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An Application and Comparison of Bankruptcy Models in the Indian Banking Sector

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Abstract

In today's era, banks are more serious about their success and survival due to increased Non-Performing Asset (NPA) over a period of time. An increased number of NPA's shows that banks are facing huge credit risk. This calls for a proper assessment of credit risk. There are many techniques available for credit risk assessment and one of the most popular approaches is using a scoring model. In the current paper, Altman Z-score, Springate and Grover and Zmweskis model are applied to assess credit risk of public, private and merged banks. The aim of this paper is to apply and compare these scoring models for credit risk assessment of public, private banks and merged banks in India. The data collected during the period 2005–2017 were tested 44 Indian banks. The result shows a similarity in Springate and Grover scoring model and has implications in assessment of banks credit risk in India. As per the ranks given by these models, Dena bank and Catholic Syrian bank in case of public and private banks, respectively, achieved the first rank, depicting a highly secured financial position of these banks.

Keywords: Bankruptcy Model, Altman Z-score Model, Springate, Grover, Zmweskis, India, Banking Sector

Introduction

Bank failure is a major concern to economy around the world as it creates high cost and heavy losses to the society. Banking system affects the economic performance of different countries. Failure of giant banks may traumatize not only the domestic economy but also put the global economy at stake (Mayanks, June 2013). The failure of one bank has a spill over effect on the other banks and throughout the world economy.

According to (Lawerence, 2015), the failure of business organization has significant economic consequences for its owners, creditors and society overall. In other words, the effect of bank becoming insolvent often leads to adverse consequences for many stakeholders, thus the prediction of bankruptcy may be highly beneficial. Some predictions may have large utility for the individual bank, government and the other stakeholders. If bankruptcy could be predicted with a reasonable accuracy ahead of time, banks could better protect their business and could take action to minimize risk and loss of business, perhaps even to prevent bankruptcy (Pongsatats, 2004). Bankruptcy study is vital for auditors as they are acknowledging the probability in the going concern of the bank. There is a need of early warning of financial distress due to the change happening in the recent economic environment. To avoid the risk of bank failure, banks should find the reliable ways to predict bankruptcy.

Literature review shows different methods available for predicting bankruptcy. One of the methods for bankruptcy study is the scoring model. The scoring model is a linear combination of the various factors (accounting variable), weighted by coefficients which provides a relevant score. The output of the scoring model is compared with a standard value to determine the financial health of a bank. Score value calculated using the model is useful to public sector banks to demand loan from the RBI or any other funding agency (Pradhan, 2014). The scoring model has the ability to classify banks into different predefined groups through an appropriate tool, which replaces the human assessment. The scoring model has become very popular during last 40 years in credit risk applications, forming a vast and fast-growing literature. In the past,

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(Vaziri, 2012) and (Hujuan, 2015) tested several method of institutional failure and tested the significant ability of each method in predicting the bankruptcy beforehand. There are many models available for bank failure predictions (to predict the health of a bank) such as Standard and Moody's financial ratios, Altman Z-score Model, Ohlson's Model, Grover Model, Springate Model, Neural Network and Zmijewskis Model. Among many techniques available for evaluating the financial performance of banks, literature survey shows that a majority of international failure prediction studies employs Altman-Z score model, Springate, Grover and Zmijewskis. Present paper is designed to assess the financial health of 44 public, private and merged banks by applying Altman Z-score, Springate, Grover and Zmijewskis bankruptcy model for a period of 2005–2017 and also compares these models with each other to find the model accuracy.

Theories and Models

Theories

Procedure Theory

There are various theories stating the bankruptcy problems of banks. In the year 2004, Charles W. Mooney developed a normative theory of bankruptcy law called ''procedure theory." The procedure theory holds that it is generally wrong in bankruptcy to redistribute a debtor's wealth away from its rights holders to benefit third-party interests, such as at-will employees and the general community. It also generally is wrong to rearrange priorities in bankruptcy as among a debtor's rights holders. The procedure theory explains what bankruptcy law is supposed to achieve, not how bankruptcy law is to achieve its proper ends. The theory of bankruptcy argues that bankruptcy should be limited to solving coordination problems caused by multiple creditors.

Hazard Theory

Hazard theory says that if banks do not have sufficient equity "at stake" when they make their investment decisions, they may make decisions which, though optimal for equity holders, are suboptimal from the point of view of society as a whole. Banks may be tempted to make excessively risky and even negative net present value investments, which maximize the returns to equity at the expense of debt-holders or the deposit insurance fund. Moral Hazard Theory states that borrower has incentive to default unless there are consequences for future application of credit. Thus lenders have difficulty in assessing the wealth of borrowers. Therefore, if the lenders cannot assess the borrower's wealth the latter will be tempted to default in borrowing. If lenders cannot assess the borrower's wealth, the latter will be tempted to default on the borrowing. Forestalling this, lenders will increase rates, leading eventually to the breakdown of the market.

Bankruptcy Model

Present paper covers application of four bankruptcy models such as Altman Z-score model, Springate Model, Zmijewski Model and Grover Model. The details of these models is given in Table 1.

Models

Table 1: Showing the Scoring Model

Sr. No.	*Model*	*Equation*	*Description*	*Score Category*
1	Altman- *Z*-Score (1993)	ZM = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4	ZM = Modified Altman-*Z*-Score X1 = Working Capital/Total Asset X2 = Retained Earnings/Total Asset X3 = Earnings Before Interest and Taxes/Total Asset X4 = Book value of (Equity/total debt)	ZM < 1.10 = bankrupt ZM = 1.10–2.60 = grey ZM > 2.60 = health
2	Springate (1978)	SS = 1.03X1 + 3.07X2 +0.66X3 + 0.4X4	SS = Springate Score X1 = Working capital/Total asset X2 = Net profit before interest taxes/ total asset X3 = Net profit before Taxes/Current liabilities X4 = Sales/Total asset	SS > 0.862 = healthy SS < 0.862 = bankrupt

Sr. No.	Model	Equation	Description	Score Category
3	Grover (2001)	G = 1.650X1 + 3.404X3 –0.016ROA + 0.057	GS = Grover Score X1 = Working capital/Total assets X2 = Earnings before interest and taxes/Total assets ROA = net income/total assets	GS ≤ -0.02 = bankrupt GS ≥ 0.01 = health
2	Zmijewski (1983)	Z = -4. -4.5X1 + 5.7X2 – 0.004X3	ZS = Zmijewski Score X1 = ROA (Net income/total assets) X2 = Leverage (Total liabilities/total assets) X3 = Liquidity (Current assets/current liabilities)	ZS > 0.5 = healthy ZS < 0.5 = bankrupt

Altman Model (I)

In the year 1967, Edward Altman, Finance Professor of Leonard N. Stern School of Business of New York University, developed the financial model to predict the likelihood of bankruptcy of a company. The model is popularly known as Altman Z-score model (1968). His work was based on the notion that univariate prediction model served in most cases as an indicator and not as a predictor of bankruptcy. Before development of Altman (1968) model, he used 22 tentative variables as significant predictors of bankruptcy from the five areas such as liquidity, profitability, leverage, solvency and activity. In his model, he used 33 bankrupt and 33 non-bankrupt firms in the period of 1946–1965. He developed a Z-Score model based on five variables that had most predictive power in Multivariate Discriminant Analysis model. His model has an accuracy rate of 94%. His model was the most influential in corporate bankruptcy prediction as it was multivariate model build on the values of selected ratios. Later on, Altman Z-score was re-estimated based on the other databases for private manufacturing company, non-manufacturing company and service companies. The Z-score model for the service companies uses four variables to discriminate between obligors. These variables are – Liquidity, Leverage, Profitability, and Solvency. Altman was applied by (Chaudhary, 2011), (Popker, 2013), (Mayanks, 2013), (Chotalia, 2014), (Pradhan, 2014), (Vaziri, 2012), (Hujuan, 2015) and (Mayanks, 2013).

Springate Model (Model II)

Springate model was the first model to be introduced by Gordon LV Springate (1978). Basically, this model is a revolution of the Altman model developed by Multiple Discriminant Analysis (MDA). The Springate model development process initially used 19 financial ratios that have been frequently used. However, after testing, Springate finally chose four financial ratios to be used to determine whether the company is said to be either a healthy company or potentially insolvent. Springate used 40 companies as the sample for this research. Springate test shows that the model has an accuracy rate of 92.5%. References paper in this area were conducted by Deakin (1972, 1977), Edmister (1972), Taffler & Tisshaw (1977), Bliderbeek (1979) Ooghe & Verbaere (1982), Micha (1984), Gloubas & Grammattus (1988), Declerk (1991) and Lussierand Corman (1994).

Grover Model (Model III)

This model was created by restoration or redesigns of the model of the Altman Z-Score. It takes X1 and X3 of the Altman model and then adds profitability ratios, which are indicated by the Return on Asset (ROA). (Chaudhary, 2011), (Popker, 2013), (Mayanks, 2013), (Chotalia, 2014), (Pradhan, 2014), (Vaziri, 2012), (Hujuan, 2015) and (Mayanks, 2013). The study shows that the model Grover has the highest degree of accuracy that is equal to 100% claimed by Grover in 2003. On the contrary, Altman model of Z-Score has an accuracy rate of 80%, Springate model - 90% and Zmijewskis model - 90%.

Zmijewskis Model (Model IV)

The finance scholar Mark E. Zmijewski created a financial distress prediction model based on Ohlson (1980) work popularly known as the Zmijewski model. Zmijewski used the Probit method to predict bankruptcy. During

the development of the model, Zmijewski took into consideration external factors, such as industry sector, size of the company, economic cycle, etc. Therefore, he used all non-financial, non-service and non-public administration firms listed on the American and New York Stock Exchange from 1972-78. His sample consisted of 40 bankrupt and 800 non-bankrupts firms. The original models reported an accuracy rate of 98.2%.

Literature Review

Literature review shows different methods available for predicting bankruptcy. One of the methods for bankruptcy study is the scoring model. The scoring model is a linear combination of the factors (accounting variable), weighted by coefficients which provides relevant score. These models are 1) Altman Z-score model, 2) Springate model, 3) Ohlson Model and 4) Zmweskis model.

There was extensive literature found on Altman Z-score model. Altman Z-score model was used by many researchers in the past such as (Tyler, 2001), (Altman, 2000), (Chaudhary, 2011) , (Popker, 2013), (Chieng, 2013), (Mayanks, 2013), (Chotalia, 2014), (Pradhan, 2014), (Cantemir, 2014), (Hujuan, 2015), (Maina & Sakwa), (Khaddafi, 2017), who applied it on select Indian commercial banks. (Popker, 2013) applied Altman Z-score model to assess bankruptcy of 15 Indian commercial banks from 2002 to 2012, and concluded that performance of all banks in selected sample is under the safety zone. (Mayanks, 2013) applied Altman Z-score model on 36 Indian commercial banks for a period of 5 years from 2007 to 2012 and also a ranking of bank was done based on Z-score. Their study conclude that financial position of sampled Indian banks is satisfactory. (Chotalia, 2014) computed Z-score for the six Indian private sector banks by applying Altman Z-score model. He concludes that sampled private banks are uncertain about credit risk and considered marginal cases to be watched with attention. (Pradhan, 2014) applied Altman Z-score and Neural Network to predict the bankruptcy of three Indian public sector banks from 2001 to 2007. She concludes that neural network technique outperforms the Altman model. (Hujuan, 2015) conducted a study on consumer goods industry in the UK and applied original Altman Z-score model (1968), in which he found that variables (Sales/Total Asset) have little contribution to distinguish bankrupt and non-bankrupt firm. Hence, he renewed the original Altman model by changing coefficients of model and concluded the renewed Z-score outperforms the original Altman model. (Maina & Sakwa) in their paper assessed the financial distress among 30 listed firms in Nairobi stock exchange in Kenya for the period from 2003 to 2007. They used T-test to test the hypothesis; the result indicated that financial health of listed company needed to be improved. (Chaudhary, 2011) developed an internal credit rating model for banks with the help of Altman Z-score model. They used Altman Z-score model to arrive at an equation of prediction. After comparing their developed model with Altman Z-score model, they found that the developed model is more accurate than Altman Z-score model. (Khaddafi, 2017) tested the Altman model for predicting bankruptcy of banking companies listed on the Indonesia stock exchange and concluded that Altman Z-score model has a good predictive power.

Some of the researchers applied multiple models and their comparison to find the accuracy and predictive power of models. These reviews are (Imanzadeh, 2011), (Kodlar, A.), (Vaziri, 2012), (Karamzadeh, 2013), (Avenhuis, 2013), (Hussein, 2014), (Timmermans, 2014), (Kumar, 2012), (Sajjan, 2016), (Aminian, 2016), (Stinjak), (Wati & Hidayat, 2015), (Primassari, 2017), (Monousaridis) and (Syamni, 2018). They used multiple models in their studies. Reviews on comparative models show that some of the researchers found better result using Altman Z-score model compared to others models such as Springate model, Ohlson Model and Zmweskis model. However, some other researcher have criticized Altman Z-score model on the ground of its predictive ability.

(Vaziri, 2012) conducted a comparative predictability of failure of financial institution and used multiple models such as Moody's model, standard and poor's, Vaziris model, Altman Z-score and Logit model on 100 banks from Europe, Asia and the US for a data period 2001 to 2010. He conclude that Z-score model makes the best prediction, however study couldn't find other factors which could lead to bankruptcy. (Karamzadeh, 2013) worked on application and comparison of Altman and Ohlson model to predict bankruptcies of companies listed in Tehran stock exchange. The sample composed of 90 corporations with 45 firms in each of the two groups – bankrupt and non-bankrupt. A comparison of Altman and Ohlson models shows that Altman works better. A study by (Primassari, 2017) made comparison of Altman, Grover, Springate and Zmijewski models to find their accuracy

on the 29 listed firms of consumer goods industry of the Indonesia stock exchange. This study shows that the most accurate model is Altman Z-score and the least accurate is Grover model as it has low R square.

Another study by (Syamni, 2018) applied and measured the impact of score on the stock prices using panel regression. They used Altman, Grover and Zmweskis models for predicting the bankruptcy of coal mining companies in Indonesia. Its study concludes that Ohlson and modified Altman Model were dominant in predictions. Another study conducted by (Chieng, 2013), on verification of Altman Z-score's predictive power on Euro zone banks' failure, suggested that Altman Z-score is a reliable predictor.

The Springate model was the first model to be introduced by Gordon LV Springate (1978). Literature review on the Springate model shows the predictive ability of this model. (Sajjan, 2016) aimed at presenting a theoretical foundation and compared the result of investigating two models, that is, Zavgren and Springate. Result indicates adjusted Springate model was efficient than other model in the bankruptcy year. One review shows that the Springate model is better than the other model; however, most of the other reviews express that other models are better than the Springate model. This depicts the need for revision of the Springate model.

Zmijewski model uses a financial performance measurement ratio on the bankrupt and non- bankrupt firms. (Hussein, 14) aims to analyse the accuracy of Altman, Springate, Zmweskis and Grover Models as a best predictor of financial distress. They used 132 companies listed under the Drafter Efteck Syriah (DES) in 2009–2012. In the study, Binary Logistic Regression (BLR) was used for data analysis. They found that Zmweskis is the most appropriate model to be used in financial distress. (Imanzadeh, 2011) applied Springate and Zmweskis models on the firms of the Tehran stock exchange. Its study concludes that the Springate model is a more conservative model than the Zmweskis model.

The Grover model is a model developed by restoration of the Altman Z-model by Jeffrey S. Grover. According to (Primassari, 2017), during the development of model, he used the sample according to Altman Z-score by adding 13 financial ratios. He used a sample of 70 companies with 35 bankrupt and 35 non-bankrupt companies. He considered a data period of 1982 to 1996. Literature review on the Grover model shows the following facts. A study by (Aminian, 2016) investigated the ability of bankruptcy prediction model such as Altman, Grover, Springate and Zmweskis of 35 listed firms of the Tehran stock exchange using regression and correlation analyses. This study shows that the Grover model shows a better bankruptcy prediction.

Some other reviews present a divergent view on all of these four models. These reviews are (Wati & Hidayat, 2015), (Kodlar) and (Avenhuis, 2013) examined the predictive ability of Zmweskis, Ohlson and Altman models for measuring the financial performance of listed and delisted banks of the Indonesia stock exchange. Its prediction shows that there exists a small difference in the predictive abilities of these models. In other words, it means all the three models have more or less same accuracy rate. (Avenhuis, 2013) tested the generalisability of Altman, Ohlson and Zmijewski models for the Dutch listed firms and re-estimated these models using logistic regression. It is found that all three models are accurate when same statistical technique is used. This implies that explanatory variable of these models are best predictors of likelihood of bankruptcy. (Kodlar A.) compared the bankruptcy prediction models such as Altman (1968), Ohlson (1980) Zmijewski, Shumway (2001), and combined model in the Tehran Stock Exchange in Iran. Its study concludes that combined model significantly outperforms the other models. These reviews summarize that all the four models have the same accuracy rate.

Many researchers used one or two models to assess the financial health of business; however, there is need to use more than two models to decide the accuracy of model. Thus, in the proposed study, four model will be used to assess bankruptcy. Though some studies do available covering a small sample size, there is need to do a study on larger sample size. The sample size of (Chotalia, 2014) and (Kumar, 2012) is too small, hence it may not give an appropriate result. Therefore, to fill up this gap, present paper will be extended to cover a bigger sample size. Similarly, ample literature is available on bankruptcy prediction covering only one sector of banking either public or private sector. However, in order to give a broad perspective, there is a need to include both sectors of banking public and private so that a comparative analysis could be made. Ample literature is available including data period of 3 to 5 years. Literature need to be developed covering a larger data period. Studies on recent period left to be examined.

Research Methodology

The present paper used 44 Indian banks in the study, out of which 21 are public banks, 18 private banks and five merged banks. In the present paper, banks are selected, because the financial data of banks are taken from publicly available financial statements, which are more reliable and will reduce measurement errors. Another reason is that banks are subject to many regulations and financial statements are monitored by outsiders such as creditors, depositors, RBI SEBI, tax authorities, etc. In the present study, the required data have been sourced from audited statements of individual banks and the RBI. Part of data is collected from reputed data sources such as Centre for Monitoring Indian Economy (CMIE) and India stats.com. The data was taken for 13 years period from the year 2004–05 to 2016–17. Four models are applied on 44 Indian banks to predict their bankruptcy position. Equations given in these models were applied on the sample to find their scores. To find the model accuracy, two approaches were used one is by detecting type I and type II errors and second by giving ranks to each bank based on the scores achieved by banks in each model and comparing these ranks to judge the accuracy of these models. The ranks given by all four models were summed up and the final rank was given for the bank to find the best bank.

Testing the Bankruptcy Mode

This part applies the Altman Z-score, Springate, Grover and Zmijewski models to assess the credit risk of banks. These models were applied on 21 public banks and 18 private banks and five merged banks from Indian banking sector.

Table 2: Showing the Mean Score of Four Bankruptcy Models for Public and Private Banks

Sr. No	*Banks*	*Model I (Altman)*	*Result*	*Model II (Springate)*	*Result*	*Model III (Grover)*	*Result*	*Model IV (Zmijewskis)*	*Result*
1	Allahabad Bank	1.15	Grey	2.23	Safe	0.41	Safe	2.23	Safe
2	Andhra Bank	1.34	Grey	2.20	Safe	0.44	Safe	2.20	Safe
3	Bank of Baroda	1.55	Grey	1.64	Safe	0.52	Safe	1.64	Safe
4	Bank of India	1.28	Grey	1.82	Safe	0.43	Safe	1.82	Safe
5	Bank of Maharashtra	1.12	Grey	1.79	Safe	0.41	Safe	1.79	Safe
6	Canara Bank	1.35	Grey	2.06	Safe	0.44	Safe	2.06	Safe
7	Central Bank of India	1.11	Grey	1.62	Safe	0.41	Safe	1.62	Safe
8	Corporation Bank	1.22	Grey	1.87	Safe	0.41	Safe	1.87	Safe
9	Dena Bank	1.39	Grey	2.19	Safe	0.47	Safe	2.19	Safe
10	I D B I Bank Ltd.	1.07	Distress	1.81	Safe	0.41	Safe	1.81	Safe
11	Indian Bank	1.19	Grey	1.69	Safe	0.40	Safe	1.69	Safe
12	Indian Overseas Bank	1.27	Grey	2.05	Safe	0.45	Safe	2.05	Safe
13	Oriental Bank of Commerce	1.32	Grey	2.23	Safe	0.44	Safe	2.23	Safe
14	Punjab & Sind Bank	1.10	Distress	2.44	Safe	0.40	Safe	2.44	Safe
15	Punjab National Bank	1.31	Grey	1.76	Safe	0.42	Safe	1.76	Safe
16	State Bank of India	1.22	Grey	0.94	Safe	0.39	Safe	0.94	Safe
17	Syndicate Bank	1.07	Grey	1.78	Safe	0.39	Safe	1.78	Safe
18	Uco Bank	1.17	Grey	1.98	Safe	0.43	Safe	1.98	Safe
19	Union Bank of India	1.04	Distress	2.04	Safe	0.39	Safe	2.04	Safe
20	United Bank of India	1.18	Grey	1.77	Safe	0.45	Safe	1.77	Safe
21	Vijaya Bank	1.25	Grey	2.30	Safe	0.48	Safe	2.30	Safe
Private Banks									
1	Axis Bank Ltd.	1.57	Grey	1.67	Safe	0.38	Safe	1.16	Safe

Sr. No	Banks	Model I (Altman)	Result	Model II (Springate)	Result	Model III (Grover)	Result	Model IV (Zmijewskis)	Result
2	Catholic Syrian Bank Ltd.	1.62	Grey	2.33	Safe	0.57	Safe	1.27	Safe
3	City Union Bank Ltd.	1.46	Grey	2.11	Safe	0.45	Safe	1.14	Safe
4	D C B Bank Ltd.	1.18	Grey	1.34	Safe	0.36	Safe	1.16	Safe
5	Dhanlaxmi Bank Ltd.	1.44	Grey	1.99	Safe	0.47	Safe	1.26	Safe
6	Federal Bank Ltd.	1.58	Grey	2.34	Safe	0.48	Safe	1.22	Safe
7	H D F C Bank Ltd.	1.40	Grey	0.95	Safe	0.33	Safe	0.83	Safe
8	I C I C I Bank Ltd.	1.55	Grey	1.28	Safe	0.39	Safe	1.04	Safe
9	Indusind Bank Ltd.	1.46	Grey	1.78	Safe	0.42	Safe	1.14	Safe
10	Jammu & K Bank Ltd.	1.49	Grey	2.13	Safe	0.47	Safe	1.23	Safe
11	Karnataka Bank Ltd.	1.39	Grey	2.48	Safe	0.46	Safe	1.24	Safe
12	Karur Vysya Bank Ltd.	1.28	Grey	2.36	Safe	0.41	Safe	1.19	Safe
13	Kotak Mahindra Bank Ltd.	1.46	Grey	1.21	Safe	0.28	Safe	1.00	Safe
14	Lakshmi Vilas Bank Ltd.	1.31	Grey	2.00	Safe	0.44	Safe	1.20	Safe
15	Nainital Bank Ltd.	2.65	Safe	1.79	Safe	0.73	Safe	1.14	Safe
16	R B L Bank Ltd.	1.74	Grey	1.60	Safe	0.48	Safe	1.18	Safe
17	South Indian Bank Ltd.	1.27	Grey	2.20	Safe	0.44	Safe	1.22	Safe
18	Yes bank	1.06	Distress	1.23	Safe	0.33	Safe	1.07	Safe
19	Bank Of Punjab (M)	1.42	Grey	1.42	Safe	0.53	Safe	1.23	Safe
20	Bank of Rajasth. (M)	1.52	Grey	1.14	Safe	0.51	Safe	1.15	Safe
21	Bharat Overseas Bank Ltd. (M)	1.39	Grey	1.81	Safe	0.33	Safe	1.15	Safe
22	Centurion Bank of Punjab Ltd. [Merged]	1.03	Distress	0.92	Safe	0.43	Safe	1.00	Safe
23	I N G Vysya Bank Ltd. (M)	1.31	Grey	1.14	Safe	0.43	Safe	1.07	Safe

Analysis

The scoring model gave guidance to the researchers to find the financial health of the institutions or banks under study. Four scoring models are used in the present study such as Altman, Springate, Grover and Zmweskis, to calculate the score of all the public and private banks. The scores of these models differ due to different ratios and discrimination zones used in calculations of these score. Table 2 shows the application of Altman, Springate, Grover and Zmweskis models on 21 public banks, 18 private banks and five merged banks in India. As per the Altman model, with respect to public sector banks three banks show distress position; whereas, in case of private banks, majority of them are in grey area and one bank lies in distress position. In case of merged banks, one bank is in the distressed zone and the rest of the four banks are under grey area. The banks which are in the bankruptcy position are Union Bank of India, IDBI (Industrial Development Bank of India), bank and Punjab National Bank among the public banks, and Yes bank (Private Banks) and Centurion Bank of Punjab (Merged Bank). The Springate, Grover and Zmweskis models show all the public, selected private and merged banks in a safe position. This shows the similarity in these three models. As per the Altman model and the Grover model, the highest score belongs to Bank of Baroda. This shows financial position of Bank of Baroda which is much more secured among the public sector banks in India. Also, since these two models give the same ratings for the banks, this shows the reliability of these models. The Springate model and the Zmweskis model show the highest score of Punjab and Sind bank and UCO bank, respectively; hence, as per these models, the financial position of these banks showed an improved position.

Model Accuracy

All the selected scoring models show most of the merged banks in the safe position. Also, the different models give different rank to the banks, Therefore, there is need to check the model accuracy rate. This accuracy is checked by detecting the type I and type II errors in the model.

Type I and Type II Errors

Table 3: Showing the Accuracy Rate of Model

Altman Model	*Bankrupt*	*Non - Bankrupt*	*Total*	*Correct*	*Correct Rate*	*Error*	*Models Accuracy Rate*
Merged Banks	01	04	05	01	20%	04 - (Type I error- 9%)	84%
Good Banks	03	36	39	36	90%	03 - (Type II error 7%)	
Total	04	39	44	37		07 (Total Error -16%)	
Springate Model							
Merged Banks	0	5	5	0	0%	05 - (Type I error- 11%)	
Good Banks	0	39	39	39	100%	0 (Type II error- 0%)	
Total	0	44	44	39		05 - (Total Error-11%)	89%
Grover Model							
Merged Banks	0	5	5	0	0%	05 - (Type I error- 11%)	
Good Banks	0	39	39	39	100%	0 (Type II error- 0%)	
Total	0	44	44	39		05 - (Total Error-11%)	89%
Zmweski Model							
Merged Banks	0	5	5	0	0%	05 - (Type I error- 11%)	
Good Banks	0	39	39	39	100%	0 (Type II error- 0%)	89%
Total	0	44	44	39		05 - (Total Error-11%)	

There are two types of error in the statistical process – type I error and type II error. Type I error is rejecting a null-hypothesis which is true while a type II error fails to reject a null-hypothesis which is false. In other words, type I error in prediction model means predicting a failed firm will not go bankrupt and type II error is predicting a non-failed firm to be bankrupt. The present paper used four models such as Altman Z-score model, Springate Model, Grover Model and Zmweskis model on a sample of 44 banks comprising of 39 good banks and five merged banks. Models' accuracy rate was calculated by finding out type I and type II errors in predicting the bankruptcy of banks. Table 3 shows the correct rate and the error rate. The Altman model has the lowest accuracy rate which is 84%. It has 16% error rate, which is the highest among all these models. Some of the studies found that the Altman model gives a correct result; however, some other studies propounded for the renewal of the Altman model as it gives a higher error rate. A study by (Tyler, 2001) proved that Z-score model is dead and totally not trustworthy anymore for predicting corporate bankruptcy. He claims half of its variables have poor predictive strength. (Monousaridis) applied Altman (1968), Springate, Zmweskis and Grover models on the firms from emerging market. Its study concludes that the Altman model is outdated and needs to be handled in cautious way. (Kumar, 2012) applied multiple models such as the Altman Z-score, Ohlson's – Oscore and Zmweskis models on Texmo industries in Coimbatore covering a period of 2005–2010. Study concludes O-score model is proposed with better prediction performance. Thus, above evidences support the error rate of this model.

There is a similarity in the model accuracy rate of Springate, Grover and Zmweskis models as the model accuracy rate of all these three models is same. All these three models have the accuracy rate of 89%. These models have failed to predict the bankruptcy of merged banks correctly. As per these models, all the merged banks fall in the safe category. Thus, these models also need a revision. As an

evidence to this fact, (Sajjan, 2016) aimed at presenting a theoretical foundation and compared the result of investigating two models, Zavgren and Springate. Result indicates that the adjusted Springate model was efficient than other models in the bankruptcy year. A study by (Qamruzzaman, 2016), on Grameen bank in Bangladesh, concludes that G-score provides conflicting predictions. (Primassari, 2017) found the Grover model as a least accurate model. Majority of the reviews on the Grover model reflect negative views on its predictions. This suggests the need for recalibrations of this model.

Ranking of Banks Based on Model

Second approach used to compare models is through ranking the banks based on the scores given by these models and comparing these ranks between these models, to decide the predictive power of these models.

Table 4 Shows the Ranking of Banks as Per Score

S. No.	Bank	Altman	Springate	Grover	Zmweskis	Total of Ranks	Final Rank
1	Allahabad Bank	15	3	12	2	32	
2	Andhra Bank	4	5	6	11	26	III
3	Bank of Baroda	1	19	1	12	33	
4	Bank of India	7	12	9	8	36	
5	Bank of Maharashtra	16	14	13	13	56	
6	Canara Bank	3	7	7	6	23	
7	Central Bank of India	17	20	14	7	58	
8	Corporation Bank	10	11	15	19	55	
9	Dena Bank	2	6	3	5	16	I
10	I D B I Bank Ltd.	19	13	16	16	64	
11	Indian Bank	12	18	17	18	65	
12	Indian Overseas Bank	8	8	4	20	40	
13	Oriental Bank of Commerce	5	4	8	3	20	II
14	Punjab & Sind Bank	18	1	18	4	41	
15	Punjab National Bank	6	17	11	5	39	
16	State Bank of India	11	21	19	21	72	
17	Syndicate Bank	20	15	20	9	64	
18	Uco Bank	14	10	10	1	35	
19	Union Bank of India	21	9	21	17	68	
20	United Bank of India	13	16	5	10	44	
21	Vijaya Bank	9	2	2	14	27	
Private Banks							
1	Axis Bank Ltd.	5	12	14	10	41	
2	Catholic Syrian Bank Ltd.	3	4	2	1	10	I
3	City Union Bank Ltd.	8	7	8	12	35	
4	D C B Bank Ltd.	17	14	15	11	57	
5	Dhanlaxmi Bank Ltd.	11	9	5	2	27	
6	Federal Bank Ltd.	4	3	3	5	15	II
7	H D F C Bank Ltd.	12	18	16	18	64	
8	I C I C I Bank Ltd.	6	15	13	16	50	
9	Indusind Bank Ltd.	9	11	11	13	44	
10	Jammu & K Bank Ltd.	7	6	6	4	23	III
11	Karnataka Bank Ltd.	13	1	7	3	24	

S. No.	*Bank*	*Altman*	*Springate*	*Grover*	*Zmweskis*	*Total of Ranks*	*Final Rank*
12	Karur Vysya Bank Ltd.	15	2	12	8	37	
13	Kotak Mahindra Bank Ltd.	10	17	18	17	62	
14	Lakshmi Vilas Bank Ltd.	14	8	9	7	38	
15	Nainital Bank Ltd.	1	10	1	14	26	
16	R B L Bank Ltd.	2	13	4	9	28	
17	South Indian Bank Ltd.	16	5	10	6	37	
18	Yes Bank	18	16	17	15	66	

Ranking is given to all the public sector banks based on these models. Those banks which have a high score are given a first rank and the lowest score is given the last rank. Later on, the ranks given by the individual model is summed up to find the final rank. In total, the final three ranks are given. The bank which has the least score in total is given the first final rank. The bank which has the second least score is given the second final rank and the bank which has the third least score is given the third final rank.

There is similarity in the ranks given by Springate and Grover models as both these models gave the same rank to Canara bank, UCO bank and Vijaya bank, in case of public banks and Federal, Indusind and Jammu and Kashmir Bank with respect to private banks. Thus, in total, six ranks of Springate and Grover models match with each other; hence, these two models have better predictive power. Also, the ranks of Grover and Zmijewskis models are matching with respect to two banks, i.e., Bank of Maharashtra and IDBI bank in case of public banks. The rank given to State Bank of India and HDFC in case of public and private bank, respectively, by Springate model tallies with the rank given by the Zmijewskis model. Lastly, the rank given by the Altman model to Bank of Baroda in case of public banks and City Union bank and Nainital bank of private banks category matches with rank given by the Grover model. Finally, the ranks given by Springate and Grover models matches with respect to six banks. Hence, both these models are more reliable compared to other models used in the present study.

The above observations support the Springate and Grover models but not the Altman model; even though it is one of the pioneers in the bankruptcy prediction model, due to time factor, the said model has lost its importance. The Altman model (1993) is 25 years old and might not be relevant to today's economic climate. There are constant changes happening in the economic environment. According to (Hujuan, 2015), the Altman model might not be valid to predict bankruptcy, since business environment evidenced tremendous changes. The result of present study shows that the predictive power of Altman is low as some merged banks are shown in safe category. According to Timmerman, when an old original model is applied to a more recent sample, the predictive power of the model is very low and the bankruptcy is over predicted. This proves that there is need to recalibrate the Altman Z-score model by changing coefficients of original Altman Z-score model using current data. Among the four models, Zmijewski is also the least important model as its results are not much matching with the other models. (Timmermans, 2014) tested the accuracy of bankruptcy model such as the Altman (1968), Ohlson and Zmijewski models after its recalibration. Its study found that accuracy of model increased after recalibrations. From the review, it is noticed that the Zmijewski model also needs revision.

Ranking result in Table 4 shows that the final first rank of public banks is achieved by Dena bank, followed by Oriental bank of Commerce at second position and Andhra bank at third position. Similarly, in case of private banks, the first position is occupied by Catholic Syrian bank followed by Federal bank at second position and Jammu and Kashmir at third position.

Conclusion

Credit risk assessment is most important activity banks need to perform due to recent trend of increased NPAs. There are different ways to perform credit risk assessment. Present paper used the scoring model to assess the financial health of banks. In the current paper, Altman Z-score, Springate, Grover and Zmijewskis models are applied to assess credit risk. The aim of this paper is to apply and compare these scoring models for

credit risk assessment of public and private banks in India. After application of these models on public private and merged banks, the result shows that public banks are more in distress category compared to the private banks. The comparison of these models was done to find out the accuracy of these models. Two approaches were used; one is by detecting type I and type II errors and second by giving ranks to each bank based on the scores achieved by banks in each model and comparing these ranks to judge the accuracy of these models. As per the first method, the Springate, Grover and Zmijewski models are more accurate compared to the Altman model. As per second method, Springate and Grover methods are more reliable as both give a similar result of predicting bankruptcy of banks. Thus, other model such as the Altman and Zmijewski models need recalibration to meet with the current environment. As per the ratings given by these models, Dena bank and Catholic Syrian bank in case of public and private banks, respectively, achieved the first rank. This shows the highly secured financial position of these banks.

Theoretical implications of present study implies that merged banks support the "Procedure Theory" as these banks do not follow the lengthy procedure of bankruptcy but merge it with the strong banks. Similarly, banks should follow hazard theory, which is a precautionary measure to avoid bankruptcy. The present study bears a limitation of taking data only of banking companies. Future studies can be in terms of testing the bankruptcy models using the data of non-banking companies. All the four models used accounting ratios to calculate the discrimination score, but other determinants of bank failure should also be considered, such as volatile stock, high exchange and interest rate. These factors can have a devastating effect on the health of banks.

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