

Recalibration and Application of Springate, Zmijewski and Grover Bankruptcy Models in Indian Banking Sector

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Abstract

Objectives: Banks' failure is a significant concern to the economy as it creates high cost and heavy losses to the individual banks and society. To avoid the risk of bank failure, banks need to find reliable ways to predict bankruptcy. Certain bankruptcy models are not working in the current economic environment. Therefore, the objective of the present paper is to recalibrate and apply Springate, Zmijewski and Grover models to assess the Indian banks' bankruptcy. Method the current study tries to recalibrate the said models by considering the fact of models criticism in past studies with respect to their predictive power, selection of variables, time factor, accuracy rate, change in the economic environment, etc. Models are recalibrated by changing coefficients of the original models using current data through multiple regression technique. Further, this study applies the recalibrated bankruptcy models such as Springate, Zmijewski and Grover to assess the banks' bankruptcy. Results the result shows that the recalibrated Grover model outperforms the original model; however in case of Springate and Zmijewski model, original model performs better than the recalibrated model. Conclusion the implications of the study direct the Reserve Bank of India to make a policy of using advanced modes such as Multiple Discriminant Analysis technique, logit, Probit models along with the CAMEL model for the financial health assessment of banks.

Keywords: Recalibration, Bankruptcy Models, Springate Model, Zmijewski Model, Grover Model, Banking Sector

Introduction

In the Indian financial system, banking plays a vital role in the up-liftment of the society. Banks' distress is a major concern to the economy all over the world, as it has direct and indirect impacts on the individual bank and the global economy. It affects individual bank in terms of direct and indirect cost. Direct cost will be in terms of legal and administration cost associated with bankruptcy proceedings and indirect cost will be in terms of loss of depositor's confidence; withdraw of amount from the bank, avoidance of investment by customer. Similarly, it affects global economy in different context. The banking system affects the economic performance of different country. Failure of giant banks may traumatize not only the domestic economy but also put the global economy at stake (Mayanka & Sharma 2013). The failure of one bank has a spillover effect on the other bank and throughout the world economy. According to (Lawrence, Pongsat, & Lawrence, 2015), the failure of business organization has significant economic effect for its owners, creditors and the overall society. 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 reasonable accuracy ahead of time, banks could better protect their business and take action to minimize risk and loss of business, perhaps even to prevent bankruptcy (Pongsat, Ramage & Lawrence, 2004). Bankruptcy study is important for auditors as they

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are acknowledging the probability in the going concern of the bank. Bankruptcy study will provide information on variables that will influence the health of bank (Stinjak & Warastuti, 2014). A proper prediction of firm bankruptcies might therefore be extremely important and of great interest wide range of relevant financial actors. There is a need of early warning of financial distress due to changes 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 scoring model. The scoring model is a linear combination of the factors (accounting variable), weighted by coefficients which provides relevant score. The scoring model has become very popular during the last 40 years in credit risk applications, forming a vast and fast-growing literature. There are many models available for bank failure predictions such as Standard and Moody's financial ratios, Beaver model, Altman Z-score model, Ohlson's model, CAMEL model, Grover model, Springate model, Neural Network and Zmijewskis model to predict the health of the bank. Among many techniques available for evaluating the financial performance of banks, literature survey shows that majority of international failure prediction studies employ Grover model, Springate model and Zmijewski model. In the past, (Vaziri O, 2012) used Z-score model for predictability of failure of financial institution and the model is found to have high predictive ability. Since model has high predictive ability, the present study applied these models on the Indian banking sector. The existing literature showed that a single bankruptcy prediction model faces limitations and multiple bankruptcy prediction model improved the prediction of accuracy in bankruptcy prediction. Therefore, the present study will apply multiple models to assess the banks bankruptcy. In the past, some of the researchers applied multiple models and its comparison to find the accuracy and predictive power of models. These reviews are: (Imanzadeh P., 2011), (Kodlar A.), (Vaziri O., 2012), (Karamzadeh, 2013), (Avenhuis, Nov 2013), (Hussein F., Dec 14), (Timmermans, 2014), (Kumar & Kumar., April 2012), (Sajjan, 2016), (Aminian A., July 2016), (Stinjak & Warastuti, 2014), (Wati M. & Hidayat R., Nov 2015), (Primassari, 2017), (Monousaridis) and (Syamni G., 2018), who used multiple models and their comparison in their studies. After the comparison, some of

the studies criticized certain models with respect to their predictive power, selection of the variables, time factor, accuracy rate, change in the economic environment, etc. According to Timmerman (2014), 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. Due to this fact, the present study will recalibrate these models by changing coefficients of original models using current data. A study by (Timmermans, 2014) found better results in its study after recalibration of the models.

Models and Literature Review

Springate Model (Model I)

The Springate model was the first model to be introduced by Gordon LV Springate (1978). This model is a revolution of the Altman model developed by Multiple Discriminant Analysis (MDA). 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%.

Grover Model (Model II)

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 Return on Asset (ROA). As a result, Grover model is the most appropriate predictive model applied to companies in the food and beverage sector. The study shows that the Grover model has the highest degree of accuracy that is equal to 100% (Grover 2003). On the contrary, the Altman model of Z-Score has an accuracy rate of 80%, Springate model, 90% and Zmijewskis models, 90%.

Zmijewskis Model (Model III)

This model uses a ratio measure of performance, leverage and liquidity applied in companies is already bankrupt, and the company can survive. If Zmijewski's models

have exceeded predictions of 0, then the company could potentially be bankrupt; otherwise, if the company has a

score of less than zero, then the company is not potentially bankrupt. This model has an accuracy rate of 90%.

Table 1: Description of Bankruptcy Models

Sr. No	Model	Equation	Description	Score Category
1	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
2	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
3	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

Source: Secondary Data

Literature Review

In the past, some of the researchers applied multiple models and their comparison to find the accuracy and predictive power of models. These reviews are: (Imanzadeh P., 2011), (Kodlar A.), (Vaziri O, 2012), (Karamzadeh, 2013), (Avenhuis, Nov 2013), (Hussein F., Dec 14), (Timmermans, 2014), (Sajjan, 2016), (Aminian A., July 2016), (Stinjak & Warastuti, 2014), (Wati M. & Hidayat R., Nov 2015), (Primassari, 2017), (Monousaridis) and (Syamni G., 2018), who used multiple models and their comparison in their studies. After comparison, some of the studies criticised certain models with respect to their predictive power, selection of variables, the time factor, accuracy rate, change in the economic environment, etc. According to Timmerman (2014), 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. Due to this fact, the present study will recalibrate these models by changing coefficients of original model using current data. A study by (Timmermans 2014) found better results in their study after recalibration of models.

Further, the recalibrated model will be compared with the original model to identify whether there exists a significant difference between these two models. If there exists a significant difference between these two models, the result of both these models will be compared with the robust test; then based on this comparison, the accuracy of the model will be discovered.

Literature review on Springate model shows the predictive ability of this model. A study by Sajjan (2016) aimed at presenting a theoretical foundation and compares the result of investigating two models Zavgren and Springate. Result indicates adjusted Springate model was efficient than other model in the bankruptcy year. A study by (Imanzadeh P., 2011) applied Springate and Zmweski models on the firms of Tehran stock exchange. Its study concludes that Springate is more conservative model than Zmweski model. Thus, most of the other reviews express that other models are better than the Springate model. This depicts the need for revision of Springate model. Zmijewski's model uses a ratio measure of performance, leverage and liquidity applied in companies is already

bankrupt and the company can survive. This model is also criticized by the reviewer such as (Timmermans, 2014). 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 from 1982 to 1996. Literature review on Grover model shows the following facts: a study was conducted by (Qamruzzaman & Jianguo, Dec. 2016) on Grameen bank in Bangladesh using the same models. Its study concludes that G-score provides conflicting predictions. (Primassari, 2017) found Grover as a least accurate model. Majority of the reviews on Grover model reflects negative views on its predictions. This suggests the need for the revision of this model.

Research Methodology

The sample used for the recalibration of bankruptcy’s model is 39 public and private banks by changing coefficients of original bankruptcy model using current data. The data period used to find the new coefficients of the recalibrated model is from 2005 to 2010 in a sample consisting of 39 banks. The multiple regression technique is used to find the coefficients of recalibrated bankruptcy model. In total, 255 observations are used to find the coefficient of recalibrated model. The variables of 41 banks are chosen as per original bankruptcy model. The recalibrated model consists of same variable as the original model but the coefficients differ. To develop

a recalibrated bankruptcy model, all the assumptions required for the regression were checked. These assumptions are correlation coefficients, independence of errors, multicollinearity, homoscedasticity, normality, normality of residuals, presence of outliers and data fit for the model. The recalibrated model is applied on 49 public and private banks covering a period of 2011–2017. Three non-working banks were not taken in the sample of recalibrated model as the recalibrated model was applied for a period 2011–2017 and these three non-working banks are not working before 2011; hence, the data was not available for a period of 2011–2017. There are several useful criteria for measuring the goodness of fit of the multiple regression models. One such criterion is to determine the multiple correlation coefficients denoted as R and the square of the multiple correlation coefficients denoted as R². After the application of recalibrated models on Indian banks, there is need to find the accuracy of these models. The model accuracy was found out by detecting Type I and Type II errors. Type I error is rejecting a null hypothesis which is true while a type II error is fail 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.

Results and Discussion

Springate, Grover and Zmijewski models were recalibrated using the above-mentioned methodology. The results of the same are presented in Table 2.

Table 2: Summary of Different Scoring Models

Sr. No	Model	Original Equation	Recalibrated Equation	Description	Types of Variable	Bases of Discrimination
1	Springate (1978)	$S = 1.03X_1 + 3.07X_2 + 0.66X_3 + 0.4X_4$	$S\text{-scores} = .093 + 1.37X_1 + 7.124X_2 + 0.585X_3 - 1.988X_4$	S = Springate Score X ₁ = Working capital/ Total asset X ₂ = Net profit before interest taxes/ total asset X ₃ = Net profit before Taxes/Current liabilities X ₄ = Sales/Total asset	X ₁ = Liquidity X ₂ = Profitability X ₃ = Profitability X ₄ = Profitability	S > 0.862 = healthy S < 0.862= bankrupt

Sr. No	Model	Original Equation	Recalibrated Equation	Description	Types of Variable	Bases of Discrimination
2	Grover (2001)	$G = 1.650X_1 + 3.404X_3 - 0.016ROA + 0.057$	$G\text{-scores} = .074 + 1.65X_1 + 3.09X_2 - .014X_3$	G = Grover Score $X_1 = \text{Working capital/Total assets}$ $X_2 = \text{Earnings before interest and taxes/Total assets}$ $ROA = \text{Net income/Total assets}$	$X_1 = \text{Liquidity}$ $X_2 = \text{Profitability}$ $ROA = \text{Profitability}$	$GS \leq -0.02 = \text{bankrupt}$ $GS \geq 0.01 = \text{healthy}$
3	Zmijewski (1984)	$X = -4. -4.5X_1 + 5.7X_2 - 0.004X_3$	$X = -2.534 - 3.79X_1 + 4.246X_2 - .081$	X = Zmijewski Score $X_1 = \text{ROA (Net income/Total assets)}$ $X_2 = \text{Leverage (Total Debt/Total assets)}$ $X_3 = \text{Liquidity (Current assets/current liabilities)}$	$X_1 = \text{Profitability}$ $X_2 = \text{Leverage}$ $X_3 = \text{Liquidity}$	$X\text{-score} < 0 = \text{Safe}$ $X\text{-score} > 0 = \text{bankrupt}$ $\text{Prob (X-score)} = \leq 0.5 \text{ "Healthy"}$ $\text{Prob (X-score)} = > 0.5 \text{ "bankrupt"}$

Source: Secondary Data

Application of Recalibrated Models

The recalibrated Springate model, Zmijewski model and Grover model were applied on 41 public, private and non-

working banks covering a period of 2011–2017. Tables 3 and 4 show the result of recalibrated models.

Table 3: Application of the Recalibrated Model on Twenty-One Public Sector Banks Covering a Period of 2011-2017

Sr. No.	Banks	S-Score	Decision	Zm Score	Probability	Decision	G-Score	Decision
1	Allahabad Bank	3.06	Safe	-1.37	0.08	Safe	0.42	Safe
2	Andhra Bank	3.12	Safe	-2.22	0.02	Safe	0.45	Safe
3	Bank of Baroda	2.36	Safe	-2.67	0.01	Safe	0.59	Safe
4	Bank of India	2.57	Safe	-1.79	0.04	Safe	0.46	Safe
5	Bank of Maharashtra	2.64	Safe	-1.32	0.08	Safe	0.43	Safe
6	Canara Bank	2.83	Safe	-1.99	0.03	Safe	0.46	Safe
7	Central Bank Of India	2.49	Safe	-0.72	0.21	Safe	0.41	Safe
8	Corporation Bank	3.17	safe	-1.51	0.06	Safe	0.42	Safe
9	Dena Bank	3.10	Safe	-1.84	0.03	Safe	0.47	Safe
10	I D B I Bank Ltd.	2.84	Safe	1.09	0.87	Safe	0.45	Safe
11	Indian Bank	2.77	Safe	-1.30	0.09	Safe	0.40	Safe
12	Indian Overseas Bank	2.88	Safe	-1.40	0.07	Safe	0.47	Safe
13	Oriental Bank Of Commerce	3.21	Safe	-0.93	0.16	Safe	0.44	Safe
14	Punjab & Sind Bank	3.66	Safe	-1.49	0.06	Safe	0.40	Safe
15	Punjab National Bank	2.82	Safe	-1.94	0.03	Safe	0.43	Safe

Sr. No.	Banks	S-Score	Decision	Zm Score	Probability	Decision	G-Score	Decision
16	State Bank Of India	2.15	Safe	-0.79	0.19	Safe	0.40	Safe
17	Syndicate Bank	2.58	Safe	-5.35	0.01	Safe	0.46	Safe
18	Uco Bank	2.42	Safe	-2.36	0.01	Safe	0.44	Safe
19	Union Bank of India	2.99	Safe	-1.04	0.13	Safe	0.45	Safe
20	United Bank of India	2.49	Safe	-1.05	0.13	Safe	0.47	Safe
21	Vijaya Bank	3.21	Safe	-0.61	0.25	Safe	0.37	Safe

Source: Authors Calculations

Table 4: Application of Recalibrated Model on Twenty-One Public Sector Banks Depicting the Scores of Individual Models Covering a Period of 2011 -2017

Sr. No.	Banks	S-Score	Decision	Zm Score	Probability	Result	G-Score	Decision
1	Axis Bank Ltd.	2.76	Safe	-2.94	0.01	Safe	0.46	Safe
2	Catholic Syrian Bank Ltd.	3.08	Safe	-1.28	0.09	Safe	0.35	Safe
3	City Union Bank Ltd.	3.14	Safe	-2.24	0.02	Safe	0.47	Safe
4	D C B Bank Ltd.	0.77	Distress	-0.08	0.46	Safe	0.30	Safe
5	Dhanalaxmi Bank Ltd.	2.73	Safe	1.79	0.96	Distress	0.38	Safe
6	Federal Bank Ltd.	3.12	Safe	-2.51	0.01	Safe	0.48	Safe
7	H D F C Bank Ltd.	5.01	Safe	-2.65	0.01	Safe	0.56	Safe
8	I C I C I Bank Ltd.	2.65	Safe	-2.47	0.01	Safe	0.39	Safe
9	Indusind Bank Ltd.	2.95	Safe	2.20	0.01	Distress	0.38	Safe
10	Jammu & Kashmir Bank Ltd.	2.94	Safe	-4.53	0.00	Safe	0.40	Safe
11	Karnataka Bank Ltd.	3.18	Safe	-1.01	0.14	Safe	0.32	Safe
12	Karur Vysya Bank Ltd.	3.39	Safe	-1.96	0.03	Safe	0.41	Safe
13	Kotak Mahindra Bank Ltd.	0.80	FD	-2.73	0.01	Safe	0.42	Safe
14	Lakshmi Vilas Bank Ltd.	3.11	Safe	-2.23	0.02	Safe	0.41	Safe
15	Nainital Bank Ltd.	2.47	Safe	-5.31	0.00	Safe	0.76	Safe
16	R B L Bank Ltd.	2.55	Safe	-8.83	0.00	Safe	0.38	Safe
17	South Indian Bank Ltd.	3.06	Safe	-1.43	0.07	Safe	0.45	Safe
18	Yes Bank Ltd.	0.45	FD	-1.96	0.03	Safe	0.36	Safe
Merged Banks								
1	Bharat Overseas. Bank Ltd. (M)	1.92	Safe	-1.02	0.14	Safe	0.43	Safe
2	I N G Vysya Bank Ltd. (M)	1.34	Safe	1.83	0.97	Distress	0.43	Safe

Source: Authors Calculations

The tested recalibrated Springate model shows three good banks in the financial distress position and the merged banks in a safe position. In the case of the recalibrated Zmijewski model, three banks are in the distress condition, whose probability of bankruptcy is more than 50%. However, this model also shows the non-working banks in the safe position. The Grover model shows all

the good banks in a safe position and also non-working banks in a safe position. Thus, the results of all the three models show certain discrepancies; hence, the need felt to check the accuracy of these models. The accuracy of models is checked by detecting the Type I and Type II errors in the model.

Table 5: Showing the Accuracy Rate of Models

<i>Springate Model</i>	<i>Error Rate</i>	<i>Model Accuracy Rate</i>
Non working Banks	Type I - 5% and Type II	88%
Good Banks	7%	
Zmijewski Model		
Non working Banks	Type I - 3% and Type II	90%
Good Banks	-7%	
Springate Model		
Non Working Banks	Type I - 5% and Type II	95%
Good banks	0%	

Source: Authors Calculations

Conclusion

The study of bankruptcy models attempts to find whether the high predictive ability, which bankruptcy models claimed, is still valid in the current business environment. The present study used three bankruptcy models such as Springate (1978), Zmijewski (1984) and Grover (2003). After the application of these models in the Indian banking sector, the results did not hold the models very strongly. The model accuracy rate was low compared to what was claimed by the original models in their own country. With this background of low model accuracy rate and the critiques of models in the past literature review, there was a need to recalibrate these models. The models were recalibrated by changing its coefficients using current data and sticking to the same variables used by original models. Multiple regression techniques were used to find the coefficients of the recalibrated model.

The results of the first model called Springate (1978) model failed to accept the hypothesis that there is no difference in the predictive ability between Springate and recalibrated Springate model. The model accuracy rate of the recalibrated model was low compared to original Springate model and also the results of robust test were matching with the original Springate model. Thus, original Springate model performs better than the recalibrated Springate model. However, it still works better in the country of its origin as it showed 93% accuracy rate over there but it proves a less accuracy in some other country as the economic conditions differ from country to country. Also, the original model shows less accuracy rate due to its sample bias; as originally, it was applied for

the manufacturing firms but in the present study it is used in the service sector. The results Zmijewski (1984) model strongly uphold the hypothesis that there is no difference in the predictive ability between the Zmijewskis and recalibrated Zmijewski's model. There was not much difference in the model accuracy rate of Zmijewski and the recalibrated Zmijewskis model; however, the original Zmijewski model rate is higher. Therefore, original Zmijewski model performs better than the recalibrated Zmijewski model. The results of the third model, known as Grover model, also strongly uphold the hypothesis that there is no difference in the predictive ability between the Grover and recalibrated Grover model. There was not much difference in the model accuracy rate of Grover and the recalibrated Grover model; however, the recalibrated Grover model rate is higher. Therefore, the recalibrated Grover model performs better than the original Grover model.

Above summary of all models shows that the recalibrated Grover model performs better than original model and original Springate and Zmijewski models showed the improved accuracy over recalibrated models.

Policy Implications and Scope for Further Study

The accounting ratios used in these models are poor predictors. The market-driven variables such as past stock returns, high exchange rate and interest rate, which are strongly related to bankruptcy probability, are neglected in these models. Combining these market-driven variables with two accounting ratios may result in a better development of this model. Thus, models should also include macroeconomic variables. Certain environmental factors such as different GDP, unemployment rate, interest rate environments, tax regimes, wage levels, and access to capital markets contribute to the environment heterogeneity. The results of previous studies show that economic environment can affect the accuracy of bankruptcy prediction model. Hence, a further study should focus on incorporating these factors into the model and evaluating their contribution to model accuracy. This may improve the model robustness. The growth of banking industry is a major contributor for the economic development of the country. Many banks enter in financial distress position for different reasons. This

may cause thousands of employees to lose their jobs and a large number of investors to lose their savings. Also, communities will lose vital services and the economy of the country will suffer. Much of these losses can be avoided with predictions of bankruptcy system, which allows adequate plans and take necessary steps. The RBI till today follows a CAMEL model to give its opinion about the banks merger. Although CAMEL model is a good indicator to highlight the banks health, it has its own limitations. Hence, the RBI should make a policy of using recent models such as MDA technique, logit, Probit models along with the CAMEL model for the financial health assessment of banks.

As a follow-up study, a further suggestion is to investigate the study to different economic periods to observe how the models perform in different environments and time periods. That would mean that a cross-sectional study would be applied. Based on the above findings and policy implications, the suggestions for subsequent research are to test bankruptcy position using data from non-banking companies. Further research can also extend to cover 10 – 20 years period of observation. The bankruptcy models used entirely a historical result. Going forward, the model should encompass not only accounting but also other determinants of bank failure. External environmental factors such as volatile stocks, high exchange and interest rate can have a devastating effect on the health of the bank.

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