Predicting Corporate Bankruptcy using Financial Ratios: An Empirical Analysis: Indian evidence from 2007-2010

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The financial failure or bankruptcy is a consequence of company inefficiency that can produce substantial losses to banks, suppliers, shareholders and a whole community. Thus, these interested parties are showing concern for predicting the company failure and more interestingly when it will fail. So, it is possible to predict the economic/financial situation of "Bankruptcy" using financial statements. These traditional analyses of financial ratios are able to detect the operative and financial difficulties of a company. This study basically aims to develop the model based on the accounting information (13 ratios) that predicts the bankruptcy. For this, we tested 26 companies listed on NSE, India from 2007-2010. The sample was composed of 13 bankrupt companies and 13 healthy companies matched on industry. Multiple discriminant analysis (MDA) was used to test these two groups i.e. bankrupts and non-bankrupts. The found function was presented followed by the discussion and implications were highlighted.

Keywords: Financial Ratios, Bankruptcy, Multiple discriminant analysis, NSE, Prediction

Introduction:

Since the 1960s, bankruptcy has been a core concern for users such as investors, banks, credit rating agencies, auditors, regulators and underwriters and has gained considerable attention of practitioners and academicians (Scarlat and Delcea, 2011). Failure is "the inability of a firm to pay its financial obligations as they mature (Beaver, 1966). Recently, interest of banks, investors etc. has been heightened by frequent corporate scandals. Investors and other users expect auditors and corporate management to provide them with a warning of approaching failure, but their unwillingness to warn about possible corporate failure eroded the confidence (Washington, 2001).

This financial failure called as 'bankruptcy' results into substantial losses to a whole community associated. Thus, it would be beneficial to be able to predict the likelihood of bankruptcy so that steps could be taken to avoid it or at least to reduce its impact. However, bankruptcy is a result of inefficient management and in few instances, recovery of interested party's investment through a bankruptcy order (Sandin and Porporato, 2007). Historically, the causes of financial failure have been attributable to financial factors, economic factors, and disasters (both man-made and disaster). However, Lifschutz and Jacobi (2010) pointed that "Altman (1968) study showed that poor management of firm (as reflected in financial ratios) and not necessarily fierce competition and economic recession is the main cause of bankruptcy".

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Considering behavioural aspect of bankruptcy, it is possible to predict the economic/financial situation of "Bankruptcy" using financial statements. The traditional analysis of ratios has been used to detect the financial and other operative difficulties faced by a company. However, when using financial ratio analysis method traditionally results into high subjectivity. To overcome this, Sandin and Porporato (2007) stressing the need for searching

mathematical models that use accounting information to determine the predictability of bankruptcy.

As said, the major threat to any company is bankruptcy. This study aims to develop a classification model and prediction model based on financial ratios that contributes to a growing body of literature of bankruptcy in India. Considering this, the objective of the study is to determine if the information available in the financial statements of companies quoted in NSE, India is useful to predict which companies are likely to go into bankruptcy. More specifically, our purpose is to test usefulness of ratio analysis to predict bankruptcy to develop classification method for investors and creditors.

In this present work, next section refers to review of literature relating to bankruptcy prediction and models used based on financial ratio. Based on this, some of the developments specifically in this arena are applied to Indian companies. After this, a new model is developed that classify companies among bankrupt and non-bankrupt (healthy companies), the results analyzed and concluded with recognition of some limitations in this work.

Review of Related Literature:

Dimitras, Zanakis & Zopundidis (1996) used 'business failure' to study the financial health of a company. Business failure was classified as economic failure, insolvency and bankruptcy (Altman, 1993). When company earned low return on investment (ROI) than required called 'economic failure', while lack of liquidity prevented company to achieve financial obligations called 'insolvency'. Above all, bankruptcy is referred as a legal status involving litigation and a petition in a federal court.

Business failure was classified as economic failure, insolvency and bankruptcy

Bernstein (1993, p. 647) defined prediction models as "…screening, monitoring and attention-direction devices hold considerable premise" and that they "complement and precede, rather than replace, the rigorous financial analysis approaches" (Sandin and Porporato, 2007). The first mark on developing statistical models

for predicting bankruptcy was done by Winakor and Smith (1935) by using different techniques and predictors, followed by Beaver (1966) who made an attempt to develop the model. After that, many studies have been carried out directing this across various industries, countries, statistical techniques, concepts and processes administered (Sandin and Porporato, 2007).

Financial ratio analysis has been regarded as indicator of business health (Green, 1978), supported by the fact that the right interpretation of ratios help assessing the liquidity, profitability and debt position (Gibson, 1982). Moreover, many studies (Chen and Shimerda, 1981; Gardiner, 1995) found that financial ratios were significant in evaluating financial performance of a company. Above all, (Bhunia, 2011) concluded that "ratio analysis continues to represent one of the financial world's most powerful and versatile tools".

However, various univariate studies used earning, liquidity and solvency ratios and showed definitive potential of ratios as strong predictors. These ratios' order of importance was made clear by Beaver (1966) and concluded that the ratio namely "cash flow to total debt" was the best predictor. Beaver (1966) collected ratio data of 79 failed companies for five years and compared them with 79 healthy companies (Salehi and Abedini, 2009). These earlier studies relating to bankruptcy prediction was univariate in nature.

Financial ratio analysis has been regarded as indicator of business health, supported by the fact that the right interpretation of ratios helps assessing the liquidity, profitability and debt position.

By cross sectioning the body of predicting bankruptcy literature, Sandin and Porporato (2007) observed that researchers used either univariate analysis (used individual ratios and bankruptcy) or multivariate analysis (used multiple ratios and bankruptcy). However, the most significant model was developed in this line of research by Altman (1968) who

developed a model based on Z-score. Altman (1968) analyzed ratio and categorical univariate variables, and produced a score that best discriminates between default and non-default companies by using multiple discriminant analysis (hereafter it is referred as MDA).

Considering limited use of univariate analysis due to confused interpretations and ambiguity, multivariate analysis was preferred by many researchers to develop models (for example, Z-score by Altman (1968), ZETA model by Altman et al. (1977), Logit model by Ohlson (1980), Probit model by Zmijewski (1984) etc.). These researchers' efforts put the literature on developing bankruptcy prediction models using statistical analysis forward and continue to grow.

Despite the growing use of statistical tools, still, few researchers identified novel variables to improve the prediction efficiency (Gentry et al., 1985; Aziz and Lawson, 1989; Emery and Cogger, 1982). Later on, more advanced estimated tools were used for model development. For example, Tam & Kiang (1992) and Altman et al. (1994) used Artificial Neural Network (ANN), Jones and Hnesher (2004) developed mixed logit model, Sun and Shenoy (2005) used Bayesian Network models etc.

However, researchers observed that logistic regression models were found to be non-sensitive to financial distress situations (Grice and Dugan, 2001). Despite the development of advanced level techniques and models in this area since 1990, multiple discriminant analysis (MDA) was considered unquestionably the widely accepted bankruptcy prediction technique (Sandin and Porporato, 2007) because of it has least Type I error (Charitou et al., 2004).

The selected ratios must reflect the characteristics of stability, profitability, growth, activity and cash flow of a corporation

Examining the works in MDA, Altman et al. (1981) model was considered the best known in early studies (Salehi and Abedini, 2009), postulating an equation which used five ratios

optimally. These five ratios were namely liquidity, financial leverage, solvency, profitability and sales activity. Other studies were carried out by Moyer (1977); Hamer (1983); and Zmijewski (1983). According to Xu and Wang (2009), "the selected ratios must reflect the characteristics of stability, profitability, growth, activity and cash flow of a corporation".

Objective of study

1. To identify and investigate financial ratios responsible for predicting bankruptcy
2. To develop model for bankruptcy prediction using financial ratios of firm

Research Methodology:

Companies selected

During 2007-2010, total 51 companies were either merged or acquired or amalgamated or liquidated because of major crash in equity market in 2008. When observed, only 20 companies were not able to pay their principals and interests or interest only to creditors. These companies may or may not be gone for legal status of bankruptcy as either out of court settlements or acquisitions by other company. So, these financially distressed companies are considered as bankrupt in this study. Out of these 20 companies, 15 companies had three years of history before financial distress. So, 13 companies were finalized from primary investigation.

The period selected for study for each failure is 2007-2010. The financially distressed companies in the sample represent small and medium scaled industries as the number of large companies failed was very few. The selected healthy companies were matched on industry and size listed on NSE (National Stock Exchange). During year of liquidation, healthy and distressed companies had definitely different financial conditions, thus considered for this study. However, 1-year prior to failure was not considered because one year time period is not enough for correction and avoidance after getting warning signals. So, the financial statements or data for each pair was collected from capital line database for two time periods: failure year and 2-year prior to failure, so as 52 (26*2). This study aims to analyze the effect of the financial ratios on the bankruptcy predictions.

Ratios selected

From the literature, it was noted that Chen & Shimerda (1981) found 41 ratios, Taffler (1983) found 4 rations and Hossari & Rahman (2005) found 44 ratios to be significant for prediction. However, Koh & Killough (1980) found that it was not needed to have large number of ratios. In fact, Bhunia (2011) used 16 ratios and found usable for companies operating in India. The category of basic ratios such as liquidity, profitability and solvency ratios were employed that includes a total of 13 ratios were finalized after the primary investigation considering the multicollinearity. Table 1 shows the ratios included in each category and their respective codes used in this study.

Profitability Ratio	
P1	Net Income / Net Sales
P2	Net Income / Total Assets
P3	Net Income / Book Value
P4	Operative Income / Net Sales
P5	Return on Capital Employed
Liquidity Ratio	
L1	Current Assets / Current Liabilities
L2	Quick Assets / Current Liabilities
L3	Net Sales / (Current Assets – Current Liabilities)
Solvency Ratio	
S1	Total Assets / Total Liabilities
S2	Noncurrent Liabilities / Total Assets
S3	Book Value / Total Assets
S4	Paid Interest / EBIT
S5	Retained Earnings / Book Value

Table 1
Selected Ratios

Moreover, these 26 companies were divided in two groups. The first group contains 13 healthy companies and the other group contains 13 un-healthy companies. Here, the analysis drew upon the introduction of dummy variables. The group consisting healthy companies was coded as '1' and the group having un-healthy or bankrupt companies was coded as '0' for further analysis.

Data analysis:

To develop a model of bankruptcy prediction for Indian companies, the study used multiple discriminant analysis (MDA) considering its popularity and use by practitioners. The study eventually develops the classification model that can be used by investors and creditors. In

this study, 13 ratios were selected and calculated for 13 bankrupt and healthy extracted companies for base year or year 0 (last financial statement before the bankruptcy for failed companies) and 2-year prior to failure. To develop discriminant function for base year data, direct method was used.

Table 2 Canonical Discriminant function

Base year	**Eigen value**	**Canonical correlation**	**Wilks' λ**	**Chi-square**	**Df**	**Sig.**
	3.026	0.867	0.248	24.74	13	0.028*

Variables	**Wilks' Lambda**	**Standardized Canonical Discriminant function's coefficients**	**Sig.**
Net Income / Net Sales (P1)	0.999	0.301	0.862
Net Income / Total Assets (P2)	0.866	-2.070	0.066**
Net Income / Book Value (P3)	0.816	1.182	0.029*
Operative Income / Net Sales (P4)	0.971	-0.372	0.406
Return on Capital Employed (P5)	0.988	1.408	0.589
Current Assets / Current Liabilities (L1)	0.998	0.351	0.843
Quick Assets / Current Liabilities (L2)	0.978	0.143	0.472
Net Sales / (Current Assets – Current Liabilities) (L3)	0.959	-0.526	0.320
Total Assets / Total Liabilities (S1)	0.940	1.153	0.227
Noncurrent Liabilities / Total Assets (S2)	**0.805**	1.091	0.024*
Book Value / Total Assets (S3)	0.910	0.790	0.137
Paid Interest / EBIT (S4)	0.968	-0.367	0.381
Retained Earnings / Book Value (S5)	0.840	-0.986	0.043*

Note:* $p < 0.05$; ** $p < 0.1$

It was observed that three variables were significant to differentiate the groups at 0.05 levels, one was at 0.1 and rests were non-significant. The Wilks' lambda value indicates that "noncurrent Liabilities to total Assets (S2)" was the one variable which provides a bigger difference between the mean of the groups (Malhotra, 1993) as it was the least value. The found discriminant function was significant which explained about 75.16 per cent (square of canonical coefficient) of the variance. The standardized canonical functions coefficients

indicate the relative importance of each of them in order to differentiate between the two groups. The results of Wilks' lambda, *F* statistics, standardized canonical discriminant function's coefficient and significant levels were displayed in table 2.

Similarly, discriminant function was found to be significant for 2-year prior to failure. The found discriminant function was significant which explained about 78.50 per cent (square of canonical coefficient- 0.886) of the variance (Table 3). However, all the ratios were found to be non-significant indicating none was providing bigger difference. The group centroids indicate the average discriminant score for variables in the two groups and the scores were equal value with opposite signs.

Table 3 Canonical Discriminant function for base 2-year prior to failure

2-year prior to failure	**Eigen value**	**Canonical correlation**	**Wilks' λ**	**Chi-square**	**df**	**Sig.**
	3.633	0.886	0.216	26.833	13	0.013*
Function Centroids	Base year		2-year prior to failure			
Bankrupt	1.671		1.831			
Non-bankrupt	-1.671		-1.831			

Note:* $p < 0.05$

Table 4 Classification results for Year of failure & 2-year prior

			Predicted Group			
	Original group	No. of cases	Bankrupt	%	Non-bankrupt	%
Base Year	Bankrupt	13	**12**	92.3	1	7.7
	Non-bankrupt	13	0	0	**13**	100
	Total	**26**				

Note: *Percentage correctly classified* = (12+13)/26=0.9615= 96.15%

	Original group	No. of cases	Predicted Group			
			Bankrupt	%	Non-bankrupt	%
2-year prior to failure	Bankrupt	13	**13**	100	0	0
	Non-bankrupt	13	1	7.7	**12**	92.3
	Total	**26**				

Note: *Percentage correctly classified* = (13+12)/26=0.9615= 96.15%

In order to test the validity of obtained discriminant function, it is required to identify whether the existing number of companies included into the groups significantly differ from the expected number. As observed in table 4, 96.15 per cent companies were correctly classifying into their groups through discriminant function, which reveals satisfactory validity (Malhotra, 1993) for both base year and 2-year prior to failure.

Implication and Limitations:

This study reports mainly two implications: first, investors can use this model to predict bankruptcy as it has good predictive ability and pays the attention to the solvency and profitability ratios which plays an important role in decision making. As solvency ratio used for measuring company's ability to meet long term liabilities, solvency ratio helps in the prediction of the possibility of bankruptcy. In solvency ratio Noncurrent Liabilities / Total Assets had shown positive and Retained Earnings / Book Value had shown negative impact on bankruptcy prediction. Profitability ratios specially, Net Income / Total Assets had shown negative and Net Income / Book Value had shown positive impact on bankruptcy prediction. This profitability ratio indicates company's efficiency for creating profits through available fund. Thus, before investing in any company investor should have apply this model and classify company as bankrupt or

Noncurrent Liabilities / Total Assets had shown positive and Retained Earnings / Book Value had shown negative impact on bankruptcy prediction.

non-bankrupt. It prevents investor from investing in company, which has possibility of bankruptcy.

Second, this paper offers a classification method that is publicly available to all investors and creditors. This model is built based on financial statements in a period of economic downturn of an emerging economy such as the case of India during 2007-2010. Considering the limitations of data availability, this study is useful to Indian as well as international economic agents in making financial and economic decisions based on financial statements of companies operating in emerging economies with macroeconomic conditions similar to those of India during 2007-2010.

Apart from this, the authors ignore the aggregate economic conditions such as effect of exchange rate policy, real interest rate etc. even knowing the importance of thus exogenous conditions. This study includes only 13 companies as a sample produces conclusions which are not definitive. And finally, in emerging economies like India, problem pertaining to data availability remains significant hurdle in making the studies of this kind.

Conclusion:

In this paper, this study attempts to investigate and adds empirical evidence of usefulness of ratios to predict bankruptcy. The methodology used in this study provides useful information regarding the discriminant function and ratios with high predictive power. Discussion about the effective use of statistical models continues and MDA has been the most used technique to investigate bankruptcy. In this study, The found ratios with high predictive power were 'Net Income/Total assets', 'Net Income/Book value', 'Noncurrent liabilities/Total assets' and 'Retained earnings/ book value'. There were considered as key factors to predict bankruptcy in the particular context or India in the horizon from 2007-2010.

The set of models tested in this paper were direct model with base year and 2-year prior to failure. The 2-year prior model had a high predictive value than year of bankruptcy model. It is observed that the type-I error (bankrupt firm classify as non-bankrupt) is low in base year

model and type-II error (non-bankrupt firm classify as bankrupt) is low in 2-year prior to failure. (Table 5).

Table 5 Comparison of models on Type-I and Type II errors

Discriminant model	Type-I (per cent)	Type-II (per cent)
Base year	7.7	0
2-year prior to failure	0	7.7

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