'. The cut-off was selected to minimise the percentage of total misclassification.

Beaver concluded that, the Cash-flow to total debt ratio had the ability to correctly classify both failed and non-failed firms to a much greater extent than would be possible through random sampling. This ability exists for at least five years before failure. His error rate was 13 percent for one year before failure and ranged between 21 to 24 percent for 2-5 years before failure.

The ratios tested by Beaver predicted the failed and non-failed firms with unequal degrees of success. Non-failed firms were correctly classified to a greater extent than the failed firms. Moreover, his findings were based on the univariate model which has several limitations. "A major limitation of the univariate approach is that different ratios can suggest different conclusions for the same company"[20]. In spite of all these criticisms, Beaver's study by using quantitative techniques, added a new dimension to the ratio analysis to assess the quality of individual financial ratios in the context of forwarning failures.

On the basis of the same body of data[21], an extension of his earlier effort was presented in another paper - "Alternative Accounting Measures as Predictors of Failure"[22], where he attempted to emphasize the need for emperical verification of a priori beliefs[23]. Beaver studied non-liquid-asset ratios (cash flow to total debts, net income to total assets and total debt to total assets) and the liquid-asset ratios divided into three

common denominator groups - a total asset group, a current debt group and a turnover group (within each denominator group four liquid asset measures were studied : Current asset, quick asset, net working capital and cash). He analysed the data at three levels : (i) the dichotomous classification test, (ii) the comparison of mean values of ratio components, and (iii) the likelihood ratio analysis, and observed that : (i) the results of the dichotomous classification test showed a consistently superior performance of the non-liquid asset ratios over the liquid asset ratios; and the superior predictive power existed not only in long-term but also in the years shortly before failure, (ii) the 'comparative mean-value' study which relied solely on the comparison of means could not be an alternative to the dichotomous classification test, and (iii) the outcome of the likelihood ratio analysis was similar to the classification test. His reason for emphasis on the dichotomous classification test was that, it was "a more convenient and accurate measure"[24]. Thus, Beaver showed that a priori beliefs in the literature did not hold good when examined by emperical evidence.

Beaver's current asset measure was strongly criticized due to the inclusion of inventory which impaired the measure's usefulness[25]. Another strong criticism was that the items of current assets when analysed in the form of current ratio, were subject to manipulation through a practice known as 'window dressing'[26].

E. I. Altman : 1968

Altman[27] evaluated the analytical quality of ratio analysis to predict corporate bankruptcy. To overcome the limitations of the univariate model, he suggested the multivariate model consisting of a few important variables. He used multiple discriminant analysis as an appropriate statistical technique and argued that ratios, if analysed within a multivariate frame-work, will take on a greater statistical significance than the standard techniques of ratio comparisons.

The model developed by Altman considered two groups of firms, viz., 'bankrupt' and 'non-bankrupt' and the initial sample was composed of sixty-six corporations with 33 firms in each group. The sample units selected for one group were bankrupt-manufacturing-firms which filed the bankruptcy petitions during 1946-65, and for the other were the paired sample of manufacturing firms which were still in existence during 1966 and were chosen on a stratified random basis. The sample firms were stratified by the industry category and the asset size. The necessary data were collected from the financial statements relating to the periods preceding the period of filing the bankruptcy petitions by the first group of sample firms.

He used 22 ratios for evaluation and these ratios were broadly classified into five categories, viz., profitability, liquidity, leverage, solvency and activity ratios. From the original list of 22 ratio-variables, five were selected as doing the best job together in the prediction of corporate bankruptcy.

To select the final profile of variables, he followed the following procedures:

(i) Observation of the statistical significance of various alternative functions including determination of the relative contributions of each independent variable,

(ii) Evaluation of inter-correlations between the relevant variables,

(iii) Observation of the predictive accuracy of the various profiles,

and (iv) Judgement of the analyst.

Thus, he selected the following ratios for his final discriminant function:

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 of Equity/Book value of Total Debts.

X_5 = Sales/Total Assets.

These five variables were introduced in the model and the discriminant scores (or Z-values) were obtained with the help of the discriminant function in the form :

$$Z = V_1 X_1 + V_2 X_2 + \ldots\ldots + V_n X_n$$

where, V_1, V_2, ... V_n were the discriminant Co-efficients and X_1, X_2 .... X_n were independent variables. His final discriminant function[28] is as follows:

$$Z = .012\ X_1 + .014\ X_2 + .033\ X_3 + .006\ X_4 + .999\ X_5$$

Altman performed the 'F-test' to find out the individual discriminanting ability of the variables. He employed an additional technique, namely, the 'Scaled vector' to determine the relative contribution of each variable to the total discriminating power of the function and the interaction between them. Thus, he observed that the ratio Sales to Total Assets had larger contribution in the group separation whereas this ratio was insignificant in his univariate study.

Altman conducted several tests to ascertain the accuracy of his model. His model, for the initial sample, classified correctly 94 percent, 72 percent, 48 percent, 29 percent and 36 percent of the sample firms for one, two, three, four and five year prior to bankruptcy, respectively. He tried a similar model on the secondary sample for the data of one year prior to the date of bankruptcy and observed that the model correctly classified 96 percent of the firms in the secondary sample. In searching the possible causes for this difference in accuracy and the superiority of the sedondary sample's result, he stated that, "two possible reasons are that the upward bias normally present in the intial sample tests is not manifest in this investigation, and/or the model, ... is something less than optimal"[29]. He concluded that "bankruptcy can be accurately predicted up to two years prior to actual failure with the accuracy diminishing rapidly after the second year"[30]. Furthermore, he suggested several practical and theoretical applications

of the model which included business credit evaluation, internal control procedure and investment guide lines.

Altman, in another study[31], attempted to find out how far the discriminant model would help Loan Officers of commercial banks and other lending institutions to develop loan evaluation techniques. He found that most of the variables which were finally selected in predicting the bankruptcy, were also potentially important in predicting the loan defaults. He claimed that his model, like any other credit scoring model, would reduce the time and costs of loan officers in evaluating loan applications. He indicated that the model is to be updated in the light of experiences.

There are several criticisms against Altman's studies. Craig Johnson states that, "the Altman's model demonstrates that failed and non-failed firms have dissimilar ratios, not that ratios have predictive power. The crucial problem is to make an inference in the reverse direction, i.e., from ratios to failure"[32]. Moreover, Johnson stated that the model built up for predicting failure have not enabled the analyst to differentiate between 'firms which will fail' and 'firms which will almost fail'. Any excercise on the prediction of alternatives to failure would be more meaningful. Ratios have a meaning only if they are related to some standard and ratios by themselves cannot describe a dynamic system like failure[33]. He argued that ratio-discriminant model is not dynamic in nature and, therefore, cannot capture

whatever time series contribution is relevant towards failure contributions[34], and concluded that Altman did not provide any evidence of the ability of ratios to predict failure. Altman has not established any logical link between the given values of ratios and grouping of failed and non-failed firms. Merely measuring the degree to which the state of failure is related to current status of firms does not differentiate between near failure and outright failure. Without additional evidence, the practical value of ratio analysis to the issue of failure is still an open question[35].

L.C. Gupta criticized that, "an implicit assumption underlying this approach is that the relationship among the various financial variables is of 'compensatory' type. This is incorrect. ..... In our opinion, this is simply not true of the various aspects of business firm's financial working. A business firm is more like a structure resting on several pillars and would collapse if even one of those pillars did not have a required minimum strength. That is why we do not think that the Altman-type approach would ever have much success in this area"[36]. In view of the misclassification rate jumped from 6 percent to 28 percent from one year to two years before bankruptcy, Gupta further criticised that "an error of this magnitude is intolerably high, higher, in any case, than the minimum accuracy needed from this view point of the practical utility of a method..... Altman's error rate reaches the absurd level of 71 percent in the prediction made from years before bankruptcy..... And even

for the three years before bankruptcy, greater accuracy than his model can be achieved by just flipping a coin"[37]. "An another serious shortcoming of Altman's model is that it was derived purely from a statistical search procedure for the 'best' function and have no basis at all in theory or logical reasoning. The lack of theoretical underpining of the model means that the relationship could turn out to be wholly spurious without even our knowing"[38].

In reply to Craig Johnson's criticisms, Altman stated that, "the question is not whether a firm should be bankrupt if it displays certain ratio measures but whether its symptoms are similar to other firms which have continued to deteriorate towards bankcruptcy. The discriminant bankruptcy model is a form of stochastic analysis specifying a general model for predictive purposes. To predict the results of individual firm, more specific model can be developed. Ratio models dealing exclusively with firms in a particular industry or product line will yield more representative parameters which can be used for further predictions of other firms in the same line of business"[39]. He further stated that, "models utilising ratios could be predictors of failure but this should not preclude complementary opportunistic analysis. Alternative strategies like mergers, may avert formal bankruptcy situation but this does not diminish the overall usefulness of the ratio model"[40].

David Ewert : 1968

David Ewert[41] studied the scope for predicting the non-repayment of receivables of a manufacturing firm. His study was based on the information supplied by the credit reports of Dun and Bradstreet Inc., Cincinnati, Ohio. He collected the relevant information from 300 trade accounts of a manufacturing concern of California. His sample consisted of small as well as large business concerns. He used 17 variables in his multiple discriminant analysis model. His 17 variables included only two financial ratios, namely, current ratio and the ratio of net sales to net working capital and 15 other non-ratios like credit repayment reports, legal form of organisations, ownership of premises, etc. Ewert found that the variables used could predict successfully the non-repayment of receivables and his model correctly classified 82 percent of the trade accounts. He observed that the ratio variables included in the list of 17 variables did predict the non-repayment of receivables and the non-ratio-variables could do equally well in the prediction of non-repayments.

Marc P. Blum : 1969

On the basis of the accounting and financial market data, Blum[42] attempted to build a theoretical model to discriminants between the failing and non-failing firms. He indicated failure as "entrance into a bankruptcy proceeding or an explicit agreement with creditors which reduces the debts of the company."[43] His sample consisted of 330 firms of which 115 were failed and

115 were non-failed. He selected the firms on the basis of industry category, annual sales, number of employees and fiscal year and adopted a paired sample design. He selected 115 firms which failed during 1954-68 with liabilities greater than one million dollers and a paired sample of 115 non-failing firms being similar to the failed firms in respect of industry, annual sales, number of employees and fiscal year. He collected the relevant and necessary data upto eight years prior to failure where available, however, five years data prior to failure were found optimal. His best overall function contained twelve ratio variables of which five were the measures of ratio trend or variance. Blum made a deliberate choice of his variables in terms of financial theory of firm. He derived separate discriminant functions for each of the five years before failure. His model had an accuracy of 93 to 95 percent when failure occurred within one year of the statement date and 80 percent at prediction for two years prior to failure and 70 percent at prediction for three years prior to failure.

Blum's primary contribution was the inclusion of ratio trends and variance (i.e. stability over time) as predictors in his prediction model; but "since his discriminant function varies according to the number of years before failure, one would not really know which particular discriminant function to apply in a particular case ex ante"[44]. This made the model impractical for adoption in spite of the higher accuracy claimed by the author.

Paul A. Meyer and Howard W. Pifer : 1970

Meyer and Pifer[45] attempted to present a model for predicting the bank failures. They studied the factors responsible for bank failure and divided them into four categories : (i) local economic conditions, (ii) general economic conditions, (iii) quality of management, and (iv) integrity of employees. Their sample consisted of 39 solvent and 39 failed banks. They studied 28 operating ratios and 4 balance sheet ratios. These ratios were computed from the data collected from the financial statements and from the information supplied by the reports of the 'Federal Deposit Insurance Corporation'[46]. The data were gathered for a period of six years. They used multiple-regression analysis to assess the predictive ability of the ratios. Their model classified correctly 80 percent and 72 percent of the banks in the initial sample for one year and two years before failure. They observed that, when the lead time was three years or more, financial variables were unable by discriminate between the viable and failing banks. Their study emphasized that along with financial ratios, the report of the 'Federal Deposit Insurance Corporation' should be studied to make a better prediction of bank failure. In other words, Meyer and Pifer's study suggested that a study of financial ratios alone would not predict the failure of banks.

Robert Edmister : 1970

Robert Edmister[47] attempted to predict the failure of firms borrowing or receiving loan guarantees. He indicated a

business as a failure if its 'Small Business Administration (SBA)' loan was written off as a loss, otherwise, the business was considered as a success. His sample consisted of 21 borrowers who failed to repay loans and other 21 borrowers who had not failed to repay loans granted under SBA programme. The borrowers were selected on the basis of the industry and the size of assets, and data were collected for a period of three years. Edmister considered 19 ratios selected on the basis of the ratios found significant in the studies conducted by Beaver, Altman, Ewert and Blum, except the ratio of 'net operating margin'[48].

The hypotheses of Edmister's study were : (i) A ratio level is a predictor of small business failure; (ii) A three year's trend of such ratio is a predictor of small business failure; (iii) The three year's average of ratio is a predictor of small business failure; and (iv) The combination of the industry relative trend and the industry relative level for each ratio is a predictor of small business failure.

His first hypothesis represented the use of ratios in their crudest form and no adjustment was made for the variations between industries and the ratios were not compared with one another. It was based on the theory that there were standards which were applicable to all firms. The relative level of borrowers' ratio to the average ratio of other small business in the same industry was hypothesized to be predictor of small business failure. To test this hypothesis, the ratio level for certain industries (based on the Robert Morris Associates' (RMA) Annual Statement Studies (1958-66) and Small Business

Administration (SBA) Annual Statement studies (1958-65)) was considered and compared with the ratio levels of the borrowers under the study. To test the second hypothesis, Edmister assigned some weights to the upward and downward trend of each ratio (value '1' to upward trend and '0' for the downward trend). To test the third hypothesis, he worked out the averages for RMA and SBA relative ratios to provide an index of the relative firm to the industry position over the three years. Averaging was expected to smooth out the ratios and to result in more representative figures than that calculated from the 'most recent statements' only. His fourth hypothesis had not been presented in previous empirical research but was an explicit representation of the conditional nature of ratios, recognised by the ratio analysis. Edmister attempted to establish an interaction between the trend and the level of ratios and for this he formed four types of interactions, namely, 'up-high level of trend', 'up-low level of trend', 'up down-high level of trend' and 'down-low level of trend' for each RMA and SBA relatives.

Edmister, firstly, divided the borrowers' ratio by the respective industry ratio (RMA or SBA) to form an industry relative of ratios; secondly, he noted the trend of the industry relative as up-down or non-existent; thirdly, he calculated the three years' average ratios; and lastly, he considered together the trend and recent level as a joint condition.

The trend and the level were considered to be variables which might 'interact' or 'act' with regard to predict failure. In the context of failure of firms in repaying the loan, Edmister used the multiple discriminant analysis, with 7 variables only, to asses the predictability of the ratios.

The results of his study showed that the discriminant model developed for small business failure demonstrated 92 percent accuracy in the initial sample and 80 percent accuracy in the validation sample. His study also indicated that ratio analyses may be benefitted by comparing industry averages with borrowers' ratios and by using a small number of ratios representing different borrowers' characteristics rather than one or a few ratios describing very similar borrowers' conditions. The study showed that the small business function failed to discriminate when 'only one statement' (financial statement) was available. (But the Altman's and Beaver's studies showed that for large business 'only one statement' was sufficient for a highly discriminant function). According to Edmister's study, at least three consecutive financial statements are necessary for the analysis of a small business failure.

Edmister concluded that multiple discriminant analysis offers one mean of selecting an optimal set of ratios and methods of assigning weights to obtain a relatively simple function and the analysts interested in predicting small business failure might find the function not only more accurate method but also a more efficient technique than that of the subjective process of the

study. Edmister attempted to enhance the quality of the ratio analysis by considering average ratios, ratio trends, ratio levels and the interaction of the trend and the level. He concluded that a linear combination of the above variables can produce better prediction of events.

Edward B. Deakin: 1972

Deakin[49] proposed an alternative model for predicting failure. He replicated Beaver's analysis on a different sample over a different time period and searched for the linear combination of the variables used by Beaver which could best predict the potential failure in each of the five years prior to failure.

Deakin selected sample firms from a population which experienced failure during 1964-70. He indicated failed firms as those which experienced bankruptcy/insolvency or were otherwise liquidated for the benefit of creditors. Each of the failed firms were matched with a non-failed firm on the basis of industry classification, asset size and availability of financial information. He applied dichotomous classification test to ascertain percentage error of each ratio and calculated accuracy of the test on the initial sample and hold-out sample. He used the Spearsman's rank-order correlation coefficient to indicate the relative order of the predictive power of the ratios. The rank-order correlation coefficients were high in four of the five years, but the coefficient in the third year prior to failure was relatively low. He attempted to find out the cause which made

the coefficient in the third year relatively low by a comparison of mean values of the ratios. The results of his univariate test were quite similar to those reported by Beaver[50] but with some higher percentage of misclassification rates.

Deakin conducted discriminant analysis by constructing separate discriminant functions for each of the five years before failure and his 'original model' included 14 variables and 'revised model' included only 5 variables. The selection of variables was based purely on a statistical search procedure. He adopted a random sampling procedure for the non-failed firms drawn from 'Moody's Industrial Manual' for the period 1962-1966. The result of the discriminant analysis programme, consisting of a set of discriminant weights, indicated that a linear combination of variables maximises the difference between the groups as well as scaled vectors which indicate the relative contributory power of each variable. His model predicted all the firms in the initial sample with the misclassification rates of 3 percent, 4.5 percent, 4 percent, 21 percent and 17 percent for each of the five years prior to failure, respectively. He tested his the model on the 'independent sample' consisting of 11 failed and 23 non-failed firms, selected at random from the same source and observed a relatively higher rate of misclassification error in the first year which was quite unusual. The error rates of 22 percent, 6 percent, 12 percent, 23 percent and 15 percent were observed for each of the five years prior to failure, respectively.

Deakin concluded that the application of statistical techniques, particularly discriminant analysis, could be used to predict business failure from accounting data as far as three years in advance with a fairly high degree of accuracy. Since, such a long period could be discovered with his method, he expected that, it should be possible for the management of potentially-failing firms to take steps to avert such an occurrence.

Selection of variables by Deakin was criticised because the selection process was not based on the financial theory of firm[51]. The selection of variables was based purely on a statistical search procedure. "The lack of under-pinning of the model means that the relationship could turn out to be wholly spurious without even our knowing it. There was a serious lacuna in his model from the practical angle : since his discriminant function varies according to the number of years before failure, one would not really know which particular discriminant function to apply in a particular case before hand. This makes even this model impractical for adoption in spite of the higher accuracy calimed by Deakin"[52].

E.I. Altman, M. Margain, M. Schedosser and P. Vernimmeni : 1974

They[53] attempted to develop a model for evaluating the creditworthiness of commercial loan applications of the firms under the cotton and wool industries in France. Their sample

consisted of 38 firms 'troubled with finance' and 99 'good' firms. They used 41 ratios which were divided into six ratio-categories, namely, liquidity, indebtedness, profitability, turnover, coverage and value added. They observed that financial ratio measures seemed to discriminate well between good and bad credit risks based on their mean values, but, this become less impressive as the time before non-repayment increases. Despite this seemingly different mean values of individual financial ratios, observation of frequency distribution of each measure showed that a large proportion of firms were difficult to discriminate from one another due to the overlapping range in univariate analysis. To overcome this problem they applied a multivariate technique, 'principal component analysis', and observed that certain group of ratios clustered together in the correlation with one principal component such that they reveal similar pieces of information. According to them, this technique provided a better understanding of the financial ratio groups than for actual discrimination between good and bad firms. Through the 'principal component analysis' they finally selected 10 variables (ratios) for their discriminant model and the linear combination of the selected variables produced a higher degree of accuracy in the prediction of firms. They, further, observed that the accuracy was reduced when 10 variables were introduced in the model. They concluded that, such reduction in the accuracy did not mean that a statistical technique for credit scoring was of no use, and one should continue to search for a modern technique

of this type to improve upon a traditional type of credit analysis.

Dalton L. Chesser : 1974

Chesser[54] attempted to develop a discriminant model for determining the 'acceptable risks' and'unacceptable risks' of the commercial loan customers in the context of their non-compliance to original loan agreement. He suggested that, non-compliance did not necessarily mean that the borrower would completely default, rather, some workout agreement might have to be arranged which would result in settlement of the loan under conditions less favourable to the lender than those specified in the original loan agreement. He attempted to predict the probability that a commercial loan customer would not be able to comply with his original loan agreement and stated that the applicant's probability of non-compliance which represented the degree of risk associated with the loan request, was still a judgement factor (subjective factor) in the mind of the loan officer. He attempted to replace subjective assignment of probability with a mathematical technique which quantified to the extent possible for an applicant's a priori probability of non-compliance of the loan agreement.

The sample, in his study, consited of 37 pairs and 21 pairs of the satisfactory and un-satisfactory loans for the first and second year before the event, respectively. He considered a loan agreement as unsatisfactory, if the borrowing firm failed to comply with the terms of its original loan agreement during

his test period (1962-71). His selection of the satisfactory loans were made on the basis of the firm borrowing the loan had complied with the terms of its agreement provided that it could be matched with an unsatisfactory loan in terms of industry and total asset size. He used 15 ratios selected on the basis of their popularity in the literature, their performances in the previous studies and availability of the relevant information from the financial statements of the firms under his study. These ratios were divided into liquidity, leverage, activity and profitability groups. He finally selected 6 ratios for his final model.

Chesser used a mathematical technique to estimate the probability that a loan customer would not be able to comply with the terms of the original loan agreement. The probability model utilized in his study, calculated 'P' (the estimated probability of a loan non-compliance) after obtaining a set of weights or co-efficients based upon the selected financial ratios. The model revised the weights according to a pre-established rule to assure that after each revision, the incremental change in 'P' was reduced to a level considered acceptable a priori. He attempted to compute probability values that could be used to classify the sample loans as either satisfactory or unsatisfactory. Since the possible probability value ranges from '0' to '1', the mid-point (0.50) of the possible values was selected as the cut-off value. In other words, if, through the application of the probability model, a test loan was assigned the 'P' value greater than 0.50,

it was considered as unsatisfactory loan and when it was less than 0.50, the loan was considered as satisfactory.

Chesser claimed that his model correctly classified 76 percent of the units in the initial sample for the first year data; when a similar test was conducted on the secondary sample, the model produced 75 percent accuracy. His model correctly classified 57.14 percent of the units in this sample for the data two years before the non compliance. He observed that this reduction in accuracy in the second year, specifically for the unsatisfactory loans, was due to the fact that non-compliance was more remote and the indications were less clear. "The serious lacuna of the model is that, the model does not specifically tell the loan officer whether to accept or reject a loan application"[55].

Inspite of the criticisms made against the model, Chesser's attempt to summarise the applicant's tendency to comply with a loan agreement, provided a better basis in the hands of the loan officer for matching the terms of the loan with the characteristics of the borrower. He suggested to modify his model for implementation by introducing non-ratio variables such as, measures of management performance, capacity utilization, diversification of products and services, fluctuation of sales, relation with employees, and general economic activity.

Jarrod W. Wilcox : 1976

Wilcox[56] suggested an alternative approach to the problems of predicting failure of firms. He called his model, the 'Gambler's

Ruin' approach and assumed that, at any moment, the firm's financial state can be defined by its 'adjusted cash position' or 'net liquidation value'. He arbitrarily defined the liquidation value of assets and debts. According to him, "the 'net liquidation value' or 'adjusted cash position' of a business firm is the difference between the liquidation value of assets and liquidation value of debts. The fluctuation in the net liquidation value from year to year is due to the inflows and outflows of liquid resources. This led to fluctuations in the financial states of the firm. That is, the financial states of the business firm can either improve or worsen from one period to another"[57]. He assumed that the change in the financial state took place always by a fixed amount. He called this fixed amount as the 'Size of the bet' ('S') and stated that, a firm would surely fail unless the probability of the firms gaining a bet ('P') exceeded that of its losing the bet ('q'); and, the length of period to the time of failure were determined by the size of the firm's net liquidation value in combination with the size and probabilities of inflows and outflows of liquid resources. He calimed great success for his prediction model on the basis of a sample study.

In criticizing the model, L.C. Gupta stated that "the idea underlying this approach is analogous to the concept of 'reserve strength' "[58], and added that "the model is, however, neither convincing nor realistic because of several arbitrary assumption on which it depends"[59].

Ahmed Belkaoui : 1978

Belkaoui[60] attempted to identify the financial characteristics of the companies that became the object of takeover. He used the term 'take-over' in its broadest sense and considered the companies that were subject to both voluntary and involuntary mergers. He used the dichotomous test on the ratios of the firms and also used discriminant analysis to search for a combination (of the same ratios) which best predict take-overs.

The author selected twenty five companies at random from a population which was the subject of take-over during the year 1960 to 1968. A 'control' group of 25 companies which were still in existence in 1973, were selected from the same industries (as the 'experimental' companies) and were within a range of 25 percent of the assets of the 'experimental' companies. For each of the fifty companies (25 'experimental' plus 25 'control') the annual reports were examined for five years prior to the take-over date. He selected 16 ratios on the basis of : (i) their popularity in literature, (ii) their possible relevance to the take-over phenomenon, (iii) their distinction between liquid and non-liquid ratios, and (iv) their appearance in the literature as indicators of the ability of a firm to avoid take-overs.

A review of the error percentage of the dichotomous classification test by the author showed a superior performance of the non-liquid asset ratios. This superiority in the predictive power of the non-liquid ratios was more striking in the short-term,

particularly in the year one, two and three than in the long-term. The second major result of the test pertained to the differences of prediction among the liquid asset ratios. The ratio "working capital over total assets predicted relatively better than the other liquid ratios specially in one, two, three and four years before takeover. The ratio had superior predictive ability to both the 'current ratio' and the 'acid test ratio' in year one, two and four.

Belkaoui used discriminant analysis with the same set of ratios which were used in his dichotomous classification test with the objective to search for a combination of ratios which best predict the takeovers. The result of his discriminant analysis for the initial sample showed the rates of misclassification at 28 percent, 20 percent, 16 percent, 22 percent and 20 percent for year one, two, three, four and five prior to the event, respectively. The result of the secondary sample (consisted of 11 pairs of another firms) showed the misclassification rates to 30 percents, 24 percent, 15 percent, 24 percent and 25 percent for each of the five years. The new sample's results are similar to those of the initial sample. According to Belkaoui "the results on both the initial and secondary sample determined the overall effectiveness of the discriminant model for a longer period of time prior to takeover"[61] and his explanation was that "either the long-term financial position as conveyed by the accounting data is more indicative of a possible takeover, or the changes in the realisability of the model from year to year have little or no meaning"[62].

He suggested that, "the inclusion of non-financial characteristics would add to the external validity of the model"[63].

C.L. Norton and R.E. Smith : 1979

The objective of the study[64] was to compare the prediction of bankruptcy based on ratios computed from General Price Level (GPL)- financial statements to the prediction based on ratios computed from traditional Historical Cost-financial statements. A sample of an equal number of bankrupt and non-bankrupt firms were chosen and the financial statements were adjusted for the effects of the general price level changes. Financial ratios were computed both from the traditional and GPL financial statements. Discriminant analysis was used for the bankruptcy classifications. The authors found that both GPL and traditional ratio exhibited the ability to predict bankruptcy. In spite of the sizeable differences in magnitude that existed between GPL and Historical cost financial statements, little differences were found in the bankruptcy predictions.

V.S. Kaveri : 1980

In his study, Kaveri[65] attempted to assess the financial ratios as predictors of borrowers' health-with special reference to the units under the small-scale industries in India. He divided the financial health of the sample units into three categories, namely, 'good','irregular' and 'sick'. These different degrees of financial health were identified on the basis of the 'extent of irregularity in their 'cash credit' account with the banks'.

His sample consisted of 200 units with the break-up of 80, 80 and 40 units in 'good', 'irregular' and 'sick' groups, respectively. The sample units were selected on the basis of the industry, size (investment made in plant and machinery), age and forms of organisation. He tested 22 ratios dividing them into five ratio groups - Working Capital, turnover, asset utilisation, profitability, and financial stability. He selected 13 ratios traditionally used by the Indian banks and another 9 (nine) ratios with the objective to make more meaningful interpretation in assessing the financial health of their (banks) borrowers. The study was made from banker's view point for better assessment of borrower's financial health.

From the original list of 22 ratios, he selected five ratios, on the basis of statistical significance tests (F-test and T-test) and the rank of the 'scaled vectors' of the ratios, for his discriminant function.

He observed that his model correctly classified 76 percent, 69.42 percent, 66.67 percent, 60.86 percent, 65 percent, 64.70 percent, and 57.74 percent of all the 200 units in the initial sample for each of the seven years before the event and 69 percent, 67.41 percent, 69.51 percent, 67.30 percent, 62.06 percent, 52.63 percent and 53.84 percent of all the firms in the hold-out sample for each of the seven years prior to the event. He further observed that, his model when tested on a random sample, correctly classified 61.87 percent, 61.26 percent, 59.34 percent, 58.32 percent, 52.02 percent, 51.26 percent, 51.56 percent and 51.35 percent of all the firms in the random sample for the two, three, four, five, six, seven, eight and nine years prior to the event.

Kaveri studied the problem in the light of the policies and practices of the banks in India. The author claimed that, "the model can be used for evaluating a large number of loan applications which are submitted along with the latest financial statements. It is possible to take quick decisions on the loan applications and thereby the bankers and the borrowers will be benefitted"[66]. His model did not indicate how far the model be useful to the practical analysts and interested parties other than the banks and borrowers.

James A. Ohlson : 1980

Ohlson[67] presented some empirical results of a study predicting corporate failure as evidenced by the event of bankruptcy. He attempted to develop, logically and systematically, the probabilistic estimates of failure by applying the methodology of 'maximum likelihood estimation'.

He used 'conditional logit analysis' with nine selected predictors but no attempt was made to select predictors on the basis of rigorous theory. The predictors were partially selected simply because they appear to be the ones most frequently mentioned in the literature. He followed the legal definition of bankruptcy and his sample consisted of 105 firms failed during the period 1970-76 and 2058 non-failed firms.

He stated that, "the evaluation of the predictive classification power of a model should be more realistic and much can be gained by improving the data base"[68]. He asserted that, "most of the previous studies have used Moddy's Manual to derive the

pertinent financial ratio and the Manual does not indicate what point in time the data were available"[69]. Pointing to the other disadvantages associated with the Manual, he stated that, "the data are often highly condensed, and it is generally complicated, if not impossible, to reconstruct actual balance sheets and income statements"[70].

He observed that his model correctly predicted 96.12 percent, 95.55 percent and 92.84 percent of the firms under his total sample for the bankruptcy within one year, within two-years and within one or two-years, respectively.

The major findings of the study were "First, it was possible to identify from basic factors as being statistically significant in affecting the probability of failure (within one year). These are : (i) the size of the company; (ii) a measure(s) of the financial structure; (iii) a measure(s) of performance; (iv) a measure (s) of current liquidity (the evidence regarding this factor is not clear as compared to cases (i) - (iii). Second, the predictive power of any model depends upon when the information (financial report) is assumed to be available"[71].

Robert W. Scapens, Robert J. Ryan and Leslie Fletcher : 1981

Scapens, Ryan and Fletcher[72] suggested that 'catastrophe theory' can provide a framework for an examination of sudden changes in corporate credit worthiness following publication of accounting information. They attempted to use the catastrophe theory[73] to model the relationship between accounting data

(interpreted by ratios) and the behavioural responses of creditors. The model did not necessarily provide predictions of failure but it indicated why some companies suddenly become 'at risk'. The purpose of their analysis was to describe a possible relationship between credit granting policy of a company's creditors and its financial performance.

The authors hypothesized that, "a model derived from Catastrophe Theory will have predictive content provided that it is possible to uniquely identify the position of the system state and direction of movements in the control variables"[74].

In their study the 'cusp-catastrophe model'[75] was used initially but latter they extended their discussion to encompass the higher-order 'butterfly model'[76]. They defined a successful company as 'a company which is earning a 'Satisfactory return' from its activities'. They suggested that the return could be measured by profits, fund flow or cash flow, expressed as a ratio of assets employed or finance raised or by a combination of ratios. A company with a relatively high return for its type of business was regarded as successful and creditors would be confident that their loans to that company would be safe (i.e. the co. bearing low probability of default). A company with a relatively low return for its type of business was regarded as having a greater potential for failure and thus, creditors would have less confidence in such companies and would might restrict or even would withdraw their credit. For their model it did not matter whether or not a measure of return, such as cash flow to total debt ratio, was in

reality a valid economic predictor of corporate failure. It was the creditors' perceptions of its predictive value which they attached much importance.

The study concluded that, a catastrophe model of corporate credit has some empirical validity. The model predicted that the size of the catastrophic change in credit policy would increase with operating risk. The authors concluded that their model or any other catastrophe model was not necessarily the only or the best possible representation of changes in credit policy or explanation of corporate failure.

L.C. Gupta : 1981

L.C. Gupta[77] reported the results of the study conducted by him to predict the corporate sickness through ratio analysis technique in the Indian situation. He opted for univariate approach built on Beaver's idea but advanced it much further.

His sample consisted of 41 textile companies having 21 non-sick and 20 sick units. The author prepared a list of the known sick textile companies first and next searched for 'matching non-sick companies' in terms of the following characteristics : (a) product or products manufactured, (b) age and (c) size (indicated by paid-up capital, assets, sales around a particular year (1962)). He collected financial data for each company for the period 1962-74; computed 56 financial ratios of two ratio - groups, namely, profitability ratios and balance sheet ratios and was primarily interested in assessing the 'relative predictive

power' of different financial ratios which were determined for each of the years separately.

The author argued that, "most American studies on bankruptcy prediction have attempted to prove the accuracy and superiority of their particular techniques or formulae by referring to the percentage error to their predictions made 1 year, 2 years, and so on, before the point of bankruptcy. However statistically neat and interesting this approach might appear, it does not seem to be appropriate or even relevant given the nature of the problem of industrial sickness in India"[78]. The time period covered under his study was divided and indicated as : (i) the period 1962-63 as a period of '3-4 years prior to the near bankruptcy stage', (ii) the year 1964 as the 'near to the stage of acute sickness', and (iii) the rest period i.e. 1965 to 1974 as the period of 'sickness'. He claimed that his "approach is more flexible and is specially tailored to the nature of the Indian problem"[79].

He observed that, the two ratios (profitability), namely, EBDIT/Sales (net of excise) and OCF/Sales (net of excise) were the best and of equal merit among all the ratios under his study[80]. He, further, observed that the following two ratios were the 'best' among the balance sheet ratios of about equal merit : (i) Net Worth/Total Debt (including both short-term and long-term); and (ii) All outside liabilities/Tangible Assets (which can be alternatively expressed in different form, viz. Net worth/Tangible Assets)[81].

The author claimed that the percentage error steadily diminished as the sick units moved nearer to the stage of acute sickness and his model's misclassification rate was 3 to 10 percent for 1-2 years prior to the event and 11 to 16 percent for 3-4 years prior to the event[82].

F. Jerry Ingram and Emma L. Frazier : 1982

The purpose of the study[83] was to compare the results of multiple discriminant analysis and maximum likelihood regression models (probit and logit) in an empirical setting characterised by a limited (non-normal distributed) dependent variable. "The specific analytical problem to be addressed, mortgage lending discrimination, was chosen because divergent statistical results could have serious analytical and legal implications"[84].

The salient features of the analysis were:

(i) Each of the model was significant at $\alpha = .01$;

(ii) The logit model's classification accuracy was slightly higher than that of the probit model and both outperformed MDA, but only marginally;

(iii) The significance of the independent variables varied substantially among the models.

"The purpose of the article has been to compare MDA, probit and logit models in an empirical setting. The results indicate that while there were only small differences in the classifying accuracy of the three approaches, substantially different (even opposite) conclusions were supported regarding the significance of the individual variables"[85].

R.J. Taffler : 1983

To evaluate the financial viability of the enterprises R.J. Taffler[86] illustrated the benefits that accrued when published accounting information was used correctly in 'an holistic and relative manner' in the context of an UK-based linear discriminant model. His sample consisted of 46 UK-based firms, bankrupt between 1969 and 1976 and 46 non-bankrupt firms, randomly matched by the size and industry with the failed sample. He identified 80 potentially useful ratios on the basis of 'what literature there is' and the ratios used by related or similar studied. Using the varimax rotated principal component analysis (PCA), he selected only 4 ratios, viz., PBT/Average Current Liabilities, Current Assets/Total Liabilities, Current Liabilities/Total Assets and Credit interval*.

To overcome the difficulties faced in assessing the relative contribution of the individual ratios to the overall discriminating power of the discriminant-model he used "the approach with most intutive appeal (which), measures the proportion of Mahalanobis D^2-distance between the centroids of two constituent groups accounted for the each variable"[87].

He observed that his model misclassified only 2 companies out of 92 i.e., the total misclassification rate was 2.17 percent

---

* It is measured in days which considered the time for which the company would be able to finance its continuing operations from its immediate assets if it could no longer generate revenue.

(i.e., classification of a failed concern as solvent was 4.3 percent and classification of a solvent as failed was zero percent). A distinguishing feature of the study was placing the performances of the enterprises 'at risk' in a scale of 0-100 which helped to study the performances over a period of time. The 'Z-Score' measures a number of performance related characteristics of a business. As such, a company with a higher score may be viewed as a better performer than one with a lower value, i.e., the z-score is ordinal. It is not possible to view a z-score of 2 as twice as good as a z-score of 1, only that it is better"[88]. To overcome these problems, he suggested to calculate a company's 'performance analysis score' (PAS) in a particular year "by ranking the scores of all firms for that year in ascending sequence and observing the percentage in which the z-score of the concern of interest lies-its PAS"[89]. Different calculations were carried out for each year for each company to obtain the Co's PAS trajectory which helped to indicate their relative performance over time.

The major findings of the study were : (i) the risk index, appeared to provide an accurate measures of the actual degrees of risk of financial distress faced by a company, (ii) a transformation of the z-score, provided a single readily interpretable measure of relative company performance, permitting valid cross-sectional and inter-temporal performance comparison.

James A. Gentry, Paul Newbold and David T.Whitford:1985

The objective of the study[90] was to determine whether relative fund-flow components by themselves can discriminate between

failed and non-failed companies. The authors used seven fund-flow components, namely, funds from operations, working capital, financial, fixed coverage expenses, capital expenditure, dividends, and other assets and liability-flows (each divided by total net flow) and a scale measure, viz., total net flows/total assets. The sample consisted of 33 failed and 33 non-failed units. Each of the failed companies was matched with a non-failed company in the same industry based on asset size and sales for the fiscal year, three years before bankruptcy. The study used only two sets of components - one by using the data from one year before failure, and the other by using the data from the mean value of each variable for three years before failure. Multiple Discriminant Analysis (MDA), Probit and Logit techniques were used to examine the predictive ability of the funds-flow components. The finding of the study was that the logit model provided the best results and the MDA and probit model did not alter the results.

The study, through Logit model, classified 77 percent to 83 percent of the sample units correctly. The model correctly classified 70 to 78 percent of the financially weak sample companies. The misclassified logit results were similar to the probit and MDA results. The logit model, tested on a secondary sample of 46 companies (having 23 financially weak and 23 non-weak companies, in the same industry, and of approximately the same asset size), correctly classified 70 to 74 percent of the financially weak companies.

The results of the logit model indicated that cash-flow from operations did not improve the classification results of failed and non-failed companies. The study observed that dividend fund-flow component was a significant variable in the failed/non-failed classification model.

H.Ooghe and E. Verbaere : 1985

Ooghe and Verbaere[91] presented the relationships between the failure of a firm and its financial characteristics, within the Belgian context. They classified the enterprises into 'failing' or 'non-failing' groups on the basis of a set of financial ratios. The results of the classification analysis was used in a 'predictive context'. The primary object of the study was to construct a practical 'predictive' instrument available to the external analyst.

The population of the 'failing companies' consisted of all firms that became bankrupt, in the judgement of the commercial court, during the year 1978 to 1980 or obtained a 'concordat' (creditors agreement) during the same period. The population of the 'non-failed' enterprises was formed by all other business firms. The division of companies into one of these two sub-populations presented an artificial character to a certain degrees: the two sub-populations were only mutually exclusive within a well-defined time horizon. The authors preferred matched sampling procedure for both the groups. By this procedure, 753 annual accounts of non-failing and 395 annual accounts of failed were collected.

The study tested a variable-set of 144 financial ratios selected on the basis of supplemental theoretical considerations, together with the liquidity, profitability and solvency measures which were differentiated into components as far as possible. Linear discriminant analysis technique was used and four models (namely, one-year before bankruptcy, two-years before bankruptcy, three-years before bankruptcy, and the model for the 'global sample') were presented.

Analysing the relative importance of the ratios, the study finally selected 16 ratios for the 'original model' and 9 ratios in total for the four reduced models (in each reduced model, five ratios were considered) on the basis of univariate analysis, multivariate analysis and statistical significance tests.

The study, on the basis of the 'critical value' of discriminant scores observed that the average percentage of misclassification for the 'original' models were 9.98%, 20.4%, 23.6% and 21.3% for 1-year, 2-year, 3-year and 'global' models; and the same for the 'reduced' models were, 11.03%, 21.97%, 27.61% and 24.39% respectively. They also observed that the percentage of misclassification for the 'reduced' models (considering only 5-ratios in each model) were slightly higher than the 'original' models (considering 16 ratios in each model). The study concluded with the comment that, "the discriminant score is a summing variable that gives an important indication of the financial situation of a firm"[92].

C.J. Casey, V.E. McGee and C.P. Stickney (1986):

Using the 'probit analysis' and the discriminant analysis, Casey, McGee and Stickney[93] attempted to assess the importance of the 'financial accounting data' and the 'security price information' for distinguishing bankrupt firms between 'that successfully reorganised' and 'those that liquidated'. In their study, a 'success' was defined as a firm that - (i) filed for bankruptcy but had a 'reorganisation plan' approved by its creditors, (ii) its plan was confirmed by the 'bankruptcy court', and (iii) continued in operation for at least three years subsequent to the confirmation date. A 'liquidation' was defined as a firm that - (i) filed for bankruptcy, and (ii) was either adjudicated bankrupt in 'bankruptcy court' or voluntarily decided to cease operations and liquidate.

The sample of the study consisted of 56 'success' and 57 'liquidators' divided into three sub-groups:

Group 1 : Combined Group (n = 113); Liquidators = 57, Successes = 56.

Group 2 : 1970-75 Filing Date (n = 72); Liquidators = 37, Successes = 35.

Group 3 : 1976-1981 Filing Date (n = 41); Liquidators = 20, Successes = 21.

The following analyses were conducted by the study:

i) Using the Group - 1 data, a probit analysis was performed to see if there was an overall difference between the 'liquidators' and the 'successes'.

ii) Using Group - 2 data, probit analysis was used to develop a best-fitting equation which was then applied to the Group - 3 data that served as the hold out sample.

The finding was that two factors —— (i) the 'free asset percentage' and (ii) the 'change in profitability' in the years preceding bankruptcy - had significant discriminating power. The probit model was able to classify correctly 69% and 59% of the firms in the estimation sample and hold out sample, respectively. It was further claimed that the discriminat model disclosed a slightly higher classification accuracy than the probit model.

Houghton, K.A. and Woodliff, D.R. (Winter 1987):

The objective of the study[94] was to examine jointly the ability of the financial ratios in predicting corporate 'success' and 'failure' (environmental predictability) and the ability of 'humans' (human information processing) to predict the cases of 'success' and 'failure'. The study defined 'success' and 'failure' in terms of Earnings Per Share (EPS).

The principal research questions of the study were:

"(1) Do ratios have in themselves sufficient information content to differentiate between companies with differing future levels of earnings per share? and

(2) Can 'humans' (i.e. human information processors) interpret those ratios sufficiently well to predict the differing future levels of earnings per share?"[95]

The data set for the study comprised a sample of forty eight (48) companies, containing 12 failure cases and 36 non-failure ('success') companies (matched for time period and industry). A financial profile of each of these 48 companies was assembled, based on five financial ratios over three years. These five financial ratios were selected on the basis of their use in literature and include measures of (1) income (EBIT/Total Assets), (2) liquidity (Quick assets/ Current liabilities), (3) dividend policy (Ordinary dividends/Ordinary earnings), (4) Cash flow (Total Debt/Gross cash flow), and (5) leaverage (Long term Debt/ Shareholder's equity).

The authors used the techniques of Discriminant Analysis and computed separate functions for the 'success' cases and for the 'failure' cases. The 'unvalidated discriminant function' of the 'success' group correctly classified 80.56 percent of the non-failure cases and the 'validated discriminant function' of the same group 'accurately classified' twenty four of the thirty six companies (66.67%). The 'unvalidated discriminant function' of the 'failure' group correctly classified ten of the twelve failures (83.33%) and the 'validated function' classified seven of the twelve failures (58.33%).

The study concluded that the financial ratios of failed firms were significantly different from those of non-failed firms and the financial ratios of firms which experienced different levels of Earnings Per Share were significantly different

in the preceding years. The Quick ratio, they observed, "to have a very low correlation with the failure function but, surprisingly, a high correlation with the relative 'success' function"[96]. They also observed that "both financially trained and untrained users significantly out performed 'chance' in a failure prediction context, achieving an accuracy similar or superior to the discriminant function"[97].

Besides these pioneers, there are a host of other studies in the related areas. A number of researchers have tried to predict the corporate bond ratings (Horrigan 1969[98]; Pinches and Mingo 1978[99]; Pogue and Soldafsky 1969[100]; West 1970[101]); to predict an economic or financial event like, corporate bankruptcy, take-overs, mergers, capital adequacy, etc, (Altman 1971[102]; Altman, Baidya and Rebeiro Dias, 1979[103]; Altman, Haldeman and Naryanan[104] 1977; Altman and Loris 1976[105]; Altman and McGough 1974[106]; Casey and Bertczak 1985[107]; Castagna and Matolesy 1981[108]; Dince and Fortson 1972[109]; Elam 1975[110]; Fogelberg, Laurent and McCorkindale 1975[111]; Libby 1975[112]; Mason and Harris 1979[113]; Martin 1977[114]; Moyer 1977[115]; Rege 1984[116]; Reuber and Roseman 1969[117]; Santomero and Vinso 1977[118]; Scott 1981[119]; Singh 1971[120]; Stevens 1973[121]; Talmer 1980[122]; Van Fredrikslust 1978[123]; White and Turnbull 1975[124]; White and Turnbull 1975b[125]; Wilcox 1973[126]); to identify differences among industries with respect to financial ratios, (Gupta 1969[127]; Gupta and Huenfer 1972[128]); to test the ratios over time, to identify the linkage between different ratios and to map a profile

of corporate financial characteristics (Courtis 1978[129]; Horrigan 1965[130]; Laurent 1979[131]; Pinches, Eubank, Mingo and Caruthers 1975[132]; Pinches, Mingo and Caruthers 1973[133]); to identify the basic properties, statistical validuty and statistical distribution of accounting/financial data/ ratios, (Barnes 1982[134]; Bird and McHugh 1980[135]; Bougen and Drury 1980[136]; Deakin 1976[137]; Donnithorne[138] 1981; Foster[139] 1978; Kennedy[140] 1975; Lev 1969[141], McDonald and Morris 1984[142]; O'Connor 1973[143]; Tamari 1978[144]; Whittington 1980[145]); to test the sensitivity of discriminant model in the context of prediction with accounting ratios (Altman, and Eisenbeis 1978[146]; Dillon 1979[147]; Eisenbeis 1977[148]; Gonedes and Dopuch 1979[149]; Joy and Tollefson, 1975[150]; Lachenbruch, Sneeringer and Revo 1973[151]; Richardson and Davidson 1983[152]; Richardson and Davidson 1984[153]); to test the effects of price level changes on the prediction model based on financial ratios (Bildersee 1978[154]; Ketz 1978[155]; Patel 1978[156]; Solomon and Beck 1980[157]); to analyse elaborately the financial ratios (Kline and Hessler 1952[158]; Tucker 1964[159]); ——— they all concluded that financial ratios, individually or in a set, contain specific information and can be used with statistical and mathematical techniques, for prediction or description of various attributes of the firm.

Table - II

Ratio Analysis in some Prediction Studies and Scope for Further Research

Sl. No.	Name of the Researcher	Year of the report of the study	Predicted Event	Analytical Tool Used	Variable for sample selection	Relevance of the study	Firms in the Sample
1.	Miller	1966	Survival of Firms	Ratios	NA	From Analysts point of view	NA
2.	Beaver	1966	Failure	Ratios	Industrial size	"	Industrial firms
3.	Altman	1968	Bakruptcy	"	"	"	"
4.	Ewert	1968	Non-repayment of receivables	Ratios & Non-Ratios	Size	"	"
5.	Blum	1969	Failure	Ratios	Industry, Size, Sales & Employees	"	"
6.	Meyer & Piffer	1970	Bakruptcy	"	Managerial ability and Honesty of Employees	"	Banks
7.	Edmister	1970	Failure	"	Industry & Size	"	Trade Accounts
8.	Deakin	1972	Bankruptcy	"	"	"	Industrial firm
9.	Altman & others	1974	Good and Bad credit risks	"	Industry	"	"
10.	Chesser	1974	Non-compliance of loan Agreement	"	Industry & Size	"	Consumer Loans
11.	Wilcox	1976	Failure	Resource movement	NA	From Analyst's point of view	NA

Table - II (Contd..)

12.	Belkaoui	1978	Takeover	Ratios	Industry & Size	From Analyst's point of view	Industrial Firms
13.	Kaveri	1980	Good, Irregular and Sick accounts	Ratios	Industry, Size, age and organi-sation	Banker Borrower Relationship	Firms under Small Scale Industries
14.	Ohlson	1980	Bankruptcy	Ratios	Time period	Analyst's point of view	Industrial firms
15.	Scapens & Others	1981	Credit worth-ness and thereby failure	Ratios	NA	"	"
16.	Gupta	1981	Corporate Sickness	Ratios	Product, age & size	"	Industrial firms specially cotton & textile firms
17.	Ingram and Frazier	1982	Mortgage lending situation	Ratios	NA	"	Industrial firms
18.	Taffler	1983	Financial viability	Ratios	Industry and Size	"	"
19.	Gentry and others	1985	Failure	Ratios	Industry, asset size and sales	"	"
20.	Ooghe and Verbaere	1985	Bankruptcy	Ratios	Time period	"	"

Table - II (Contd..)

21.	Casey, et al	1986	Reorganisation Possibilities of Bankrupt firms	Ratios	Bankruptcy petitions, firms with reorganisation plans	Analyst's point of view	Industrial firms
22.	Houghton and Woodliff	1987 (Winter)	Corporate 'Success' and 'Failure'	Ratios and 'Human information processing'	Time period and Industry	"	Industrial firms
23.	Scope for further research		Financial health	Ratios	Industry, locational area, and organisational structure	"	Agricultural firms (Tea Industry of India)

From the comparative analysis of the major studies (Table - II) it could be observed that the researchers have attempted to predict corporate bankruptcy, failure, loss or bad accounts, unsatisfactory performance, takeover, corporate sickness etc which are basically qualitative in nature. But most of them have not agreed to any common definition in the matter of identification of financial health hazards experienced by their sample units. The matter has been interpreted and defined differently by the authors themselves. Most of the above studies have provided some sort of their own definition of financial sickness; but in fact, those definitions were the indication of different degrees of sickness or illness of the financial health of their respective sample units. In general, two major groups in this regard (i.e. the opinion about the financial health) could be observed. One group studied the failed or bankrupt or insolvent or closed units* and the other group covered the existing units having all or some of the financial characteristics and symptoms which had commonly been found in the units which were already bankrupt or failed or closed insolvent**. Beaver[160] identified failure as a business unit defaulting on interest payments of its debts, overdrawing

---

* The studies conducted by Beaver, Altman, Meyer and Piffer, Deakin, Belkaoui, Ohlson, Ooghe and Verbaere, Gupta, etc.

** The studies conducted by Ewert, Mare Blum, Edmister, Chesser, Scapens and others, Ingram and Frazier; Taffler (1983) etc.

its bank accounts or declaring bankruptcy. Altman[161] took up the bankruptcy situation directly. Marc Blum[162] identified failures as "entrance into a bankruptcy proceeding or an explicit agreement with creditors which reduced the debts of the company". Meyer and Piffer[163] considered failed banks as those which were insolvent. According to Edmister[164], a business was identified as a failure if its 'Small Business Administration's' loan was written-off as a loss : otherwise the business was considered as a success. Deakin[165] identified failed firms as those which experience bankruptcy, insolvency or were otherwise liquidated for the benefit of the creditors.

A simple observation of the above quoted studies indicated that the authors identified a unit as a 'sick' one when it had filed the petition of bankruptcy or when the unit had been closed down or when the unit had really became bankrupt; and likewise, 'the units at risk' had been identified as basically a running unit disclosing all or major symptoms and financial characteristics of the closed or bankrupt one, but depended "largely upon various factors which might increase or decrease their probability of failure"*[166].

The present study has considered the matter (i.e. corporate/industrial sickness) in a different manner. This study attempted

---

* For instance, suppliers, bankers, etc. may be reluctant to advance credits to such companies and this may bring about their collapse[172].

to analyse the corporate financial health and/or its different degrees of sickness following the guidelines as have been provided by the Indian Parliament[167], the Reserve Bank of India[168], the State Bank of India[169] and the Development Commissioner, Small Scale Industries[170]. The present study considered the corporate financial health of the sample units as has been provided by the Indian authorities concerned[171], as the variable to predict and is concerned with the analyses of the significance (predictability) of the financial ratios in this context to discriminate between the 'sick' one and the 'good' one.

The corporate financial sickness prevail upon by degrees through phases. It could be observed that the units suffering from the deficiency or shortage in working capital incur cash losses and the resultant effect of these two led to errosion of net worth of the units. The shortage or deficiency in working capital* of an enterprise invited unfavourable operating cash flows** and the effect of these two resulted in errosion of networth*** and turned the enterprise to be into financial sickness. In other words, when the working capital, operating

---

* The negative value of working capital was considered as the signals for shortage or deficiency in working capital.

** The negative value in operating cash flows was considered as the signals for unfavourable operating cash flow and which further indicate the excess in outflow over the inflow of cash which was also the symptom of poor earning capacity and cash losses.

*** This is, generally, indicated by showing the zero or negative value of net worth.

cash flows and net worth of an enterprise disclosed zero or negative value, the enterprises were considered to be in acute financial distress.

In India, the term 'industrial sickness' provides a different connotation and the essence of 'sickness' has been considered by the authorities concerned in a different way because the background of corporate culture influence the views of the authorities responsible to Government. As the present study is based on the financial data of the corporate bodies governed by the enactments drawn upon by those authorities and as the published financial statements are drawn upon according to the dictum[173] of such enactments and examined by the qualified professionals also on the basis of the guidelines and dictum[174] provided by the enactments, we have no alternative but to accept the definitions provided by such authorities.

The information and explanations collected so far have forced the present author into the belief that in India, the share-holders, the financial institutions, the commercial banks and the political leaders considered an enterprise to be a 'sick' one for reasons born of their self-interests, and that it is very difficult to accept the way they view an enterprise to be a 'sick' one.

As the present study is based on the Indian context, the definition for identification of the units are grounded on the definitions given by the authorities already referred to[175].

The present study, on the basis of such given definitions, regards the financial health of a particular unit at a particular point of time (i.e the annual financial statement date) as the 'sick' one when it discloses negative working capital, negative operating cash-flow and negative net worth; and likewise, the financial health of an unit has been considered a 'good' one when it discloses a positive value of these three particular financial variables. The financial health of the units lying between these two extremes have been considered as units having 'semi-good'/'semi-sick' - financial health.

It is to note that the earlier studies in this line have considered either the units of manufacturing industry or the trade accounts of the units of manufacturing industry or the trade accounts of banks (vide, Table - II), but none has studied the sample units of agro-industry in this context. The present study has identified the agro-industry as the area to be looked into and has particularly chosen the Tea Industry to test the predictability of the financial ratios to predict the financial health of the sample units.

* * *

N O T E S & R E F E R E N C E S

1. Webster's New Collegiate Dictionary, Eighth edition, G & C Mirraim, Spring-field, Mass : 1975, p. 958.
2. Deardean, J. and Bhattacharya, S.K. : Accounting for Management; Text and Cases ; Vikas Publishing House, New Delhi, 1976, pp. 277, 278.
3. Horrigan, J.O., "Some Emperical Bases of Financial Ratio Analysis", The Accounting Review, Vol. 40, July 1965, pp. 558-568.
4. Altman, E.I., "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", Journal of Finance, Sept., 1968, p. 590.
5. Edmister, R, "Financial Ratios and Credit Scoring for Small Business loans", The Journal of Commercial Bank lending, Sept. 1971, p. 10.
6. Courtis, J.K., "Modelling a Financial Ratios Categoric Framework", Journal of Business Finance and Accounting, Vol. 5, No. 4, 1978, p. 371.
7. Beaver, W.H., "Financial Ratios as Predictors of Failure", Emperical Research in Accounting, Selected Studies, 1966, Supplement to Journal of Accounting Research, 1966, p. 71.
8. Gupta, L.C.,:Financial Ratios for Monitoring Corporate Sickness; Oxford University Press, New Delhi, 1983, p. 1.
9. Kaveri, V.S.,:Financial Ratios as Predictors of Borrower's Health, (with Reference to Small-Scale Industries in India); Sultan Chand & Sons, New Delhi, January 1980, p. 1.
10. Altman, E.I., op. cit.,pp. 590-591.
11. Smith, R.F. and Winakor, A.H.,: Changes in the Financial Structure of Unsuccessful Corporations, University of Illinois, Bureau of Business Research, 1935.
12. Beaver, W.H., 1966, op. cit., pp. 71-111.

13. Altman, E.I., 1968, op. cit, pp. 589-609.
14. Scapens, R.W., Ryan R.J. and Fletcher, L., "Explaining Corporate Failure : A catastrophe Theory Approach", Journal of Business Finance and Accounting, Vol. 8, No. 1, 1981, p. 5.
15. Kaveri, V.S., op. cit, p. 2.
16. Miller, Donald E., The Meaningful Interpretation of Financial Statements, American Management Association, New York, 1966.
17. Gupta, L.C., op. cit, p. 2.
18. Beaver, W.H., 1966, op. cit, pp. 71-111.
19. Gupta, L.C., op. cit, p. 5.
20. Scapens and others, op. cit, p. 5.
21. Beaver, W.H., 1966, op. cit, pp. 71-111.
22. Beaver, W.H., "Alternative Accounting Measures as Predictors of Failure", The Accounting Review, 43, January 1968, pp. 113-22.
23. It is believed in the literature that the liquid-asset-ratio predict failure better than the non-liquid-asset ratios; and also believed that the liquid-asset-ratios are more useful to the short-term prediction and the non-liquid-asset ratios are useful to the long term prediction.- Foulke, Roy A., Practical Financial Statement Analysis, McGraw-Hill, New York, 1957, p. 71.
24. Beaver, W.H., 1968, op. cit, p. 113-22.
25. Fess, P. , "The Working Capital Concept", The Accounting Review, April 1966, pp. 266-70.
26. Sorter, G.H. and Benston, G., "Appraising the Defensive Position of a Firm : The Internal Measure", The Accounting Review, October 1960, p. 639.
27. Altman, E.I., 1968, op. cit, pp. 589-609.
28. Ibid, pp. 589-609.
29. Ibid, p. 602.
30. Ibid, p. 609.
31. Altman, E.I., "Corporate Bankruptcy Prediction and its Implications for Commercial Loan Evaluations", The Journal of Commercial Bank lending, December, 1970, pp. 8-22.

32. Johnson, Craig G., "Ratio Analysis and the Prediction of Firm Failure", The Journal of Finance, Vol. 25, December, pp. 1166-1168.

33. Ibid, pp. 1166-1168.

34. Ibid, pp. 1166-1168

35. Ibid, pp. 1166-1168

36. Gupta, L.C., op. cit, p. 8.

37. Ibid, pp. 81-84.

38. Ibid, p.8.

39. Altman, E.I., "A Reply to Craig G. Johnson's Ratio Analysis and the Prediction of Firm Failure", The Journal of Finance, Vol. 25, December 1970, pp. 1169-72.

40. Ibid, pp. 1169-72.

41. Ewert, David, "Trade Credit Management : Selection of Accounts Receivable Using Statistical Model", Unpublished Ph.D. dissertation, Stanford University, 1968.

42. Blum, Marc, "The Failing Company Doctrine", Unpublished Ph.D. dissertation, Columbia University, 1969.

43. Ibid.

44. Gupta, L.C., op. cit, p. 10.

45. Meyer, Paul A. and Piffer, H.W., "Prediction of Bank Failures", The Journal of Finance, Vol. XXV, Sept, 1970, pp. 853-68.

46. Ibid, pp. 853-68.

47. Edmister, R.O., "Financial Ratios as Discriminant Predictors of Small Business Failure", Unpublished Ph.D. dissertation, The Ohio State University, 1970.

48. Edmister, R.O., "Financial Ratios and Credit Scoring for Small Business Loans", The Journal of Commercial Bank Lending, September, 1971, p. 14.

49. Deakin, E.B., "A Discriminant Analysis of the Predictors of Failure", Journal of Accounting Research, Vol. 1, No. 10, Spring 1972, pp. 167-179.

50. Beaver, W.H., 1966, op. cit, pp. 71-111.
51. Gupta, L.C., op. cit, p. 10.
52. Ibid, p. 10.
53. Altman, E.I., Margain, M., Schedosser, M. and Vernimmeni, P., "Financial and Statistical Analysis for Commercial loan Evaluation, A French Experience", The Journal of Financial and Quantitative Analysis, March 1974, pp. 195-211.
54. Chesser, Dalton L., "Predicting Loan Non-compliance", The Journal of Commercial Bank Lending, August 1974, pp. 28-38.
55. Kaveri, V.S., op. cit, p. 22.
56. Wilcox, Jarrod W., "The Gambler's Ruin Approach to Business Risk", Sloan Management Review, Vol. 18 (Fall 1976) pp 33-46.
57. Ibid, pp. 33-46.
58. Gupta, L.C., op. cit, p. 11.
59. Ibid, p. 11.
50. Belkaoui, Ahmed, "Financial Ratios as Predictors of Canadian Takeovers", Journal of Business Finance and Accounting, Vol. 5, No. 1, 1978, pp. 93-107.
61. Ibid, p. 104.
62. Ibid, p. 104.
63. Ibid, p. 104.
64. Norton, C.L. and Smith, R.E., "A Comparison of General Price Level and Historical cost Financial Statements in the Prediction of Bankruptcy", The Accounting Review, January 1979, pp. 72-87.
65. Kaveri, V.S., op. cit, 1980.
66. Kaveri, V.S., op. cit, p. 217.
67. Ohlson, James A., "Financial Ratios and the Probalistic Prediction of Bankruptcy", Journal of Accounting Research, Vol. 18, No. 1, Spring 1980, pp. 109-131.

68. Ibid, p. 113.
69. Ibid, p. 113.
70. Ibid, p. 113.
71. Ibid, p. 110 and 130.
72. Scapens and others, op. cit., pp. 1 to 26.
73. Catastrophe theory provides an insight into the dynamic behaviour of system as they approach areas where instability may occur. It is concerned with the analytical explanation of sudden changes in the behaviour of a system arising as a result of smooth changes in those factors which determine the attainable equilibrium states of that system. It also provides an analytical explanation of system behaviour under the influence of multiple control variable.

    Thom, R., Stabilite Structurelle et Morphogenese, (Benjamin, New York), Translated as Structural Stability and Morphogenesis, (Benjamin-Addison Wesley, New York) 1972.

74. Scapens et al, op. cit, p. 2.
75. Ibid, pp. 1 to 26.
76. Ibid, pp. 1 to 26.
77. Gupta, L.C., op. cit, 1983.
78. Ibid, p. 128.
79. Ibid, p. 128.
80. Ibid, p. 117.
81. Ibid, p. 119.
82. Ibid, p. 33.
83. Ingram, F.J. and Frazier, E.L., "Alternative Multivariate Tests in Limited Dependent Variable Models : An Emperical Assessment", The Journal of Financial and Quantitative Analysis, No. 2, Vol. XVU, June 1982, pp. 227-240.

84- Ibid, p. 227.

85. Ibid, pp. 227-240.

86. Taffler, R.J., "The Assessment of Company Solvency and Performance Using a Statistical Model", Journal of Accounting and Business Research, Autumn, 1983, pp. 295-307.

87. Ibid, p. 298.

88. Ibid, p. 305.

89. Ibid, p. 305.

90. Gentry, J.A., Newbold, P. and Whitford, D.T., "Classifying Bankrupt firms with Funds Flow Components", Journal of Accounting Research, Vol. 23, No. 1, Spring 1985, pp. 146-160.

91. Ooghe, H. and Verbaere, E., "Predicting Business Failure on the basis of Accounting Data : The Belgian Experience", The International Journal of Accounting, Vol. 20, No. 2, Spring 1985, pp. 19 to 44.

92. Ibid, p. 41.

93. Casey, C.J., McGee, V.E., and Stickney, C.P. "Discriminating Between Reorganised and Liquidated Firms in Bankruptcy", The Accounting Review, Vol. LXI, No. 2, April 1986, pp. 249-262.

94. Houghton, K.A. and Woodliff, D.R., "Financial Ratios : The Prediction of Corporate 'Success' and Failure", Journal of Business Finance & Accounting, 14(4), Winter 1987, pp. 537-554.

95. Ibid, p. 539.

96. Ibid, p. 552.

97. Ibid, p. 552.

98. Horrigan, James O., "The determination of Long-term Credit Standing with Financial Ratios", Emperical Research in Accounting : Selected Studies, Supplement to the Journal of Accounting Research, Vol. 4, 1966, pp. 42-62.

99. Pinches, George E. and Mingo, Kent A., "A Multivariate Analysis of Industrial Bond Rating", The Journal of Finance, Vol. 28, No. 1 (March) 1978, pp. 1-18.

100. Pogue, Thomas F. and Soldafsky, Robert M., "What's in Bond Rating?" Journal of Financial and Quantitative Analysis, Vol. 4, No. 2 (June) 1969, pp. 201-228.

101. West, Richard, "An Alternative Approach to Predicting Corporate Bond Ratings", Journal of Accounting Research, Vol. 8 (Spring)1970, pp. 118-128.

102. Altman, E.I., "Corporate Bankruptcy in America", Lexinton, Mass, D.C. Health, 1971.

103. Altman, E.I., Baidya, T.K.N. and Ribeiro Dias, L.M., "Assessing Potential Financial Problems for Firms in Brazil", Journal of International Business Studies, Vol. 10, No. 2 (Fall 1979) pp. 9-24.

104. Altman, E.I., Haldeman, R.G. and Narayanan, P., "ZETA Analysis : A New Model to Identify Bankruptcy Risk of Corporations", Journal of Banking and Finance, Vol. 1, No. 1 (June) 1977, pp. 29-54.

105. Altman, E.I. and Loris, B., "A Financial Early Warning System for Over-the-Counter Broker-Dealers", Journal of Finance, Vol. 31, No. 4 (September) 1976, pp. 1201-1217.

106. Altman, E.I. and McGough, T., "Evaluation of a Company as a Going Concern", Journal of Accountancy, (December) 1974.

107. Casey, C. and Bartczak, N., "Using operating Cash flow Data to Predict Financial Distress : Some Extensions", Journal of Accounting Research, (Spring) 1985, pp. 384-401.

108. Castagna, A.D. and Matolcsy, Z.P., "The Prediction of Corporate Failure : Testing the Australian Experience", Australian Journal of Management, Vol. 6, No. 1, (June) 1981, pp. 23-50.

109. Dince, R.R. and Fortson, J.C., "The Use of Discriminant Analysis to Predict the Capital Adequacy of Commercial Banks", Journal of Bank Research, Vol. 3 (Spring) 1972, pp. 54-62.

110. Elam, R., "The Effect of Lease Data on the Predictive Ability of Financial Ratios", The Accounting Review, Vol. XLX, No. 1, January 1975, pp. 25-43.

111. Fofelberg, G., Laurent, C.R. and McCorkindale, D., "The Usefulness of Published Financial Data for Predicting Take-Over Vulnerability", University of Western Ontario, School of Business Administration, (Working Paper 150, November 1975).

112. Libby, Robert, "Accounting Ratios and the Prediction of Failure, Some Behavioural Evidence", Journal of Accounting Research, Spring 1975, pp. 150-161.

113. Mason, R.J. and Harris, F.C., "Predicting Company Failure in the Construction Industry", Proceedings of the Institution of Civil Engineers, Vol. 66 Part I, (May) 1979, pp. 301-307.

114. Martin, D., "Early Warning of Bank Failure : A Logit Regression Approach", Journal of Banking and Finance, Vol. 1 (Nov) 1977, pp. 249-276.

115. Moyer, R., "Forecasting Financial Failure : A Re-examination", Financial Management, Spring 1977.

116. Rege, Udayan P., "Accounting Ratios to Locate Take-Over Targets", Journal of Business Finance and Accounting, 11(3), Autumn 1984, pp. 301-311.

117. Reuber, G.L. and Roseman, F., "The Take-Over of Canadian Firms, 1945-61 : An Emperical Analysis, Economic Council of Canada, Special Study No. 10 (Ottawa, Information Canada) 1969.

118. Santomero, A. and Vinso, J.D., "Estimating the Probability of Failure for Commercial Banks and the Banking System", Journal of Banking and Finance, September 1977.

119. Scott, J., "The Probability of Bankruptcy", Journal of Banking and Finance, Vol. 5, 1981, pp. 317-344.

120. Sing, A., "Take-Overs", (Cambridge : Cambridge University Press 1971).

121. Stevens, D.L., "Financial characteristics of Merged Firms: A Multivariate Analysis", Journal of Financial and Quantitative Analysis, March 1973, pp. 149-158.

122. Talmor, Eli, "A Normative Approach to Bank Capital Adequacy", Journal of Financial and Quantitative Analysis, Vol. XV, No. 4, November 1980, pp. 785-811.

123. Van Frederikslust, R.A.I., "Predictability of Corporate Failure : Models for Prediction of Corporate Failure and for Evaluation of Debt Capacity", Nijhoff, 1978.

124. White, R.W. and Turnbull, M., "The Probability of Bankruptcy : American Railroads", Working Paper, Institute of Finance and Accounting, London University Graduate School of Business, February, 1975a.

125. ——"The Probability of Bankruptcy for American Industrial Firms", Working Paper, July 1975b.

126. Wilcox, J.W., "A Prediction of Business Failure Using Accounting Data", Emperical Research in Accounting, Selected Studies, 1973, pp. 163-179.

127. Gupta, Manek C., "The effect of Size, Growth and Industry on the Financial Structure of Manufacturing Companies", The Journal of Finance, Vol. 24, No. 3, June 1969, pp. 515-529.

128. Gupta, Manek C. and Huenfer, Ronald J., "Cluster Analysis of Financial Ratios and Industry Characteristics", Journal of Accounting Research, Vol. 10, Spring 1972, pp. 77-95.

129. Courtis, John K., "Modelling A Financial Ratios Categoric Framework", Journal of Business Finance & Accounting, Vol. 5, No. 4 (1978), pp. 371-386.

130. Horrigan, James O., "Some Emperical Bases of Financial Ratio Analysis", Accounting Review, Vol. 4, July 1965, pp. 558-568.

131. Laurent, C.R., "Improving the efficiency and effectiveness of Financial Ratio Analysis", Journal of Business Finance & Accounting, Vol. 6, No. 3, 1979, pp. 401-414.

132. Pinches, G.E., Eubank,A.A., Mingo, K.A. and Caruthers, J.K., "The Hierarchical Classification of Financial Ratios", Journal of Business Research, Vol. 3, No. 4, Oct, 1975, pp. 295-310.

133. Pinches, G.E., Mingo, K.A. and Caruthers, J.K., "The Stability of Financial Patterns in Industrial Organisations", The Journal of Finance, Vol. 28, No. 2 (May) 1973, pp. 389-96.

134. Barnes, Paul, "Methodological Implications of Non-Normally Distributed Financial Ratios", Journal of Business Finance & Accounting, Vol. 9, No. 1, 1982, pp. 51-62.

135. Bird, R.G. and McHugh, A.G., "Financial Ratios : An Emperical Study", Journal of Business Finance & Accounting, Vol. 4, No. 1, Spring, 1977, pp. 29-45.

136. Bougen, P.D. and Drury, J.C., "U.K. Statistical Distributions of Financial Ratios, 1975", Journal of Business Finance & Accounting, Vol. 7, No. 1, 1980, pp. 39-47.

137. Deakin, E.B., "Distributions of Financial Accounting Ratios : Some Emperical Evidence, "The Accounting Review, January 1976, pp. 90-96.

138. Donnithorne, C., "Statistical Distributions of Financial Accounting Ratios: Further Emperical Evidence", Proceedings of the South West Regional AAA Meeting (1981), pp. 125-32.

139. Foster, G., Financial Statement Analysis, Prentice-Hall, 1978, pp. 170-171.

140. Kennedy, H., "A Behavioural Study of the Usefulness of Four Financial Ratios", Journal of Accounting Research, Spring 1975, pp. 97-116.

141. Lev, B., "Industry Averages as Targets for Financial Ratios", Journal of Accounting Research, Vol. 7, Part 2, 1969, pp. 290-299.

142. McDonald, Bill and Morris, Michel H., "The Statistical Validity of the Ratio Method in Financial Analysis : An Emperical Examination", Journal of Business Finance & Accounting, Vol. 11, No. 1, Spring 1984, pp. 89-97.

143. O'Connor, M.C., "On the Usefulness of Financial Ratios to Investors in Common Stock", Accounting Review, April 1973, pp. 339-352.

144. Tamari, M., "Financial Ratios, Analysis, and Prediction", Paul Elek, 1978.

145. Whittington, Geoffrey, "Some Basic Properties of Accounting Ratios", Journal of Business Finance & Accounting, Vol. 7, No. 2, 1980, pp. 219-232.

146. Altman, E.I. and Eisenbeis, R.A., "Financial Applications of Discriminanant Analysis : A Clarification", Journal of Financial and Quantitative Analysis, 13 (March 1978), pp. 185-95.

147. Dillon, W.R., "The Performance of Linear Discriminant Function in Non-optimal Situations and the Estimation of Classification Error Rates: A Review of Recent Findings", Journal of Marketing Research 16 (August 1979) pp. 370-81.

148. Eisenbeis, R.A., "Pitfalls in the Application of Discriminant Analysis in Business, Finance and Economics, " Journal of Finance, 32 (June 1977) pp. 875-900.

149. Gonedes, W.J. and Dopuch, N., "Economic Analysis and Accounting Techniques : Perspective and Proposals", Journal of Accounting Research, 17 (Autumn 1979) pp. 384-410.

150. Joy, O.M. and Tollefson, J.O., "On the Financial Applications of Discriminant Analysis", Journal of Financial and Quantitative Analysis, 10 (December 1975), pp. 723-39.

151. Lachenbruch, P.A., Sneeringer, C. and Revo, L.T., "Robustness of the Linear and Quadratic Discriminant Function to Certain Types of Non-Normality", Communications in Statistics, 1(1), 1973, pp. 39-56.

152. Richardson, Frederick M. and Davidson, Lewis F., "An Exploration into Bankruptcy Discriminant Model Esensitivity", Journal of Business Finance & Accounting, Vol. 10, No. 2, 1983, pp. 195-207.

153. _____, "On Linear Discrimination with Accounting Ratios", Journal of Business Finance & Accounting, Vol. 11, No. 4, Winter 1984, pp. 511-525.

154. Bildersee, J.S., "Discussion of the Impact of Price-Level Adjustment in the Context of Risk Assessment and the Effect of General Price-Level Adjustments on the Predictive Ability of Financial Ratios", Journal of Accounting Research, Supplement to Vol. 16, 1978, pp. 285-292.

155. Ketz, J.E., "The Effect of General Price-Level Adjustments on the Predictive Ability of Financial Ratios", Journal of Accounting Research, Supplement to Vol. 16, 1978, pp. 273-284.

156. Patel, J.M., "Discussion of the Impact of Price-Level Adjustment in the Context of Risk Assessment and the Effect of General Price-Level Adjustments on the Predictive Ability of Financial Ratios", Journal of Accounting Research, Supplement to Vol. 16, 1978, pp. 293-300.

157. Solomon, I. and Beck, P.J., "A Comparison of General Price Level and Historical Cost Financial Statements in the Prediction of Bankruptcy : A Comment", Accounting Review, Vol. 55, No. 3, July 1980, pp. 511-515.

158. Kilne Jr., C.A. and Hessler, L. Howard, "Du Point Chart System for Appraising Operating Performance", N.A.C.A. Bulletin, Conference Proceedings, August 1952, pp. 1595-1619.

159. Tucker, S., Successful Managerial Control by Ratio Analysis, Pretice-Hall Inc., Engle-Wood Cliffs, New Jersy, 1964.

160. Beaver, W.H., 1966, op. cit, pp. 71-111.

161. Altman, E.I., 1968, op. cit, pp. 589-609.

162. Blum, Marc, op. cit, 1969.

163. Meyer, P.A. and Pifer, H.W., op. cit, pp. 853-68

164. Edmister, R.O., op. cit, 1970.

165. Deakin, E.B., op. cit, pp. 167-179.

166. Scapens and others, op. cit, p. 6.

167. Please see Notes & Ref. No. 27d of Chapter I

168. Please see Notes & Ref. No. 27b of Chapter I

169. Please see Notes & Ref. No. 27a of Chapter I

170. Please see Notes & Ref. No. 27c of Chapter I

171. The Indian Parliament, The Reserve Bank of India, The State Bank of India, The Development Commissioner, Small Scale Industries, for the definitions provided by these authorities, please see No. 27 of the Notes and References of Chapter I.

172. Scapens and others, op. cit, p.6.

173. The Indian Companies Act, 1956 and its amendments.

174. The Indian Chartered Accountant Act, 1949.

175. Please see Notes & Ref. No. 171 of Chapter II.

* * *