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Analyzing financial distress in the automobile industry: a comparative study of Altman Z-Score, Springate S-Score, Zmijewski Z-Score, and Grover G-Score

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Abstract

Purpose: The main purpose of the present study is to examine the predictive quality of four financial distress models, including the Altman, Springate, Zmijewski, and Grover models, and the disparity in the capability of the models in predicting financial distress for the Indian automobile sector. ***Methodology:*** Logistic regression was utilized in the study, and the dependent variable is demonstrated as a binary variable. While the independent variables include the Altman Z-Score, Springate S-Score, Zmijewski Z-Score, and Grover G-Score, A subset of 10 automotive firms was selected. The secondary data was taken from the websites Money Control, NSE, and BSE, and a 10-year time interval was taken from 2013–14 to 2022–23 for detailed evaluation over time. Result authentication and data configuration, along with their hypotheses, were determined by software like EViews 10 and Microsoft Excel 365. ***Findings:*** The results indicate that among the four independent variables, only the Zmijewski model shows a statistically significant relationship with the dependent variable, financial distress, and can predict distress with 62% accuracy. ***Practical Implications:*** The study's insights are crucial, highlighting the significance of the Zmijewski model and guiding its prioritized use in distress analysis. The study also exposes the gaps among the distress models, enabling the ease of model selection for managers and investors. ***Originality/Value:*** This research will be extremely useful for financial distress model selection and financial risk management in the particular industry context.

Keywords: #Financial distress, #Altman's Z-Score, #Springate S-Score, #Zmijewski Z-Score, #Grover's G-Score, #Indian #Automobile Sector

Introduction

The Indian automotive industry remains the bedrock of the country's industrial landscape, known for its robust infrastructure and huge market potential with an ecosystem that includes passenger cars, commercial vehicles, and two-wheeler vehicles. The automobile sector makes a healthy contribution to the nation. The industry also creates various employment opportunities for the masses with its impressive marketing and distribution networks.

The Indian automobile sector seeks solutions for financial insecurity, as the causes of debt can be taken from internal and external factors. Another major obstacle is the susceptibility of the industry to volatile economic situations and dynamic market processes. In addition to that, the sector is dragged down by strong competition among the domestic and international players who choose to conquer the market, which is often accompanied by price reductions and profit decrements.

Even after the ample number of ongoing research and studies around the globe, the same research and understanding are scarce of the factors resulting in financial distress for automotive companies in India. Early diagnosis of further financial and managerial barriers in such automotive firms is approachable with the different analytical methods endorsed by the researchers. Altman's Z-Score model, Springate Score, Zmijewski Score, and Grover's Score are some of the most common models for predicting financial distress in automobile companies.

The Indian automobile sector has been proven to suffer a lot from either improper planning, market bursts, or global market crashes such as COVID-19. Similarly, automakers like Maruti Suzuki and Tata Motors cover a broad field and reported huge declines in sales volumes of their cars during lockdowns and later economic slowdowns. The debt picture worsened, as evidenced by the sharp decline in income sources. The sudden increase in debt load

was due to the use of borrowing to keep the companies operational even in the face of revenue reduction. In addition to that, the corporations also had to deal with low profit margins, which were a result of immense operational costs and disruptions to the supply system. These events brought home a clear understanding of the sensitivity of the sector towards non-economic factors and pinpointed the health checks to address, among others, Indian auto companies in general.

The main aim of this research is to determine the forecasting power of four financial distress models currently used in financial distress evaluation, namely: Altman Z-Score, Springate S-Score, Zmijewski Z-Score, and Grover G-Score, while investigating ten automobile companies listed on the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE). The research also seeks to figure out how the models perform in terms of accuracy and which one shows promise in the prediction of financial distress.

Research Gap

The available literature on financial distress prediction models in the automobile sector is mostly based on developed markets, without much examination of the applicability of these models to emerging economies like India. This study seeks to fill that area of by undertaking a comparative study on four distress prediction models in the automobile industry in India.

Review of Literature

Smith and Johnson (2019) conducted an exhaustive comparative allocation of financial distress prediction models in the global auto business. They executed a comparative evaluation of multiple models' efficiency depending on the diversity of the infrastructures, stressing differences in their initial accuracy of the forecast and the possibility of improvement as a result of tuning the model. By examining research results from different regions, the paper gave an inter-regional comparative perspective that helped to define objectives, principles, and methods of effective risk assessment in the automotive sector on an international basis.

Park and Kim (2020) identified the types of financial distress prediction models in the automobile industry within South Korea. From the studies, which provided insights into the working of different models in certain regional environments considering market dynamics and regulatory frameworks, one was able to envisage the whole picture that would make him a better manager. The study has answered the relevant question regarding the capacity of different techniques in predicting financial distress in the automotive companies of South Korea by offering remarkable insights that stakeholders would use to decrease the risk of financial malpractices and enhance the stability of the local industry.

The study of Jones and Brown (2019) is worth noting based on a cross-national comparative study of bankruptcy prediction models in the automotive industry, looking at the changes in model performance in different countries. Their work stressed considering the details of a given country and its peculiar legal frameworks in this context. A study can provide important perspectives by comparing the results of the different regions, and this contributes to enhancing the accuracy of information on financial distress within the global automotive industry.

Wang and Liu (2018) performed the modeling for automobile companies in China for financial distress prediction. Research on such models gave elaborated features that took into account the structure of the industry, the actions of the government, and the economic situation of China. Meanwhile, as the research explored the outcome when different methodologies were applied in determining the financial distress of Chinese automotive firms, the study demonstrated the importance of those methodologies in practice and policy-making as the local industry was very complicated.

In their book "Corporate Financial Distress and Bankruptcy: Causes, Models, and Strategies," Altman and Hotchkiss (2006) provided an in-depth

examination of corporate financial distress and bankruptcy, which is made up of the factors that are responsible for financial problems, predicting crisis models, and handling financial difficulties. This authoritative text is of real importance both for professionals and experts, as well as for politicians, since it allows them to comprehend and resolve problems of corporate financial health and stability.

Cheluget, J., Gekara, M., Orwa, G., & Kero, V. (2014) devised the liquidity factor affecting insurance industry issues in Kenya and how wealth may enhance or destroy it. Investors can gain extensive knowledge regarding risk management techniques applied in insurance companies through insightful work on liquidity, which becomes the driving force influencing financial stability. The research is useful for insurers, regulators, and policymakers.

Diakomihalis (2012) uses Altman's bankruptcy models to determine how effective they are in the representation of the hotels. The reliability of these models in predicting the probability of bankruptcy of these hotels can also be verified, which will help directors in the hospitality markets make decisions about risk management and finance more informed than they were before.

Enyew et al. (2019) aimed to investigate the determinants of financial distress in the beverage and metal sectors in Ethiopia. The study therefore comes with specific factors that make the operation of sectors prone to financial instability. This is an eye-opener to the risks here and there for those in the business line in emerging countries like Ethiopia, and it is a way forward for risk mitigation by the stakeholders and policymakers.

Since service sector companies have a diversity of assets and various ways of earning income, Grover and Lavin (2001) built on Altman's Z-Score model and investigated the accuracy of financial ratios and discriminant analysis in predicting corporate bankruptcies. The research brings about the perspective of the service sector by applying the framework of Altman. It is a great opportunity to see how the model can be stretched to fit real life and what ideas this might bring for financial experts and researchers.

Hendel (1996) investigated how competition operates in a financial crisis context, providing a framework for firms to manage competition during tough economic times. The study seeks to explain the mutual effect of financial difficulties and market competition. Through this, the study makes an important contribution to the general understanding of firm behavior and company strategy in the face of different environmental problems.

Kosikoh J. C. (2014) conducted a study that focused on the core elements that directly cause financial problems amongst insurance firms operating in the country. The study focuses on this sector in particular, therefore giving a first-hand look into the issues surrounding financial stability and risk management in the insurance sector, thus enabling insurers and regulators as well as policymakers to come up with solutions to address these concerns so that the insurance industry remains resilient and thereby able to withstand any risks.

The one that centers on the link between financial distress and employment, addressed by Ogawa (2003), was about the Japanese case during the 1990s. The study increases the understanding of employment responses under financial distress by comparing them with economic downturns to help control disruption of the labor market due to financial instability and provide information to researchers and policymakers on how to respond effectively in different contexts.

Pranowo et al. (2010) studied the key components of corporate financial distress in Indonesia between 2014 and 2008. Through examining stock market data in Indonesia, the researchers distinguish the factors that make financial stressors bigger in emerging economy situations and offer insights that can be helpful in risk management and in formulating interventions to achieve the desired financial stability.

Prasetianingsih and Kusumowati (2019) contrasted the forecasting precision of Altman's, Grover's, Zmiiewski's, and Springate's strategies regarding the

prediction of financial distress. This is done through their examination. They come up with the strengths and weaknesses of those models. This may also be a good enough example of what model of financial distress prediction methodology is best as well as why.

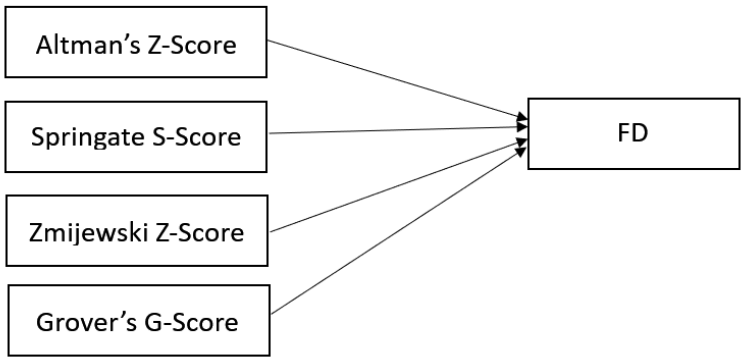
Springate, G. L. V. (1978), is more concerned with precise failure prediction based on Canadian firms' discriminant analysis. Consequently, the proposed model that applies the analysis of the data and predicts the failure probability contributes to the corporate bankruptcy prediction literature and brings to light tangible information for stakeholders to identify and alleviate financial risks.

According to Wruck (1990), distress plus bankruptcy reorganization can either lead to or result from inefficiency in the firm. Through the economics-based empirical analysis, the author investigates the most efficient way of corporate restructuring through reorganization; this provides useful information for those in mainstream corporate restructuring and turnaround practices, providing them with a solution that will see the best out of the situation with long-term benefits.

Zmijewski, in his book (1984), covered the very same areas, examining reasons for financial problems, prediction tools, and the effects of bankruptcy on stakeholders. Through studies of corporate bankruptcy, Zmijewski covered a wide area of the phenomenon, making progress in exploring the subject and proffering suggestions for financial distress resolution.

Conceptual Framework

The research study is built around the framework of four financial distress-predicting models, namely Altman's Z-Score, Springate S-Score, Zmijewski Z-Score, and Grover's S-Score, which serve as independent variables and financial distress, which serves as a dependent variable.



Objectives

- To examine the predictive quality of well-known financial distress models such as Altman's Z-Score, Springate S-Score, Zmijewski X-Score, and Grover's G-Score for the Indian automobile sector.
- To find the disparities in the prediction capability of the financial distress models while they are implemented for the Indian automobile industry.

Methods of data analysis

Logistic regression was utilized in the study, and the dependent variable is clearly demonstrated as a binary variable that shows the presence or absence of the event of interest. In this case, "financial distress," which is the dependent variable, is binary in numbers, in which 1 represents the presence of the event of interest or the probability of financial distress (e.g., when a firm is named to be having financial distress). 0, on the other hand, represents the absence of the event of interest or financial

distress (e.g., when a firm is not in financial distress). These terms are considered to analyze the probability of financial distress as a dependent variable of the logistic regression, which is based on independent variables.

The dependent variable, "financial distress," acts as an outcome of interest, that reflects whether a firm is experiencing financial distress or not, represented by binary values (1 for presence and 0 for absence). Whereas, the independent variables in this study are financial distress-predicting models (Altman, Springate, Zmijewski, and Grover), each employing a distinct set of financial ratios. These independent variables differ from each other in terms of the specific financial ratios they utilize, and the weighting assigned to them in the respective models. Every model features its own set of financial indicators, differentiating from each other to determine the individual characteristics of a firm's financial health.

$$\textbf{logit}\ (FD_{it}) = \beta_0 + \beta_1(\textbf{Altman Z Score}_{it}) + \beta_2(\textbf{Zmijewski Score}_{it}) + \beta_3(\textbf{Springate Score}_{it}) + \beta_4(\textbf{Grover Score}_{it}) + u_{it}$$

Where:

logit (FD_{it}) represents the log odds of financial distress for company i at time t.

Log odds of financial distress is represented by logit (FD_{it}) for company at i at time t.

Intercept term = β_0

Independent variables are related with their respective coefficients, $\beta_1, \beta_2, \beta_3, \beta_4$ (Altman Z score, Springate score, Zmijewski score, and Grover score).

The independent variables for company i at time t are Altman Z Score$_{it}$, Springate Score$_{it}$, Zmijewski Score$_{it}$, and Grover Score$_{it}$

u_{it} shows the error term by defining the divergence in financial distress for a company i at time t.

The subscript i represents the company, and the subscript t represents the interval of time in the year. The formula is used to understand the influence of independent variables on the financial distress of a company over a time period.

EViews 10 software was used to implement the regression equation, in which panel data is selected precisely to estimate the panel data regression techniques.

Financial Distress Prediction Models

1. Altman Z-Score

To differentiate between bankrupt firms and non-bankrupt firms, Altman came up with five factors that can predict the financial future of a company. These ratios or factors are very accurate in making predictions.

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 of equity/Book value of total liabilities

X_5 = Sales/Total assets

These five ratios were proposed in 1968 by Altman for the Z-score model for the firms that were traded publicly.

2. Springate model

Another model to predict financial distress is the Springate model, which is used to assess the probability of a company experiencing This model was given by Keith Springate in 1978; it works within the components of discriminant analysis and financial ratios. A mathematical expression is created using discriminant analysis, which is focused on financial ratios that can distinguish between distressed and non-distressed firms.

X1 = Working Capital / Total Assets

X2 = Net Profit Before Interest and Taxes / Total Asset

X3 = Net Profit Before Taxes / Current Liability

X4 = Sales / Total Assets

3. Zmijewski model

Ron Zmijewski also developed a method to predict financial distress in 1983, later to be known as the Zmijewski Model. The model considers a direct statistical approach to logistic regression analysis to predict a firm facing financial distress or bankruptcy. The model uses only three ratios to provide insights into a company's financial health and the potential risks it faces, assisting stakeholders in making informed decisions to mitigate financial challenges.

X_1 = Earnings after tax / Total Assets

X_2 = Total Debt / Total Assets

X_3 = Current Asset / Current Liabilities

4. Grover model

Jeffrey S. Grover prepared a method to predict bankruptcy in firms, which is called the Grover Method. It was first used in 2001 when Grover aligned and reassessed the Altman Z-Score method. The ratios used are:

X_1 = Working Capital / Total Assets

X_2 = EBIT / Total Assets

X_3 = EAT / Total Assets

Table No. 1 shows the formula as well as the judgment criteria of the four distress-predicting models used.

Category	Variable Name	Formula	Judgement Criteria
Dependent Variable	Financial Distress (FD)		1= Financial Distress 0= Financially Sound
Independent Variables	Altman Z-Score	$Z=1.2X_1+1.4X_2+3.3X_3+0.6X_4+1.0X_5$	Z-Score < 1.81: Bankruptcy is predicted in a few years 1.81 □ Z-Score □ 2.67: Distress is predicted Z-Score > 2.67: No financial distress/ Bankruptcy is predicted
	Springate S-Score	$S = 1.03X_1 + 3.07X_2 + 0.66X_3 + 0.4X_4$	S-Score < 0.862: Bankruptcy is predicted
	Zmijewski Z-Score	$Z = -4.3 - 4.5X_1 + 5.7X_2 - 0.004X_3$	Z-Score □ 0: Bankruptcy is predicted in a few years Z-Score < 0: No financial distress is predicted
	Grover G-Score	$G = 1.650\ X_1 + 3.404\ X_2 + 0.016\ X_3$	G □ -0.02: Potential Bankruptcy G □ 0.01: Healthy Condition

Hypothesis:

Ho: There is no significant difference in the accuracy levels among the Altman Z-Score, Springate, Zmijewski, and Grover's G-Score methods in predicting financial distress.

Ha: There is a significant difference in the accuracy levels among the Altman Z-Score, Springate, Zmijewski, and Grover's G-Score methods in predicting financial distress.

Model Specification

A distinctive approach was used for the quantitative research in this paper. A subset of 10 automotive firms was selected from all the companies active in India. The time interval of 2013-14 to 2022-23 was taken for detailed evaluation over time. Website

money control, NSE, and BSE played a crucial role in acquiring the financial statements of these automotive firms, and secondary data was collected. Result authentication and data configuration, along with the hypothesis, were determined by software like Eviews 10 and Microsoft Excel 365.

Financial distress acts as the dependent variable, while the independent variables include the Altman score, Springate score, Zmijewski score, and Grover score. To understand the influence of the four studied distress models on financial distress, logistic regression analysis was selected for the best accuracy.

Diagnostic Tests:

To check the validity of the regression outcomes, a set of pre- and post-estimation diagnostic tests were done.

Panel unit root:

The panel root test was conducted using a "Fisher-type unit root based on the augmented Dickey-Fuller" test with the null hypothesis stating that all panels had unit roots. The result indicates that the variables financial distress and Zmijewski Z-Score do not have a unit root (p-values < 0.05) at level. Whereas, Grover's G-Score does not have a unit root at first difference with constant and trend, while the remaining variables, including Altman's Z-score and Springate's S-score, do not have a unit root at first difference without constant and trend, i.e., significant at 5%.

Multicollinearity:

Coefficients testing multicollinearity indicated that correlation coefficients were below 0.80 for all variables, so that the independence of the explanatory variables was not violated. It was revealed that the obtained VIF values, which are below 5.00 for all independent variables, are in accordance with the previous research.

Autocorrelation:

In the Wooldridge test, "there is no first-order autocorrelation" is the null hypothesis. Autocorrelation by Wooldridge testing turned out to have p-values less than 0.05, indicating the existence of autocorrelation in the panel data.

Results

Among the independent variables, Zmijewski has a coefficient with a statistically significant z-statistic of 2.437 (p-value = 0.0148), indicating a significant relationship with the dependent variable FD at the 5% significance level. The other independent variables (Altman, Springate, and Grover) do not exhibit statistically significant coefficients at conventional levels of significance (p-values > 0.05).

Table No.2: Descriptive statistics

	FD	ALTMAN	SPRINGATE	ZMIJEWSKI	GROVER
Mean	0.140000	11.53198	1.293353	-4.294086	0.528409
Median	0.000000	8.951787	1.204242	-4.47999	0.499332
Maximum	1.000000	49.34287	2.808702	-1.582857	1.408385
Minimum	0.000000	1.127196	-0.320724	-5.893721	-0.65306
Std. Dev.	0.348735	9.171861	0.735097	0.896661	0.480582
Skewness	2.075006	1.449672	0.100486	0.926104	-0.24213
Kurtosis	5.305648	6.039882	2.7091	3.41679	2.584683

Source: Authors own calculations using EViews 10

Table No.3: Regression Equation Analysis

Dependent Variable: FD				
Method: ML - Binary Probit				
Included observations: 100				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
ALTMAN	0.063482	0.038393	1.653494	0.0982
SPRINGATE	-0.062934	0.928427	-0.067786	0.946
ZMIJEWSKI	1.855759	0.761491	2.437008	0.0148
GROVER	-0.176942	1.338676	-0.132177	0.8948
McFadden R-squared	0.623036			
Mean dependent var	0.140000			
S.D. dependent var	0.348735			
S.E. of regression	0.163307			
LR statistic	50.46137			
Prob(LR statistic)	0.000000			

Source: Authors own calculations using EViews 10

Model Fit:

The McFadden R-squared value of 0.623 indicates that the model explains a substantial part of the variance in the dependent variable. The model appears to fit the data reasonably well, with a mean dependent variable of 0.14 and a standard deviation of 0.349. The AIC value is 0.405, which is close to the SC value of 0.536, which implies a relatively good fit with a moderate complexity model.

Model Performance:

The LR statistic assesses the overall significance of the model. The p-value associated with the LR statistic is extremely small ($p < 0.001$), indicating that the model as a whole is statistically significant. The results suggest that among the independent variables, only the Zmijewski model shows a statistically significant relationship with the dependent variable, FD. The model as a whole demonstrates a good fit for the data and is statistically significant.

Managerial Implications

The study's findings hold significant importance for Indian auto industry management professionals. The study identified that the Zmijewski Z-score turned out to have the highest predictive power, with an accuracy rate of 62%. The managers can now focus on the use of this model in the financial analysis of companies' health. Moreover, the study reveals the gaps among the distressed model categories; hence, strategic decisions need to be made concerning financial distress model selection and its peculiarities.

Limitations and Scope for Further Study

The study is limited to only four financial distress models, i.e., Altman, Springate, Zmijewski, and Grover, that are used to predict the distress within one of the various sectors, the automobile sector of India. Future studies can be conducted across diverse sectors using alternative combinations of financial distress-predicting models that may enhance the insights and reliability of the models.

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