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Financial Ratios, Econometrics and Prediction of Corporate Bankruptcy-an Empirical Study

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Abstract

The discriminant function developed using discriminant analysis is Z = -3.4532 + 0.03605 Current ratio + 0.6589 Asset turnover +3.1129 Proprietary ratio. This helps in assigning 'Z' score to a company, which is capable of assigning a company either belonging to the group of solvent companies or to the group of bankrupt companies. By applying the discriminant model to the financial ratios of Lehman Brothers, Bear Sterns, and Freddie Mac we find that the application of this model would have helped in raising an alarm about the bankruptcy of these companies well in advance and acted as 'Whistle Blower.'

Keywords: Discriminant function; Bankruptcy; Financial ratios; Wilks' lamda; Eigen value

Introduction

As a setback of Sub-Prime Crisis large number of business houses and banks, particularly in the field of financial services, and financial markets faced the situation of corporate failure and incidence of bankruptcy across the globe. Even it is surprising for certain analysts and thinkers that despite of having financial ratios as a powerful tool to analyze financial health of a business organization, no one could predict the fast approaching incidence of large scale bankruptcy. The answer lies in the fact that different financial ratios are either correlated with each other or have collinearly relationship; therefore interpretation of individual financial ratio can rarely help in proper, accurate and timely interpretation about financial health of a business organization under diagnosis or analysis. But this does not undermine the use of financial ratios in financial analysis or predicting financial outcomes of a business organization. Different financial ratios used in combination with certain statistical techniques like multiple regression analysis, multiple discriminant analysis, factor analysis or multiple analysis of variances can definitely help in developing a fore-warning system which can function as a Whistle Blower before the actual incidence of bankruptcy takes place. Out of various statistical methods quoted here discriminant analysis using financial ratios as independent variables to choose bankruptcy predictor has been used. The main purpose of the research study undertaken and presented here was to develop a model which could help in identifying statistical significant financial ratios, out of the whole bunch of financial ratios used for financial analysis, which could discriminate between a healthy business organization and a bankrupt (not healthy) business organization. The discriminant model so developed established a 'Z Score' and a 'Cut Off Point' which when applied in assessing financial performance can assign a discriminant score to each of the business organization under observation and help in classifying it either into the group of healthy business organization or bankrupt (not healthy) business organization. When this discriminant model is applied successively year after year using financial ratios of different financial years in a sequence can help in generating a signal whether the business organization under scrutiny is likely to face the situation of bankruptcy or it is not likely to face such situation. Therefore the model so developed can be used as a Whistle Blower in predicting bankruptcy of business organization under observation.

Discriminant Analysis Discriminant Model

Discriminant analysis is a statistical technique useful in classification of individuals or observations into two or more mutually exclusive groups, on the basis of a set of predictor variables. Under discriminant analysis it is believed that there is one nominal dependent variable and two or more interval scaled predictor (independent) variables. The groups in which the individuals or the objects are classified are mutually exclusive and exhaustive, such as sick and healthy, good and bad, user; casual user and non-user, and so on. The variance and covariance of the predictor variables are equal across the groups. Discriminant analysis tries to derive a linear combination of two or more independent variables that are capable of discriminating between the groups classified a priori defined groups. Discriminant analysis is applicable only when the dependent variable is non-metric and categorical, that is, it is capable of being classified into two or more well-defined finite groups, such as sick and non-sick, financially viable and non-viable, and so on. The dependent variable is related with several independent variables which all happen to be metric or continuous and the groups are multivariate normal with equal variance and covariance. The main objective of discriminant analysis is to determine the variables, which account for major portion of inters group difference. Using different statistical value of these variables discriminant coefficient for each of the significant variables is arrived at which is used to calculate 'Z Score' for each of the observations as well as for each of the groups. 'Z Score' of each of the groups is further used to arrive at a bench mark score called 'Cut Off Point' which serves the basis for assigning new individuals to one of the groups, assuming that it belongs to one of the groups defined a priori. In this research study discriminant analysis is applied to develop discriminant model capable of classifying different stock broking firms and investment bankers into two distinct groups, that is, bankrupt (insolvent) and solvent. The dependent variable in our research study is status of bankruptcy and status of being solvent

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whereas independent variable are different financial ratios capable of indicating financial performance of a broking firm and investment banker.

Review of Literature

Argenti's J [1] a Study on Corporate Failures is by far the best theoretical study in analysis of failure. The approach is dynamic and traces the firm's path from health to failure. Argents has typified three trajectories of organizations' failure. He, however, does not claim that firms fail only along these three trajectories. Argents distinguished the symptoms of failure from the causes of failure and explained. He says, "If the management of a company is poor the accounting information will be neglected or such information will be deficient and the company will not respond to change, some may be damaged because of a powerful constraint. Poor managers will make at least one of the three errors; they will overtrade; or they will launch a big project; or they will let the gearing rise to level that even a normal business hazard will become a constant threat. When these symptoms appear, the financial ratios will deteriorate and managers will resort to creative accounting, which helps companies escape predictive models based on financial ratios. In a few cases luck may run out". Bidhani and Mitra [2] have identified internal and external causes of sickness. The internal and external causes are classified on a functional basis. Basically it is considered that internal reasons are controllable and external reasons are not under the control of corporate management have compared the process of sickness in an industry with that of a human body having a biological organism, which generally passes through various stages before it may become sick. They categorized sickness into three types of failures like Type I failure- failure of small enterprises in which performance does not rise beyond poor performance level and life of the enterprise is between two to five years. Type II failure- failure of young enterprise that has achieved 100% growth but it is believed by the entrepreneur that growth beyond 100% is not possible. Type III failure - failure of mature companies which has an age old background of existence in the industry. Accordingly, if the sickness continues for a long period it may become chronic ultimately relate to Type II and Type III failure. Gupta's comprehensive approach to corporate sickness advocates that there are no causes like internal or external. Gupta opposed such a classification of causes. He identified five basic typologies of industrial sickness as operating, strategic, staying-power deficient, stale born and catastrophic. Sahu and Misra according to them "sickness in an industrial unit like in the human body, is an organic process which generally passes through various stages before it manifests fully in the bankruptcy of the industrial unit". Srivatsava [3] based the process of sickness on the principle forewarning signals. He identified four financial ratios as significant and capable of discriminating between the performances of financially sound and financially unsound companies. Further he has taken financial parameters to explain the different stages in the process of sickness. Misra identified the symptoms of sickness initially in the functional area. Further he explained the process of sickness on similar lines of Srivatsava taking the financial parameters. Misra has taken the management factor like management defects and selected four ratios for identifying the symptoms for forewarning the sickness in the process of sickness.

Research Methodology

In the year 2008 to 2009 the impact of US Sub-Prime Crisis was very severe which resulted in the failure/closure/bankruptcy of a large number of companies across the globe [4-8]. The majority of companies facing failure belonged to financial market segment like investment companies, stock broking firms/companies, banks and insurance companies. During this phase many companies could withstand the shocks of sub-prime crisis and survive during the period of crisis. As it is believed that corporate failure does not take place overnight rather it is a gradual process through which the incidence of sickness occurs. This phenomenon prompted the researcher in carrying out a study with the aim to develop a model that could predict corporate failure much before the incidence of failure occurs. The research study was undertaken to develop a model for predicting corporate failure using financial ratios on the principles of discriminant model. For the purpose of research work two exclusive groups of stock broking companies/ investment bankers were identified. The group 'A' comprised all those companies which survived during the period of sub-prime crisis and group 'B' comprised all those companies which could not survive during the period of sub-prime crisis. Group 'A' companies were labeled as 'Healthy Companies' and group 'B' companies were labeled as 'Sick Companies.

- Research Type: The research study carried out was empirical in nature.
- The Universe: Stock broking companies and investment bankers.
- Sampling Frame: Stock broking companies and investment bankers listed on the stock exchange Mumbai (BSE).
- Sampling Design: Random sampling by draw of the lots.
- Sample Size: 20 Companies 10 each from group A and group B.
- Date Type: Secondary in nature.
- Data Source: Annual Reports of sample companies for five financial years i.e., from 2003-to 2004 through 2007 to 2008.
- Tools for Analysis : (i) Ratio Analysis, (ii) Discriminant model, (iii) 't' test for testing hypothesis at 5% significance level, and (iv) other statistical measures like eignvalue, Wilk's Lamda, chi-square and similar other measures.
- Hypothesis

Null hypothesis: There exists no such set of financial ratios which act as discriminating factor between companies of group 'A' and Group 'B', that is, there is no difference between the performance of companies of group 'A' and the performance of companies of group 'B'.

Alternate hypothesis: There exists a set of financial ratios that acts as discriminating factor between companies of group 'A' and Group 'B', that is, there is a difference between the performance of companies of group 'A' and the performance of companies of group 'B'.

- Scope of the study

The data used for the study were of the five financial years from 2003 to 2004 through 2007 to 2008. In the study Stock Broking Companies and Investment Bankers working in India were studied and a random sample by the draw of the lots was selected, in which companies from all the parts of India found the place like Southern India, Northern India, and Maharashtra, etc. A paired sample of ten companies each from both the groups was selected.

- Significance of the study

Since the study was aimed at developing a model that could predict corporate failure much before the incidence of corporate failure occurs the model was developed using financial ratios and concept of

discriminant analysis. The model so developed has great significance for Government authorities designing regulatory norms for the companies covered under the study, investors making investment in these companies, clients of these companies and in general for researchers and academicians.

- Limitations of the study

The findings of the study are subject to following limitations:

a) The ratio analysis was carried out on the basis of data available in the annual reports which might have been subjected to certain window dressing effects or creative accounting.

b) The difference in the inter firm accounting policies might have affected the results of the research.

c) The Discriminant Model developed will find its' application only in the circumstances which were applicable to the sample data.

d) Findings are subject to the limitations of Discriminant Analysis and Ratio Analysis.

Developing Discriminant Model Using Financial Ratios

The process of developing discriminant model was carried out by performing several logical steps. Different financial ratios for the financial year 2007 to 2008 through 2003 to 2004 were used as independent variables [9]. The year 2007 to 2008 was identified as one year prior to the incidence of actual bankruptcy, similarly the year 2006 to 2007, 2005 to 2006, 2004 to 2005 and 2003 to 2004 were identified as two, three, four and five year prior to the incidence of actual bankruptcy, respectively. The logical steps are detailed below:

Identification of statistically significant set of financial ratios

The first step for developing the model was to identify significant set of financial ratios that could differentiate between the performances of group 'A' companies and group 'B' companies. For this purpose 'Student's t-test was applied to measure whether the difference between the mean values of financial ratios of companies belonging to group A and group B was statistically significant or not. (Refer Table 1 for 't -test' value of different ratios). It was presumed that, there exists no difference between the mean values of ratios for the two groups one year prior to the incidence of corporate failure/bankruptcy, that is, for the financial year 2007 to 08. Null hypothesis -There was no significant difference between the mean values of ratios for the two groups one-year prior (2007-08) to the incidence of corporate failure. Alternate hypothesis - There was a significant difference between the mean values of ratios for the two groups one-year prior (2007-08) to the incidence of corporate failure. An observation of (Table 1) reveals that current ratio with calculated t-value 2.87, asset turnover ratio with calculated t-value 2.64 and proprietary ratio with calculated t-value 3.69 whereas for rest of the financial ratios, calculated t-value is less than the table value (2.10) at 5% level of significance with 18 degree of freedom [10,11]. Hence it is concluded that these three ratios could discriminate between the financial state of health of companies of group 'A' and group 'B' companies.

S.No.	Ratio	Calculated t-value
1	Current Ratio	2.87
2	Short Term Bank Finance to Working Capital	1.89
3	Asset Turnover Ratio	2.64
4	Proprietary Ratio	0.92
5	Interest coverage Ratio	0.55
6	Debtors Turnover Ratio	0.16
7	Capital Adequacy Ratio	1.46
8	Proprietary Ratio	3.69
9	Deposits to net owned fund	1.03
10	EBIT to Total Tangible Asset	1.24
11	Return on Net Worth	0.87
12	Earning Per Share	0.15
13	Interest coverage ratio	1.26

Table 1: Result of 't - test' using financial ratios for the year 2007-08 of sample companies.

The discriminant function and discriminant co-efficient

Using the financial ratios for all the twenty companies (ten from each of the group 'A' and group 'B') for the financial year 2007 to 2008 discriminant function and discriminant co-efficient for these three financial ratios was calculated using statistical software- 'Win Stat'. The results are as discussed below.

Determination of discriminant co-efficient: Discriminant coefficient was calculated by multiplying the inverse of the within groups variance-covariance matrix by the vector of mean different. Inverse of within groups' variance-covariance was calculated using standard statistical methodology. The results are presented in (Table 2).

Discriminant function: The relative contribution of each of the independent variable in arriving at the 'Z Score' is assessed with the help of beta coefficient of each of the independent variable considered significant. Higher the beta coefficient also knows as discriminant coefficient more is the importance of the variable in discriminating between the groups. An observation of (Table 2) reveals that discriminant coefficient of proprietary ratio is 3.1129 which is highest, followed by asset turnover ratio with discriminant coefficient 0.6589, and least is 0.03605 for current ratio. The constant also known as alpha of the discriminant function is -3.4532. The discriminant function is written as

$$(1)\ Z = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n$$

Here,

Z = discriminant function score capable of discriminating between dependent variables

α = constant in the discriminant function also known as alpha (α) component of 'Z' score

$\beta_1, \beta_2 \ldots \beta_n$ = beta (β)coefficient also known as discriminant coefficient of variable $x_1, x_2, \ldots x_n$ this also signifies relative importance of respective independent variable in the discriminant function

$x_1, x_2, \ldots x_n$ = independent variables of discriminant function

The discriminant function developed using significant financial ratios is as follows

$$(2)\ Z = \alpha + \beta_1 \text{Current ratio} + \beta_2 \text{Asset turnover} + \beta_3 \text{Proprietary ratio}$$

(3) Z = -3.4532 + 0.03605 Current ratio + 0.6589Asset turnover + 3.1129 Proprietary ratio

Ratio/Function	Non-Standardized Discriminant Coefficient
Current ratio	0.03605
Asset Turnover Ratio	0.6589
Proprietary Ratio	3.1129
Constant	-3.4532

Table 2: Non-Standardized discriminant function.

Discriminant score: By using the discriminant function depicted above, the discriminant score of each of the observation that is company under study was calculated. (Table 3) shows the discriminant score of all the twenty companies covered under the study.

Group centroids: This is the mean value of each group of the dependent variable for discriminant function discussed above. The group centroid is the mean value for the discriminant scores of all the companies classified a priori while developing discriminant function. The group centroid for group 'A' is 1.3172 whereas it is -1.3172 for group 'B'. These group centroids have further been used to arrive at the cut-off point (score).

Cut off point: The cut off point is the mean of group centroids. In our study it happened to be 0 that is zero. This is used to prepare classification (Table 4) and confusion matrix. This is also used to classify sample independent companies, that is, the companies other than the sample companies. For the new company discriminant score is calculated using discriminant function and depending upon its discriminant score it is classified either as solvent or bankrupt. If score is more than the cut-off point it is classified as solvent otherwise it is classified as bankrupt [12-15]. In our study companies with discriminant score more than zero (0) are classified as solvent and companies having discriminant score less than zero (o) are classified as bankrupt.

Measuring strength of relationship-confusion matrix

To measure the predictive accuracy of the discriminant function developed using sample data a confusion matrix also known as error matrix was prepared. This is a table in which the rows are the observed categories of the dependent variables (observations) and the columns are the predicted categories of the dependent variables (observations). When prediction is perfect, all cases will lie on the diagonal. The percentages of cases on the diagonal add up to make the percentage of correct classifications, whereas, percentages of classification falling in rest of the cells add up to make the percentage of wrong classification. The percentage of correct classification is also called the hit ratio. The confusion or classification matrix developed using the classification for the year 2007-2008, that is one year prior to the incidence of bankruptcy reveals that 95% of the classifications (Table 5) were correct whereas only 5% of the classifications were wrong when compared with the prior classification. This shows that the Z score, that is, 0 (zero) calculated using the discriminant model is capable of classifying the companies into two distinct groups, that is, solvent or bankrupt with high level of accuracy.

Test of statistical significance of discriminant function

Three financial ratios identified as significant financial ratios (independent variables) capable of discriminating between the financial performance of group 'A' companies and companies of group 'B' were put to certain statistical test so as to testify the statistical validity and

Company	Current ratio	Asset Turnover Ratio	Proprietary Ratio	Z Score	Group
1	3.18	6.45	0.52	2.52987	A
2	5.06	3.51	0.83	1.62556	A
3	3.7	5.19	0.35	1.18925	A
4	3.85	3.66	0.48	0.59126	A
5	1.68	2.95	0.17	-0.9198	A
6	6.01	3.26	0.42	0.2188	A
7	4.33	1.62	0.91	0.60302	A
8	6.02	5.8	0.51	2.17285	A
9	1.77	6.66	0.31	1.9637	A
10	4.65	6.06	0.37	1.85897	A
11	1.2	0.44	0.12	-2.7465	B
12	1.47	2.15	0.6	-0.1159	B
13	2	0.53	0.2	-2.4093	B
14	4.7	2.89	0.27	-0.5391	B
15	1.33	3.4	0.06	-0.9783	B
16	1.83	1.1	0.18	-2.1021	B
17	3.09	3.12	0.13	-0.8814	B
18	3.19	2.68	0.43	-0.2339	B
19	0.6	1.41	0.2	-1.88	B
20	4.55	3.23	0.18	-0.6007	B

Table 3: Discriminant score of group A and group B companies.

	Current ratio	Asset Turnover Ratio	Proprietary Ratio	Discriminant Function
Eigen value	0.007134897	0.170739837	0.22775264	1.927812437
Variance (percent)	100	100	100	100
Percent cumulative	100	100	100	100
Canonic correlation	0.084168583	0.381889074	0.430701388	0.811448129
Wilks' Lambda	0.99291565	0.854160735	0.814496314	0.341551934
Chi-Square	0.124417363	2.758628048	3.590744077	17.72521634
Degrees of Freedom	1	1	1	3
P of F test	0.724292026	0.096731169	0.058102231	0.000501135
Mahalnobis Distance	0.160267	0.784	0.90548	2.6344

Table 4: Statistical measurements of significant financial ratios and discriminant function.

significance of these three financial ratios as well as the discriminant function developed using three financial ratios. The results and their interpretation are as discussed below:

Eigen value: In discriminant analysis, the number of functions is equal to the number of groups minus one or the number of independent variables, whichever is smaller, in this case there was only one discriminant function combining the effect of three significant financial ratios. The effectiveness of the function in comparison to the effectiveness of individual financial ratios is testified by interpreting eigen value. By referring to (Table 6) we observe that the Eigen value of individual ratios is not so significant but the eigen value of the discriminant function so developed is 1.9278 which comparatively is very much significant from statistical viewpoint because the higher the Eigen value, the greater the percentage of the grouping variable's variance explained by the function.

Canonic correlation: This value can be directly derived from the eigen value, Canonical Correlation = sqrt(eigen value / (1+eigenvalue) and is a measure of the overall dependency of the grouping variable on the given function [16]. Squared canonic correlation (R_c^2) is the percent of variation in the dependent discriminated by the set of independent variables in multiple discriminant analysis. By referring to (Table 4) it can be observed that canonical correlation is 0.8114 which translates to 65.83% (0.8114^2 that is canonical correlation put to power 2) of the variation in the dependent variables is explained by this discriminant function.

Wilks'Lamda: This value is obtained by subtracting the squared canonic correlation from 1. Wilks' Lamda is used to test the significance of the discriminating variable as well as the significance of the discriminant function as a whole. Smaller value of Wilks' Lamda is preferred. This signifies the proportion of the variance in the depend variable not explained by the discriminant function. Therefore smaller value of Wilks' Lamda is preferred. By observing Table 4 we find that the Wilks' Lamda of the discriminant function is 0.3416 it implies that about 34.16 % of the variations in the dependent variable are not explained by the discriminant function so developed and 65.84 % of the variations in the dependent variable are explained by the discriminant function so developed. A further test of significance of Wilks' Lamda is established with the help of 'p-value'. If the 'p-value' is less than 0.05, we conclude that the corresponding function explains the group membership well [17,18]. An observation of table 4 shows that the 'p-value' of discriminant function is 0.0005, implying that the discriminant function so developed is capable of making a clear distinction between two groups with minimal of overlapping. Same is supported by Mahalnobis distance which is 2.63. Mahalnobis distance shows the distance between the groups usually larger the mahalnobis distance less will be the chance of overlapping between the group observations.

Predictive probability: The probability of misclassification using the model was calculated by using area under normal curve corresponding to the group centroids of each of the group and it is 9.51%, which implies that there is a most likely chance that the discriminant function so developed will make 9.51% wrong classification using financial ratios of one year prior to the actual incidence of bankruptcy [19-22]. This further translates to the fact that there is 90.49% probability of accurate classification by using the discriminant function so developed one year prior to the actual incidence of bankruptcy.

Actual Group	Predicted Group		Total
	A	B	
A	9	1	10
B	0	10	10
Total	10	10	20

Table 5: Confusion matrix for the financial year 2007-2008.

Company	2006-2007	2005-2006	2004-2005	2003-2004	Group
1	4.528	4.298	3.548	2.138	A
2	-0.042	-0.052	-0.532	-1.242	A
3	0.508	0.008	-0.752	-1.572	A
4	0.968	0.858	0.528	2.948	A
5	0.888	2.008	0.508	-0.222	A
6	0.078	0.028	0.058	-0.012	A
7	5.418	2.838	3.288	4.418	A
8	1.328	2.098	2.708	2.308	A
9	0.318	1.288	-1.292	-0.682	A
10	2.238	1.928	2.218	1.078	A
11	-2.572	-2.422	-2.552	-2.062	B
12	-1.132	-2.682	-2.692	-2.922	B
13	0.678	0.368	3.358	1.368	B
14	3.128	1.568	1.338	-0.262	B
15	-0.292	0.878	0.618	1.028	B
16	-3.092	-3.122	-3.042	-3.002	B
17	0.978	1.888	2.158	1.408	B
18	-0.052	-0.312	1.278	-2.732	B
19	-9.502	-1.222	-1.482	-1.602	B
20	-0.932	-1.182	-1.172	-1.132	B

Table 6: Discriminant score for the financial year 2006-2007 through 2003-2004.

Results two to five years prior to the incidence of bankruptcy

A second level test of the discriminant function (model) developed through the process of research was undertaken by applying the function on the financial ratios for the financial year 2006 to 2007, 2005 to 2006, 2004 to 2005 and 2003 to 2004, that is respectively two to five years prior to the incidence of actual bankruptcy. The results of discriminant scores of companies have been presented in Table 6. These results were also used to prepare confusion matrix for each of these financial years (for confusion matrix refer (Tables 7a and 7b). A company having discriminant score (Z Score) more than the cut-off point (0 that is zero) was classified as belonging to 'A' group, whereas, a company having discriminant score less than the cut-off point was classified as belonging to group 'B'. An interpretation of (Tables 7a and 7b) reveals that the percentage of correct classification two year prior to the actual incidence of bankruptcy that is in the year 2006- to 2007 was 80%, as compared to the percentage of correct classification 75%,

2006-2007			2005-2006	
Actual Group	Predicted Group		Predicted Group	
	A	B	A	B
A	9	1	9	1
B	3	7	4	6
Total	12	8	13	7

Table 7a: Confusion matrix for the financial year 2006-2007 to 2005-2006.

2004-2005			2003-2004	
Actual Group	Predicted Group		Actual Group	
	A		A	
A	7	A	7	A
B	5	B	5	B
Total	12	Total	12	Total

Table 7b: Confusion matrix for the financial year 2004-2005 to 2003-2004.

60% and 60% three year, four year and five year prior respectively from the actual incidence of bankruptcy. This shows that the percentage of correct classification increased as we moved closure to the actual incidence of bankruptcy. The percentage of correct classification was 95% (Table 5) one year prior (year 2007 to 2008) to the actual incidence of bankruptcy taking place in the year 2008 to 2009. Increasing accuracy percentage shows the effectiveness of the discriminant function in making correct classification [23]. Thus it can be concluded that application of the discriminant model so developed in classifying companies in two distinct groups that is solvent and bankrupt is within the significance level with minimal error percentage.

Type I and type II error

Based upon the confusion matrices of all the financial years under study total wrong classifications were further classified as Type I Error and Type II Error. Type I Error implies rejecting a null hypothesis when it is true, in our case it implies predicting a non-sick (solvent) company as bankrupt [24]. Type II Error implies failing to reject a null hypothesis when it is not true, in our case it implies predicting a sick company as solvent (not bankrupt). Observation of (Table 8) shows that the Type I Error percentage in the year 2007 to 2008 was 10%, whereas it was 10%, 10%, 30% and 50% in two through five years prior respectively to the incidence of bankruptcy. Similarly, Type II Error percentage in the year 2007 to 2008 was nil, whereas it was 30%, 40%, 50% and 30% in two through five years prior respectively to the incidence of bankruptcy. These results of Type I and Type II error show that as we approached near the incidence of bankruptcy the error percentage of Type II error declined, implying less risk in using the model so developed. Thus the predictive accuracy of the model so developed is authenticated statistically.

Empirical Testing of Model Using Sample Independent Data

The Model so developed was empirically tested by applying it on the financial results of Bear Stern, Lehman Brothers and Freddie Mac. For this purpose financial statements of these companies were used to calculate relevant financial ratios for the financial year 2007 and 2006. These three companies could not survive during the phase of sub-prime crisis. To establish the fact about the possibility of generating a warning signal about the expected bankruptcy of these companies by applying discriminant function on the financial ratios for the year 2007 and 2006. An observation of (Tables 9a and 9b) reveals that the discriminant score of these three companies was significantly less than the cutoff point (zero) indicating the classification of these three companies as bankrupt. The discriminant score of Bear Sterns, Lehman Brothers and Freddie Mac for the year 2007 was -3.31, -3.27 and -3.33 respectively; similarly it was -3.29, -3.29 and -3.33 respectively for the year 2006. Supporting that these three companies could very well be classified as bankrupt in the year 2006 and 2007 [25]. Thus it can be concluded that the application of discriminant function (model) can help in triggering the warning signal well in advance before the actual incidence of bankruptcy. Therefore application of discriminant model in evaluating financial performance of these companies or similar other companies in the same category can act as 'Whistle Blower', leaving sufficient scope for corrective action to avoid large scale losses.

Conclusion

On the basis of research findings it is concluded that using discriminant function with financial ratios as independent variable, instead of individual financial ratios can help in proper diagnosis and analysis of financial performance. Application of discriminant function for calculating Z score can help in generating warning signal about expected bankruptcy much ahead of the actual incidence of bankruptcy. The discriminant function developed is Z=-3.4532+0.03605 Current ratio+0.6589 Asset turnover+ 3.11 Proprietary ratio. Eigen value 1.92, chi-square value 17.73 and Wilks' Lamda 0.33 indicate about statistical soundness of the discriminant function. This model explains the about 67% of the changes in the dependent variable, that is classification of companies into two groups is explained by this discriminant function whereas about 33% of the changes in the dependent variable is not explained by the discriminant function. Canonical correlation of 0.81 indicates high degree of relationship between independent variables -these three financial ratios and dependent variable - grouping companies. Mahalnobis distance of 2.63 indicates that the application of this discriminant function can help in making clear and well defined classification of companies into two groups defined a priori with minimal of grey area of classification. A low percentage of Type II error during one year and two year prior to the actual incidence of bankruptcy indicates about predictive accuracy of the model so developed and at the same time it indicates about the low risk in applying this model for predicting bankruptcy of companies of the universe of the study.

Z score can be used as a 'Whistle Blower' about expected bankruptcy. The outcome of this research in the form of discriminant function indicate that three financial ratios, that is, current ratio, asset turnover ratio and proprietary ratio happen to be the significant financial ratios out of the complete set of financial ratios. Using the cut-off 'Z' score (zero in this research study) helps in identifying the group of a company to which it belongs, a company having 'Z' score less than

Year	2007-2008	2006-2007	2005-2006	2004-2005	2003-2004
Type I Error	10.00%	10.00%	10.00%	30.00%	50.00%
Type II Error	0.00%	30.00%	40.00%	50.00%	30.00%

Table 8: Type I and type II error matrix.

Year	2007-2008	2006-2007	2005-2006	2004-2005	2003-2004
Type I Error	10.00%	10.00%	10.00%	30.00%	50.00%
Type II Error	0.00%	30.00%	40.00%	50.00%	30.00%

Table 9a: Z score of sample independent companies for financial year 2007.

Company	Current Ratio	Asset Turnover Ratio	Proprietary Ratio	Z Score
Bear Sterns	0.48967	0.04085	0.02983	-3.31
Lehman Brothers	0.48634	0.08589	0.03274	-3.27
Freddie Mac	0.27816	0.00633	0.03481	-3.33

Table 9b: Z score of sample independent companies for financial year 2006.

zero is identified as belonging to the group of bankrupt companies whereas a company having 'Z' score more than zero is identified as belonging to the group of solvent companies.

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