

Predicting Corporate Defaults Using Multiple Discriminant Analysis

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ABSTRACT:

Study aimed to develop a predictive model which shall predict and classify the companies according to their financial positions. Model has developed particularly for the Indian Listed companies by using Multiple Discriminant Analysis. Study has also compared it with the Altman (1968) Z score model and Recalibrated model. Sample of 90 BSE Listed companies has been selected and data extracted for the period 2010- 2014 from its financial statements. Developed model has taken into consideration the financial ratios which reveal the liquidity and solvency of the companies and help to predict the financial viability of the companies. Comparison has been done on the basis of model's efficiency in classifying defaulting and non defaulting companies from the data. After analysing the empirical results study concluded that the Z score model developed in this paper has the highest accuracy in discriminating the companies into defaulted and non defaulted.

KEY WORDS: Z score, Default, Multiple Discriminant Analysis, Predictive models, Altman Z score, Recalibrated Model.

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Website: http://heb-nic.in/cass-studies	
Received on 27/09/2019	
Accepted on 03/10/2019 © HEB All rights reserved	

INTRODUCTION

According to the “ The Insolvency and Bankruptcy Code , 2016” Bankruptcy means any debt owned by a person/ corporate has become due but companies fail to pay their principal amount and interest due on it (www.mca.gov.in, 2016). Bankruptcy occurs when companies fail to meet its liabilities and becomes short of assets and cash. Corporate failure in Indian economy has been increasing since the global crisis emerged in 2008.

There are two types of defaulters in India who defaults in repayments of their corporate loans.

These are “Wilful” defaulter and “Non Wilful” defaulters (Kaul, 2015). Wilful defaulters are following :

- Who defaults in repayment of their loan in spite of being capable to repay.
- Who has diverted the money for the other purpose which was not mentioned while accessing the loan.
- Who has siphoned off funds
- Defaulted the loan and sold the collateral against which loan was granted.
- “Non Wilful” defaulters are those who become incapacitates to meet the obligations of the loan amount. Causes of Banruptcy:
 - Fraudulently diversion of funds to the undisclosed business ventures.
 - Financial statements shown before sanctioning of loan was not showing the true picture of the financial position of the companies.
 - Dubious rating given by the rating agencies.
 - Projects for which loan has been taken turned out to be unprofitable or failed.

All these factors results into the bankruptcy of the organisations which ultimately contributes to the NPA (Non Performing Assets) of the country which has become the major economic problem in India. To overcome this problem and to reduce the NPA it has become necessary of the banks to prepare some predictive models which will help them to assess in advance the repayment capacity of the companies seeking loans and to discriminate the companies into defaulted and non defaulted.

In India majority of debt accessed by the companies belongs to the public and private banks unlike other developed countries where loans were taken in the forms of bonds issued by the companies to the public.

RBI has issued guidelines on Credit Risk Management in the year 2002 to be a part of the BASEL Committee norms set for the banks those which wants to perform the international transactions across the world and to become an international bank (Bodla & Verma, 2009).

In the credit risk management mechanism commercial banks perform the following activities.

- Industry study
- Period credit calls
- Periodic plant visits
- Developing MIS
- Risk scoring
- Annual review of accounts

Therefore, internal credit management system has become the crucial part of every large organisation including banks. Credit management is not only useful for the entities itself but it also play a great role in the economy in which these companies operates as the failure of one company leave its impact on the various sectors of the economy like GDP, National Income, Employment etc. Thereby in the area of financial/ economics research bankruptcy prediction is emerged as a significant topic to explore. All companies whether small, mid, large operates on a borrowed capital and default occurs when these companies fail to pay back the borrowed fund to the creditors. In India where banks have a major stake holding in companies as they contribute the most in terms of borrowed funds. We have already witnessed the large companies name in the defaulters list like Kingfisher Airlines, Moser Baer, Lanco, Videocon Industries, S Kumar, Alps Industries, Electrosteel etc.

Therefore, every stakeholder like banks wanted to have valid and reliable models to forecast such failures. For investors it's important to know the financial health of the companies in which they want to invest that's why they evaluate the company's portfolio, financial books and its market credibility in the capital market. For them Z score model is also useful tool where they can get the information of the companies bankruptcy in advance.

REVIEW OF LITERATURE

This paper has included the literature from the very first Altman's publication on the multiple discriminant analysis to the contemporary publications which has used the modified version of the original model and applied it in the various sectors and companies according to their requirements.

The first and the famous paper by (Altman, 1968) in which the study investigated whether ratios are able to judge the financial viability of the companies and can be a better tool to classify them into defaulted and non defaulted. For assessment purpose Study has incorporated MDA to give weight to the five ratios namely: Liquidity, Profitability, Leverage, Solvency, activity ratios. Result has found that MDA is competent tool to classify the companies with 95% accuracy. Thereafter the earlier publication revised (Altman, 2000) in this study Z score, Zeta model and MDA has been used to evaluate the bankruptcy then study found that Zeta was capable to predict the bankruptcy five year prior to the default with accuracy 90% in comparison to Z score which predict 2 year prior to bankruptcy. Still MDA is the better tool for classification of companies. (Samarakoon & Hasan, 2003) predict the bankruptcy in

Srilanka three Altman's z score namely Z, Z', Z' applied on the data obtained from 26 firms listed in the Colombo stock exchange for the period 1986-1997. Paper concluded that accuracy of the Z' was highest. (Liang, 2003) compared the MDA and Logistic regression on the basis of bankruptcy prediction. And concluded that logistic regression has higher predictive capacity and lower Type I and Type II errors. (Altman & Sabato, 2005) build a Distress Prediction model for the US SMEs by taking panel data for the period 1994-2002 and validated it on 26 bankrupt companies for the period 2003-2004. MDA and Logit functions applied on the data. Comparison of the models has been performed to select the best model for building the corporate model. Study also tried to find the most predictive variable that affects the financial position of the companies. Result indicated that Logit's predictive power is more than MDA. (Altman, 2006) this study has applied Z score on S&P 500 index bonds and on the steel manufacturing companies to build internal credit worthiness of the companies. Result conveyed that Z score was successful in predicting and classifying the companies with 85-90% accuracy level. (Bandyopadhyay, 2006) developed a model using Altman Z Score, Altma and Logit model which will be helpful in giving indication of bankruptcy before the event occur. Panel data of 104 indian companies has been used for the period 1998-2003 which included both solvent and insolvent companies. Findings has depicted that Z score proved better than Altman Z score but while considering type 1 and type 2 error Logit outperform other models. (Jayadev, 2006) Attempts to examine the predictive capacity of financial indicators of the Indian banks for assessing the borrower's repayment capabilities and also to investigate the forecasting power of three MDA models applied on the companies who has borrowed money from Indian commercial banks. Study taken the defaulters list of banks like sbi, pnb, bob, boi, cbi for which 56 companies were selected. Study suggested banks should apply Z score to develop their predictive model. (Salehi & Abedini, 2009) examined the power of financial ratios for predicting financial viability of the firms listed in Tehran Stock exchange. Multiple regression model is applied which covers the ratios like: Liquidity, Profitability, debt and Property. It was founded that the prediction capacity of model increased by adding financial ratios in it. (Rashid & Abbas, 2011) Used the models such as logit, probit, Linear probability and MDA to classify the company' financial health, data has been collected from the financial statements of the companies listed in the Karachi stock exchange. 24 ratios examined for 1996-2006. Result of the study indicated that MDA succeeded to classify with 76.9% accuracy level. (Pradhan, Pathak, & Singh, 2011) study has incorporated BPNN(back propagation neural network) with Z score for estimating the financial health of Axis bank for the period 2001-2008. Conclusion of the paper is that the model capable to judge the financial position of the firm and to able to create policies for giving loans and predicting the credit repayment capacity of creditors of the banks. (Chijoriga, 2011) Assessed whether incorporation of the financial ratios in MDA enhance the model's ability to predict the firm's repayment capacity of the loan of banks. Data have been collected from the 56 defaulted and non defaulted companies for the period 1985-1994. Result indicated that MDA's classified the companies more accurately by incorporating variables in MDA. (Pang & Kogel, 2013) developed three predictive functions which are different from the ALTMAN and BMW which will classify the companies with more accuracies. Data was collected from the 40 retail firms (18 defaulted and 22 non defaulted) and concluded that retail firms must have specific model of the prediction which considers the particular of that specific industry. (Ijaz, Hunjra, Hameed, Maqbool, & Azam, 2013) Applied Altman Z score and CA/CL to test the financial health of the sugar sector firms listed at karachi stock exchange. Result of the study indicated that both of them have great contribution in classifying the companies according to their financial positions. And there is also a positive correlation between Altman's Z score and current ratio. (Sulphey, 2013) study has selected 220 companies listed at BSE small cap index and classifies the firms into safe,

grey and distress zone using Z score. Result conveyed that Z score is proved to be the best tool for the classification of the firms and that can be used by the investors for taking decisions regarding investment. (Micudova, 2013) Study has covered the period from 2008 to 2010 to test the capacity of Z score model and to identify which variable has influence on the misclassification of the companies default prediction. Study concluded that Asset turnover has influence on the misclassification of companies in terms of insolvency. (Mohammed & Soon, 2013.) Study used Edward's Altman Z score model for predicting the financial bankruptcy of the firms. Model has incorporated financial ratios that obtained from the financial reports available from the Malaysian stock exchange for the period 2003-2009. Result revealed that Altman is the best predictor and indicator to classify firms according to their financial health. (Sharma & Mayanka, 2013) examines the financial viability of the 20 Indian public banks and 16 Indian Private Banks with Altman Z score and ratios like WC, RE, EBIT, BV of Equity, Total Liabilities and Total Assets. Study found that out of 36 banks 2 banks got into distressed category although its Capital Adequacy Ratio was higher than its peer banks. Therefore, it's been concluded that Capital adequacy is not the significant factor to judge the financial viability of the banks. (Altman & Laitinen, 2014) Different versions of Z score have applied across the industries like Z" score for non manufacturing companies. Study found that performed well with 75% accuracy and on some special cases with 90% accuracy. And to classify the companies industry specific model should be adopted for accuracy. (Smaranda, 2014) Study attempts to examine the predictive capacity of the models like: Altman, Taffler and Logistic regression methods and cluster analysis also checked on the data collected from the 105 SME's of Romania divided equally in to defaulted and non defaulted groups. Findings of the study indicated that Logistic regression is most suitable method which surpass the Multiple Discriminant Analysis to predict the bankruptcy of the companies. (Pradhan, 2014) This study attempts to calculate the Z score of 3 public sector banks internal risk management system and to categorize them into Safe, Grey and Distress zones using BPNN. Data obtained from CMIE database and published financial statement. Period covered for prediction purpose was 2001 to 2007 and it's been validated to the year 2008 to 2013. Result indicates that BPNN is able to compute the Z score for prediction purpose. (Kumar & Rao, 2014) Study builds a multivariate non linear model by incorporating transformed financial ratios instead of traditional ratios and for computing the credit score. Result depicted that the proposed MDA model is better predictor with accuracy level at 98.6% in comparison to the old Altman Model. (Dumitra & Tudor, 2014) Study tried to discriminate 20 companies which are listed in Bucharest stock exchange into solvent and default. MDA have been applied on the data for the period 2005-2013. Result says that MDA classifies the companies with 90% accuracy. (Chouhan, Chandra, & Goswami, 2014) study attempts to test the existence and validity of Altman Z score in the contemporary time by applying it on the 30 companies listed at BSE. Findings show that Altman Z score measured the credit worthiness of the companies successfully i.e. Z score is still valid to use for predicting and classification of companies.

(Almansour, 2015) Univariate logit model is used to examine the predictive ability of various accounting ratios which consists of liquidity, leverage, solvency, activity. And Multivariate Logit model to predict the bankruptcy probability of the 22 Jordian Companies for the period 2000 to 2003. It was found that WC to TA, CA to CL, MVE to BVD, RE to TA and SALES to TA are the best indicator of probability of bankruptcy. (Kiraly, 2015) Paper summarizes the evolution of prediction models by citing various previous research papers. Study recommended that time series is significant for prediction of bankruptcy. (Desai & Joshi, 2015) It has applied both predictive model and Altman z score on the 60 emerging companies (30 defaulted and 30 non defaulted) using MDA and by incorporating financial ratios. Sectors which covered by the

study were paper, paint, pharma, textile, machinery etc. and concluded that the developed Z score model is more accurate than Altman for the growing companies which can also be used for predicting the bankruptcy of commercial banks and finance companies. (Kovarnik & Hamplova, 2015) This study applied various models like Altman Z score, Taffler's model and IN model by incorporating financial ratios on the same companies data to verify whether it gives alike results which are comparable. Result reveals that all models depicted the comparable results therefore, it's been recommended by the study to use multiple models on the company's data to check its solvency. (Mizdrakovic, Knezevic, & Stanic, 2015) For evaluating financial distress of the hotel industry in Republic of Serbia for the period 2008-2012 study used the models like: Altman Z, Z", Mscore, Kralicek's df score and Z score. Altman score depicted the decrease in worth approximately by 70% and approximately same given by the other models too.

(Abid, Masmoudi, & Ghorbel, 2016) Data for the period of 2010 to 2012 for 633 consumer loan have been collected from the Tunisian commercial bank and study developed a predictive model to classify the companies into defaulted and non defaulted using Logistic and MDA model. Result confirms the accuracy of logistic is 89% and MDA is 68.49%.

(Khemais, Nesrine, & Mohamed, 2016) by using both MDA and Logistic regression on the data of 195 SME's data for the period 2012-2014 to develop the model for assessing the bankruptcy of the borrower companies of the one Tunisian commercial bank. Result of the study indicated that both MDA and Logistic regression are competent enough to judge the financial health of the companies but Logistic regression is first in the race of significant tool of prediction. (Slefendorfas, 2016) Data for period 2007/2013 of 145 companies of lithuania (73 defaulted and 72 operational) was analyzed using MDA to assess the predictive ability of the model and also the best indicator of the financial position of the company. It was found that with accuracy of 89% companies were distinguished to default and non defaulted. (Mihalovic, 2016) This study constructed a bankruptcy prediction using MDA and Logit model and compared them. result has indicated that logit has more accuracy in prediction and the most effective predictor variable is net income to total Assets. Instead of MDA study has recommended Artificial intelligence it does not require to oblige the assumptions like statistical tools.

(Chadha, 2016) To judge the financial performance and risk of the Kuwait firms to get the information that will help in making investment decisions study used Z score and Zmijewski models. Data has been extracted from the 196 companies which are listed in Kuwait stock exchange website for the period 2009-2014. Study revealed that Z score successfully classified the companies according to their financial performance and risk. Study concluded that Zmijewski is not suitable tool to forecast the solvency of the Kuwait companies. (Lestari, Oktaviani, & Arafah, 2016) This study used Z score to assess whether it can forecast the stock prices of the companies and study also try to identify those ratios which are the significant factor which influence the stock prices. Study able to prove that Z score is competent to predict the stock price and EBIT/TA is significant ratio to which influence stock prices. (Pathak, 2016) Study aimed to establish the relationship between ROE and Z score. For that data for 14 years has been obtained from the listed manufacturing companies of India and China. Result depicts that there is a direct relation between ROE and Z score which depict that companies having higher Z score having yield high ROE. (Aditya, 2016) Study tested the financial worthiness of ONGC by using Altman Z score along with the Ratios for the year. Findings of the study are: ONGC's financial worth is sound but it shows declining score which might shift it to the

bankruptcy category although Profit earning capacity and short term capacity of the company is good. (Jaffari & Ghafoor, 2017) This study has analyzed 35 bankrupt and 35 non bankrupt small sized company's data to identify the best indicator of the bankruptcy and to assess the models used for the prediction namely MDA and Logistic regression. Variable like profitability ratios, liquidity ratios, leverages, activity ratios and cash flow ratios were examined. Data obtained from the Karachi stock exchange website for the period 1996 – 2012 and it was found that MDA is the best one to classify the companies. (EI-Ansar & Benabdellah, 2017) Study focused to test the predictive capacity of financial ratios and their significance for the forecasting of bankruptcy. Data collected from the financial statement of the 150 moroccan agricultural firms from 2011-2013 out of them 75 were solvent and 75 were defaulted. For the classification of companies both MDA and Logit method have been used to construct the model. Result proved that Logit's accuracy is more than the the MDA. (Hassan, Zainuddin, & Nordin, 2017) Both MDA and Logit function have been compared in the context of their characteristics especially their predictive capacity in the various situations or the companies. Comparison was theoretical in nature which had been done by taking data from the previous studies. Study concluded with the suggestions that logit is better than MDA. (Geethalakshmi & Jothi, 2017) Classify the Pharmaceuticals companies for the period 2006-07 to 201516, data collected from the financial reports of the companies using Z score. Study recommended that firm must adopt the policies like maximizing assets and minimizing liabilities to enhance the financial viability of the companies. (Djamaluddin, Putridan, & Ali, 2017) This study aimed to evaluate the various prediction models like: Z score, Ohlson Y score, and the Zmiejewski X score for predicting the bankruptcy of electronic sector of Japan. Evaluation based on the accuracy of type I and Type II error. Findings indicated that Ohlson is the most accurate model for predicting the defaultd. (Altman, 2018) Study explored the use of Z score in building the internal credit risk models in the various areas like lenders, loan pricing, investment in bonds, stock, and to predict the financial failure of the companies. Study has realized that the Z score has become a standard base for developing internal risk management system for the various financial and non financial sectors. (Rafique, 2018) For predicting the financial distress and to establish the causal relation of ratios and Z score modified Altman z score has been used. Data has been obtained from companies listed on Karachi stock exchange for the period 2012-2016. Result indicated that there is an opposite relation between financial distress and corporate cash flow. Firm size, operating profit and working capital productivity are directly related to the financial distress. (AlAli, 2018) Study used Altman Z score for evaluating the financial worthiness of the healthcare sector companies listed at Kuwait stock exchange. Data extracted from the stock market exchange for the period 2013-16. Study found that z score successfully classified the firms into the bankruptcy risk zone. (Basovnikova, Konecny, Dubovy, & Masarova, 2018) Paper aimed to verify whether poor financial management in companies leads to bankruptcy using Altman Z score and Zem Score. Study concluded that by applying the model it has proved that poor financial management results in a bankruptcy and it has also recognized that ROE has affects the accuracy of Model.

SIGNIFICANCE OF STUDY

India witnessed the defaults of large as well as small companies in the current scenario like II & FS, Bhushan Steel, Lanco Infratech Ltd, Amtek Auto, Monnet Ispat and Energy, Jaypee Infratech Ltd, ABG Shipyard Ltd which contributes the most to the NPA's of the country. And the major causes of NPA's are the failure of these companies in repayment of their debts to the banks which are also the main cause of the deficit of the economy in India. Therefore it becomes necessary to find those methods which can be helpful in combating with these

economic evils which are turbulent to the growth of the country and makes the banking sector less profitable. Fewer studies have been explored on the predictive models and forecasting of the financial worth of the companies particularly for the Indian context where banks are the major creditors of the companies. This paper has developed such models which will assess the financial position of the companies, predict the bankruptcy risk in advance and help to distinguish the companies into defaulted and non defaulted so that a corrective action can be taken to minimise the risk of default and control the failure which are mounting the value of NPA's in Indian economy.

OBJECTIVES OF THE STUDY

- To develop a model which can efficiently discriminate between defaulting and non defaulting companies?
- To Recalibrate Altman's original model.
- Compare the empirical results of the proposed method with the Altman Z score and Recalibrated Model.

Data

This paper has undertaken a sample of 90 BSE Listed companies which includes defaulted and non defaulted. Samples are selected from across the sectors like Cement, Steel, Automobiles, Telecommunication, Healthcare, Infrastructure, Pharmaceuticals, Electronics, Software, Manufacturing etc. 444 cases considered for the period 2010 to 2014. After identifying outliers 417 cases have been selected to develop the model by using SPSS version 23. Data extracted from the financial statements of the companies which is available on the moneycontrol.com & the data for share prices obtained from the BSE Website.

METHODOLOGY

Z score model developed:

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A model has been developed to predict the defaults of the companies using Multiple Discriminant Analysis which has been performed using the software IBM SPSS version 23 on the data extracted from Annual financial statements of the companies.

Following equation is prepared.

Calculation of Z score $Z = 1.238 + 1.129 * WC/TA + 1.522 * RE/TA + 6.897 * EBIT/TA + .000 * MVE/TBD + .147 * SALES/TA + .825 * NI/TA + -.147 * NP/TE - .358 * TBD/TA + .000 * EBIT/INT + .004 * OCFR + 1.707 * GRA.$

Where:

- WC/TA: Working capital to total asset .
- RE/TA: Retained earnings to total asset.
- EBIT/TA: Earnings before interest and tax to total asset.
- MVE/TBD: Market value of equity to book value of total debts.

- SALES/TOTAL ASSETS: Turnover of the company in terms of total assets. □ NI/TA: Net income to total assets.
- NP/TE: Net profit to total equity.
- TBD/TA: Total value of debts to total assets.
- EBIT/INT: Earnings before interest and tax to interest expenses.
- OCFR: Operating cash flow ratio.
- GRTA: growth rate of total assets.

Altman Z score model

Original Altman Z score is also applied on the data which was developed by Edward I Altman in his paper titled “financial ratios, discriminant analysis and the prediction of corporate bankruptcy” in 1968. In which he has used five ratios to predict the bankruptcy. Therefore, an equation is prepared using only those five ratios mentioned in his study.

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

Where

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 equity/ Book value of total debt

X 5 : Sales/ Total Assets.

Ratios Recalibrated Model:

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The third model developed in this study is basically based on the 5 fundamental ratios mentioned by Altman in his original publication in 1968. Multiple Discriminant Analysis function is also performed on the data. And the equation has been formed using the constants resulted from the MDA function performed in SPSS.

$$Z = -1.547 + .574 * WC/TA + 1.498 * RE/TA + 4.491 * EBIT/TA + .000 * MVE/TBD + .152 * SALES/TA$$

EMPIRICAL RESULTS and ANALYSIS

Table 1

Test of equality of group Means of Z score model			Recalibrated model	
Ratios	Wilks’ Lambda	Sig.	Wilks’ Lambda	Sig

WC/TA	0.987	0.021	0.987	0.021
RE/TA	0.687	0	0.687	0.000
EBIT/TA	0.71	0	0.71	0.000
MVE/TBD	0.984	0.01	0.984	0.010
Sales/TA	0.89	0	0.89	0.000
NI/TA	0.725	0		
NP/TE	0.976	0.002		
TBD/TA	0.856	0		
EBIT/Int	0.984	0.009		
OCFR	0.943	0		
GRTA	0.927	0		

Source: Author (SPSS output)

P Values of all the ratios both in Z score model and in Recalibrated model are less than 0.05 i.e. all the ratios considered as the predictive variables are good predictor of the bankruptcy of the companies.

Table 2

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Eigenvalues & Canonical Correlation of Z score model & Recalibrated Model					
Function	Eigenvalue	Canonical Correlation	Function	Eigenvalue	Canonical Correlation
Z score Developed Model	0.760	0.657	Recalibrated Model	0.603	0.613

Source: Author (SPSS output)

Model seems to fit good if its Eigen value is close to 1, in this paper the Eigen values of both the models are 0.760 for Z score model and 0.603 for Recalibrated model which are closer to 1. Therefore, the values in the table 2 depicts that model is satisfactory for discriminating the companies according to their financial health.

And the value of Canonical Correlation also more than 0.5 that also reveal that model satisfactorily good enough to use for discriminating the companies and predicting the default probabilities.

Forming a function of Z Score Model using the coefficient given in the table 3.

Table 3

Coefficients of Z score Model	
Ratios	Function
	1
WC/TA	1.129
RE/TA	1.522
EBIT/TA	6.897
MVE/TBD	0
Sales/TA	0.147
CA/CL	-0.119
NI/TA	-4.825
NP/TE	0.147
TBD/TA	-0.358
EBIT/Int	0
OCFR	0.004
GRTA	1.707
Inventory	0
Turnover	
Fixed Assets Turnover	-0.009
(Constant)	-1.238

$$Z = 1.238 + 1.129 * WC/TA + 1.522 * RE/TA + 6.897 * EBIT/TA + 0.000 * MVE/TBD + 0.147 * SALES/TA - 0.119 * CA/CL - 4.825 * NI/TA + 0.147 * NP/TE - 0.358 * TBD/TA + 0.000 * EBIT/INT + 0.004 * OCFR + 1.707 * GRTA + 0 * INVENTORY TURNOVER - 0.009 * FIXED ASSETS TURNOVER$$

An equation is made using coefficients to discriminate the companies by considering centroid calculated in the next section.

Source: Author (SPSS output)

Recalibrated Model:

A function is formed using coefficient calculated by using SPSS program.

$$Z = -1.547 + 0.574 * WC/TA + 1.498 * RE/TA + 4.491 * EBIT/TA + 0.000 * MVE/TBD + 0.152 * SALES/TA$$

Group Centroid of Z score Model and Recalibrated Model

Table 4

Group Centroids of Z score model and Recalibrated model		
Z	Z score	Recalibrated
	model	Model
	1	1
0	0.466	0.415
1	-1.624	-1.446

Source: Author (SPSS output)

The centroid calculated for Z score model using the data given in table 4 is -0.00012 which is the threshold limit to discriminate the companies into defaulted and non defaulted. Therefore, that if Z score less than -0.00012 then company shall default and if Z score is more than -0.00012 then company shall not default. For Recalibrated model the centroid is 0.000043, which means the companies having Z score less than 0.000043 shall be defaulted company otherwise non defaulted.

Original Altman Z score Method

Thereafter Altman Z score is also applied on the current data and the results are:

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

Where

X 1: Working Capital /Total Assets

X 2: Retained Earnings/Total Assets 5

X 3 : Earnings before interest and taxes/ Total assets

X 4 : Market Value equity/ Book value of total debt

X 5 : Sales/ Total Assets.

Companies having Z score less than 1.81 are belonging to the defaulted group (Altman, 1968).

Classification of Results of Z score model, Recalibrated Model & Original Altman Z score Model

Table 5

Z score Model				Recalibrated				Altman Z Model			
	0	1	Total		0	1	Total		0	1	Total
0	314	10	324	0	318	6	324	0	102	241	343
1	35	58	93	1	42	51	93	1	1	99	100
			417				417				443
Type I Error	2%			Type I Error	1%			Type I Error	70%		
Type II Error	8%			Type II Error	10%			Type II Error	1%		
Accuracy Level	89%			Accuracy Level	88.48%			Accuracy Level	45%		

Source: Author (SPSS output)

The Accuracy level of Z score model developed in this paper is 89.2%, for Recalibrated model accuracy level is 88.48% and for Original Altman Model accuracy level of prediction probability of default is 45%. Result reveal that the developed model of the study has the highest accuracy level i.e. it is capable of predicting and discriminating the companies on the basis of their financial model. Errors pertaining to the above discussed models are the following

Type I errors:

- 2.3% for Z score developed Model
 - 1% for Recalibrated Model
 - 70% for the original Altman Model
- Type I error is highest in the Altman Model and least in the Recalibrated Model.

Type II errors are:

- 8% for Z score developed Model
 - 10 % for Recalibrated Model
 - 1% for the Original Altman Model
- Type II error is highest in the Recalibrated Model and least in the Original Altman Model.

Conclusion and Discussion

This paper has been organized into sections first section consist of introduction related to bankruptcy which includes meaning of bankruptcy causes of bankruptcy and the ways to get over it by using the predictive models. Second section is comprises past literature in which the various causes of bankruptcy, methods of predicting the bankruptcy, methods of classification of companies studied by various authors had been discussed. Next section is pertinent to the significance of study, objective of the study and the hypothesis proposed in the study. Then, another section covers the data and methodology applied in the paper such as: Original Altman Z score, Modified Altman Z scores model and Recalibrated model. This section also covers empirical analysis performed on the SPSS.

The last section is the vital part of the study without which study couldn't be possible here the section test the various models (Developed model and recalibrated) using the statistical tests like Wilk's Lambda and Canonical correlation which conveys that models are the suitable tools to predict the default probability of the companies and classifying them into bankrupt and non bankrupt, functions of both the models have been also been prepared and Z score is calculated using the coefficients resulted from MDA (Multiple Discriminant Analysis) function in SPSS. Study calculated the centroid which is like a critical value to decide whether company is defaulted or non defaulted. A threshold limit is set and companies were discriminated in the guidance of critical value. Further the original Altman Z score model applied on the given data without using MDA. And at end the result arrived from all of the three models namely Z score developed model, Recalibrated model, Altman model. Results of the models have been classified and displayed in the tabular form. The comparison of the results is performed by comparing the predictive accuracy of the models and its Type I and Type II errors.

Empirical results shows that the highest accuracy level have been attained by the Z score developed model ie. 89% and least is for the Altman Z score model ie. 45% that means the Z score model developed in this paper has more predictive capacity for the Indian context and Altman Z score model is not even stands near to the developed models in terms of accuracy of prediction. Type I error is highest in original Altman Model and least in Recalibrated model therefore, study reveal that in terms of Type I error the Recalibrated model is more successful in discriminating the companies. Type II error is highest in Recalibrated and lowest in original Altman Z score model. Though Altman and Ratio model is simpler than the proposed model but to recognize the best predictor this model is more suitable for the internal credit management. Therefore, study able to achieve the objectives mentioned above. Hence, it's been concluded that developed model is the most suitable for prediction as well as classification of the companies listed in the BSE.

The limitations of the study are that it has only taken listed firms, default prediction is only based on accounting ratios whereas there are many other factors like market price of the shares, market volatility, market value of assets, economic condition of the country, industry specific factors, other micro and macro variables which impacts the financial position of the firms have not been considered.

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