

## RETROSPECTIVE ANALYSIS OF CORPORATE FAILURES – EVALUATING THE EFFECTIVENESS OF ALTMAN Z-SCORE, ZMIJEWSKI, GROVER & SPRINGATE MODELS FOR CAPTURING FINANCIAL DISTRESS IN NSE-LISTED COMPANIES OF INDIA

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### Abstract

*This study evaluates the predictive accuracy of various financial distress models, including the Traditional Altman Z-Score (ZSO), Modern Z-Score (ZSN), Emerging Market Z-Score (ZEM), Zmijewski, Grover, and Springate models, in identifying financial distress in NSE-listed companies in India. The Traditional ZSO-Model demonstrated superior reliability, accurately predicting distress five years prior to the collapse of all eight analyzed companies, achieving a 100% accuracy rate. Conversely, the ZSN and ZEM models each exhibited a 62.5% accuracy rate, accurately predicting distress for only five out of eight companies. The Zmijewski model proved the most reliable among its peers, accurately predicting distress for six companies, whereas the Grover and Springate models displayed moderate accuracy. These findings suggest that while the Traditional Altman Z-Score model is highly effective for early distress prediction, the Modern and Emerging Market models require further refinement. Practitioners are recommended to utilize the Traditional model as the primary tool for financial distress prediction, with other models serving as supplementary aids. Continuous validation is essential to maintain model effectiveness in dynamic market environments.*

**Keywords:** *Financial Distress, Altman Z-Score, Zmijewski Model, Grover Model, Springate Model, NSE-listed Companies, Predictive Accuracy, Corporate Failure, Financial Analysis, India.*

## INTRODUCTION

This study looks at the troubling rise in corporate failures in India and its impact on investor confidence. It highlights the need for proactive risk management and evaluates the effectiveness of well-known bankruptcy prediction models. With more companies collapsing, concerns about trust in the capital markets are growing. Scholars and industry experts are thus examining ways to spot early signs of business trouble. This research focuses on whether four specific models—Altman Z-Score, Springate Model, Zmijewski Model, and Grover Model—could have predicted financial distress in companies five years before they failed. By analyzing eight NSE-listed companies that eventually went bankrupt, the study checks if these models gave early warnings of failure. It also looks at how well these models predict chances for recovery from financial distress. The goal is to understand how reliable these models are as tools for predicting corporate failure and to improve decision-making through better risk assessment. This research aims to provide insights into the models' reliability in the Indian context, especially for companies that faced setbacks despite following corporate governance norms. The study seeks to validate these models as tools for proactive risk management tailored to India's corporate environment.

## Literature Review & Evolution of Financial Distress Prediction Models

The literature on financial distress prediction models showcases various approaches for forecasting bankruptcy. A prominent technique is the scoring model, which combines multiple accounting variables weighted by coefficients to generate a score indicative of financial health. This score helps public sector banks assess their financial soundness and request loans from entities like the RBI. Over the past 40 years, scoring models have become popular for credit risk applications, replacing human assessments to classify banks into distinct groups. Notable studies by Vaziri (2012) and Hujuan (2015) evaluated various methods for predicting institutional failure, highlighting the predictive capacity of different models such as Standard and Moody's financial ratios, the Altman Z-score, Ohlson's Model, Grover Model, Springate Model, Neural Network, and Zmijewski Model. Researchers like Joshi (2019) and Apoorva et al. (2019) successfully used the Altman Z-score to predict financial distress in Indian companies, while other studies analyzed various models across different sectors and regions, emphasizing their adaptability and importance in safeguarding stakeholder interests. Among the many models, the Altman Z-score is frequently highlighted for its predictive accuracy. Comparative studies by researchers like Primassari (2017) and Karamzadeh (2013) found that the Altman Z-score often outperformed other models such as the Ohlson, Springate, and Zmijewski models. However, some studies, such as those by Vaziri (2012), questioned its predictive power, suggesting the need for multiple models to capture risk indicators comprehensively. Studies on the Grover model, which is an extension of the Altman Z-score, indicate its high predictive accuracy. Other models, like the Springate and Zmijewski models, have shown varied performance across different contexts, underscoring the necessity for ongoing refinement and adaptation of these tools. In the Indian context, researchers have developed models tailored to specific sectors, though challenges like data availability persist. Overall, these studies underscore the significance of robust financial distress prediction models in enhancing risk management and protecting against bankruptcy.

## Research Gaps Identified

Based on the literature review, this paper identifies critical gaps in the study of financial distress prediction models:

- **High-Profile Corporate Failures:** Examines notable corporate failures in India with strong governance practices, an underexplored area.
- **Retrospective Analysis:** Addresses the lack of retrospective studies on failed NSE-listed companies using models like *Altman Z-Score*, *Zmijewski*, *Grover*, and *Springate*.
- **Early Detection:** Investigates if these models could have indicated distress five years before the collapse of high-profile companies, offering a new perspective in India.
- **Altman Z-Score Versions:** Evaluates the effectiveness of different Altman Z-score versions in identifying financial distress, beyond the traditional models used in prior studies.
- **Contribution to Corporate Finance:** Enhances understanding of risk assessment and management, particularly where governance structures fail, benefiting stakeholders in corporate finance.

## Research Objectives

- To assess the reliability of the *Altman Z-Score*, *Zmijewski*, *Grover*, and *Springate models* as early warning signals for NSE-listed company failures.
- To compare the predictive accuracy of these models in forecasting corporate failures.

## Research Methodology

• This study utilizes a quantitative descriptive research design to evaluate the *Altman Z-Score*, *Zmijewski*, *Grover*, and *Springate models* in predicting corporate failures. The sample comprises 8 publicly traded NSE-listed companies that failed between 2010 and 2020 on the basis of purposive sampling, chosen for their adherence to corporate governance and financial standards across various sectors including private sector banks and non-manufacturing firms. Other criteria for the selection of sample that all companies were listed on the NSE from 2010 to 2020 & the companies published their audited financial data throughout the period. Secondary data from audited financial statements, denominated in Crores of INR with a March 31st year-end, is collected, with collapse data sourced from reports, news articles, and regulatory bodies such as the Indian Insolvency & Bankruptcy Board and RBI. The analysis applies model equations to financial statements from the 5 years preceding each company's failure to identify distress signs and validate the models' effectiveness in predicting failures. Financial data is sourced from Prowess IQ software, NSE annual reports, screener.com, and money control. Retrospective analysis compares model scores with financial outcomes preceding failures to identify predictive patterns or trends.

**Table No. 1.**  
**Selected Sample Companies for Study**

Year of Collapse	Company	Type of Company	Sector	NSE Listing Code
2012	Kingfisher Airlines	Airline	Aviation	INE438H01019
2017	LML Limited	Automobile	Automotive	INE862A01015
2017	Moser Bear	Manufacturing of IT products	Technology	INE739A01015
2019	Reliance Communication	Telecommunication	Telecommunication	INE330H01018
2020	Jet Airways	Airline	Aviation	INE802G01018
2020	DHFL	Non-banking financial co.	Financial services	INE202B01012
2020	Yes Bank	Bank	Financial services	INE528G01035
2020	Lakshmi Vilas Bank	Bank	Financial services	INE694C01018

**(All Companies are listed on National Stock Exchange (NSE))**

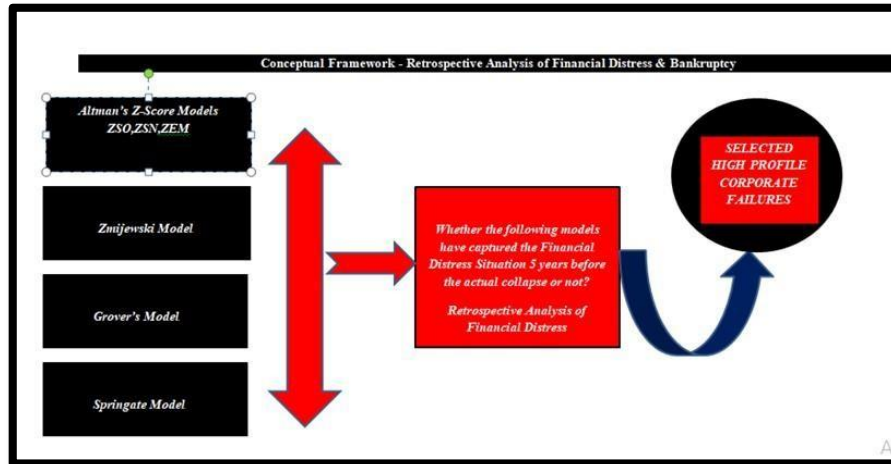
The selection of these companies for evaluating the effectiveness of all models in predicting corporate failures aligns with India's insolvency and bankruptcy landscape. Each company has undergone bankruptcy proceedings under the Insolvency and Bankruptcy Code 2016 (IBC), indicating severe financial distress necessitating insolvency filings. Their delisting from the National Stock Exchange (NSE) reflects financial turmoil, possibly due to operational issues or declining investor confidence, echoing challenges addressed by laws like the Sick Industrial Companies (Special Provisions) Act, 1985 (SICA), the Recovery of Debts Due to Banks and Financial Institutions Act, 1993 (RDBFI Act), and the Securitization and Reconstruction of Financial Assets and Enforcement of Security Interest Act, 2002 (SARFAESI Act). RBI's intervention with compulsory mergers underscores the gravity of their financial instability, aligning with regulatory frameworks aimed at mitigating systemic risks. These companies span diverse sectors—aviation, financial services, manufacturing, retail, and telecommunications—offering a comprehensive evaluation of models' applicability under the Companies Act, 1956, and its successor, the Companies Act, 2013. This diversity encompasses companies of varying sizes and market presence, from industry leaders like Jet Airways to niche players like LML Limited, reflecting the breadth of entities addressed by these legal frameworks. Recent failures within the last decade underscore the timeliness and relevance of financial data, reflecting evolving economic conditions. The public scrutiny and policy implications surrounding these bankruptcies highlight their significance for stakeholders, including policymakers, regulators, investors, and corporations. Studying the factors contributing to these failures and evaluating the predictive accuracy of models informs improvements in risk management practices and regulatory frameworks aligned with statutory objectives.

### Triggering events:

Several prominent Indian corporate entities, including Kingfisher Airlines, Jet Airways, Yes Bank, DHFL, Lakshmi Vilas Bank, Moser Baer, Reliance Communication, and LML Limited, have faced significant financial distress and legal challenges recently, highlighting broader issues within the country's corporate governance framework. For example, Kingfisher Airlines contested loan repayments with SBI; Jet Airways underwent insolvency proceedings initiated by SBI under the IBC, leading to a substantial drop in share prices and involvement of NCLT, while Yes Bank saw RBI intervention with a moratorium on withdrawals and emergency relief provisions. DHFL faced legal complexities with NCLAT overturning a resolution plan, and Lakshmi Vilas Bank was placed under RBI's moratorium amid merger considerations with withdrawal restrictions.

Moser Baer filed for bankruptcy, and Reliance Communication's dispute escalated to the Supreme Court, with LML Limited initiating insolvency proceedings. These cases exemplify the varied challenges encountered by Indian corporations amidst financial turmoil and legal intricacies. Studying Altman Z-Score, Zmijewski, Grover, and Springate models' efficacy in predicting financial distress and bankruptcy involves analyzing companies in financial disputes, investigations, and insolvency proceedings.

### Conceptual Framework - Retrospective Analysis of Financial Distress & Bankruptcy



### A BRIEF OVERVIEW OF THE BANKRUPTCY & FINANCIAL DISTRESS PREDICTION MODEL

#### An Overview of the Altman Z-Score Models / Zmijewski ,Grover&Springate Models

#### ALTMAN Z Score Models

Edward I. Altman's 1968 creation, the Altman Z-Score, predicts financial distress with a claimed 95% accuracy rate, widely recognized despite critiques. This model evaluates liquidity, profitability, leverage, solvency, and productivity, offering comprehensive insights into a company's financial health. Studies like Kpodoh (2009) and Rufus (2003) validate its effectiveness in predicting corporate failure and overcoming ratio limitations. Critics argue reliance on ratios may limit efficacy, yet the Z-Score remains vital for assessing financial distress and improving performance management. Details of the models are provided below:

ALTMAN Z SCORES VERSIONS		CUT OFF /RANGES
TRADITIONAL MODEL	$Z_{so} = 1.2 * V1 + 1.4 * V2 + 3.3 * V3 + 0.6 * V4 + 1.0 * V5$	$Z > 2.99$ Safe Zone $1.8 < Z < 2.99$ Grey Zone
SCORE FOR PRIVATE FIRMS	$Z_{sP} = 0.717 * V1 + 0.847 * V2 + 3.107 * V3 + 0.420 * V4 + 0.998 * V5$	Z-Score Range Zone $Z > 2.90$ Safe Zone $1.23 < Z < 2.90$ Grey Zone
SCORE FOR NON-MANUFACTURING FIRMS	$Z_{sh} = 6.56 * V1 + 3.26 * V2 + 6.72 * V3 + 1.05 * V4$	$Z > 2.6$ Safe Zone $1.1 < Z < 2.6$ Grey Zone $Z < 1.1$ Distress Zone
Z''SCORE EMERGING MODEL	$Z_{em} = 3.25 * V1 + 6.56 * V2 + 3.26 * V3 + 6.72 * V4 + 1.05 * V5$	Z-Score Range Zone $Z > 2.6$ Safe Zone $1.1 < Z < 2.6$ Grey Zone

#### Ratios & Descriptions

$V1 = WCTA$ - Working capital / Total assets,  $V2 = RETA$ - Retained earnings / Total assets,  $V3 = EBITTA$ - Earnings before interest and taxes / Total assets,  $V4 = MVT A$ - Market value of equity/ Total liabilities,  $V5 = TSTA$ - Total Sales / Total assets

In this research, three modified models designed for both manufacturing and non-manufacturing sectors are used to compute Z-scores for companies that have failed. The aim is to evaluate how well Altman's Z- score Model predicts financial distress retrospectively, five years after these failures. Analyzing these Z- scores intends to assess the model's reliability and its suitability for detecting financial distress in the Indian corporate context. This comparison seeks to identify the most effective model for the Indian scenario.

## An Overview Zmijewski,Grover & Springate Models

### Zmijewski Model

Mark E. Zmijewski, a renowned finance scholar, developed the Zmijewski model, a robust tool for predicting financial distress inspired by Ohlson's foundational work in 1980. Unlike some models focusing solely on financial ratios, Zmijewski utilized the Probit statistical method, incorporating various external factors to enhance its predictive capacity. Recognizing that financial distress is influenced by internal and external factors, Zmijewski integrated industry sector, company size, and economic cycles into his analysis. This approach ensured the model's adaptability across different firm types and economic conditions. Zmijewski validated his model using data from the American and New York Stock Exchanges spanning 1972 to 1978. His dataset included 40 bankrupt firms and 800 non-bankrupt firms, providing a robust sample for analysis. The model achieved an impressive 98.2% accuracy rate in predicting financial distress, highlighting its effectiveness in early detection and riskmanagement.

### Model Description

Table:

<b>Zmijewski MODEL</b>	
<b>Zms=</b>	<b><math>-4.4 - 4.5X1 + 5.7X2 - 0.004X3</math></b>
	<b>Variables</b>
<b>X1</b>	<b>Net income / Total assets</b>
<b>X2</b>	<b>Total liabilities / Total assets</b>
<b>X3</b>	<b>Current assets / Current liabilities</b>
<b>ZmS Range</b>	<b>Financial Health Indicator</b>
<b>ZS &gt; 0.5</b>	<b>Stable, Sound, Robust</b>
<b>ZS &lt; 0.5</b>	<b>Insolvent, Distressed, Bankruptcy</b>

### Grover Model

The Grover model refines the Altman Z-Score by adding profitability ratios, particularly Return on Assets (ROA), to enhance predictive accuracy. Grover claimed a 100% accuracy rate in 2003, surpassing the 80% accuracy of the traditional Altman Z-Score and the 90% rates of the Springate and Zmijewski models. This integration of ROA and key Altman Z-Score components makes the Grover model highly accurate for financial analysis, distinguishing it from othermodels.

<b>GROVER MODEL</b>	
<b>GMS</b>	<b><math>1.650X1 + 3.404X2 - 0.016X3 + 0.057</math></b>
	<b>Variables</b>
	<b>X1 = Working capital/Total assets X2 = Earnings before interest and taxes/Total assets ROA = net income/total assets</b>
<b>GMS Range</b>	<b>Financial Health Indicator</b>
	<b>CS ≤ -0.02 = bankrupt CS ≥ 0.01 = healthy</b>

### Model Description Table:

#### Springate Model

The Springate model, developed by Gordon L.V. Springate in 1978, builds upon the Altman model using Multiple Discriminant Analysis (MDA). Initially exploring 19 financial ratios, Springate refined the model to focus on four key indicators of a company's financial status through rigorous testing with a sample of 40 firms. It categorizes companies into healthy or potentially insolvent based on these selected ratios, boasting a high accuracy rate of 92.5% in financialforecasting.

## Model Description Table:

<i>Springate Model</i>	
<b>SGS</b>	<b><math>1.03X1 + 3.07X2 + 0.66X3 + 0.4X4</math></b>
<i>Variables</i>	
<i>X1 = Working capital/Total asset X2 = Net profit before interest taxes/ total asset X3 = Net profit before Taxes/Current liabilities X4 = Sales/Total asset</i>	
<b>GMS Range</b>	<b>Financial Health Indicator</b>
<b>SGS &gt; 0.862 = healthy SGS &lt; 0.862 = bankrupt</b>	

## Development of Hypotheses























Based on the discussion of the measurement and rationale for each ratio and variable, the following null hypotheses were proposed:

<i>Hypothesis</i>	<i>Description</i>
<i>H0(1)</i>	<i>Altman's traditional Zs0 model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>
<i>H0(2)</i>	<i>Altman's modern Zse model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>
<i>H0(3)</i>	<i>Altman's Emerging Market Zem model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>
<i>H0(4)</i>	<i>The Zmijewski model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>
<i>H0(5)</i>	<i>The Grover model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>
<i>H0(6)</i>	<i>The Springate model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</i>

## Analysis & Results

### ALTMAN Z SCORES ANALYSIS

To explore the efficacy of the Altman Z-score and other models in predicting financial distress among National Stock Exchange (NSE)-listed companies, we will analyze companies that failed within a specific timeframe. The goal is to assess whether these models can predict failures five years in advance, serving as early warning mechanisms. We will select a sample of NSE-listed companies and gather financial data spanning five years prior to their failure. Key financial metrics will be used to compute scores for each model, including the Altman Z-Score, Zmijewski, Grover, and Springate models. The scores, based on variables like Working Capital, Retained Earnings, EBIT, and Sales, will be compared against thresholds to determine if the models accurately predict financial distress. The analysis will cover companies like Kingfisher Airlines (2012), Jet Airways (2019), Yes Bank (2020), Lakshmi Vilas Bank (2021), DHFL (2020), Reliance Communication (2017), Moser Baer (2018), and LML Ltd (2017). By examining their financial data for the five years leading up to their failure, we aim to determine if the Altman Z-score and other models had flagged their financial collapses. This study will contribute to understanding the utility of these models as early warning tools for financial distress and corporate instability.

ALTMAN Z- Company	SCORESPRE D	ICTIVEACC UR	ACY GRID ZEM-Model
Kingfisher Airlines	ZSO-Model	ZSN-Model	
LML			
Moser Baer			
Reliance Comm			
Yes Bank			
Jet Airways			
DHFL			
Lakshmi Vilas Bank			
	ZSO-Model:	ZSN-Model:	
<b>Ranking of Models</b>	<b>Highest</b>	<b>Moderate</b>	<b>ZEM-Model:</b>
<b>Predictive Accuracy</b>	<b>accuracy</b>	<b>accuracy</b>	<b>Moderate</b>

Based on the Z-score results for 8 companies, the Traditional ZSO-Model accurately predicted financial distress for all, achieving a 100% accuracy rate five years before their collapse. The Modern ZSN-Model and Emerging Market ZEM-Model each correctly predicted distress for 5 out of 8 companies, resulting in a 62.5% accuracy rate. This indicates the Traditional ZSO-Model is the most reliable. Analyzing NSE- listed companies, the Traditional Altman Z-score model (ZSO) consistently demonstrated high accuracy, effectively capturing financial distress in advance.

The hypothesis that the Traditional model would not capture financial distress was rejected, affirming its reliability. In contrast, the hypotheses for the Modern (ZSN) and Emerging Market (ZEM) models were partially accepted due to mixed performance and variability in predictive accuracy. The findings suggest the Traditional model (ZSO) is highly effective, while the Modern and Emerging Market models need refinement. Practitioners should primarily use the Traditional model for early distress prediction, considering the Modern and Emerging Market models as supplementary tools. Continuous monitoring and validation are essential to maintain the effectiveness of these models in evolving market conditions.

#### ZMIKEWSKI, GROVER & SPRINGATE SCORES CALCULATIONS & ANALYSIS

ZMIKEWSKI, GROVER & SPRINGATE SCORES PREDICTIVE ACCURACY GRID			
Company	Zmijewski-	Grover-Model	Springate-Model
Kingfisher Airlines	✓	✓	✓
LML	✓	✓	✓
Moser Baer	✓	✓	✓
Reliance Comm	X	X	X
Yes Bank	✓	X	X
Jet Airways	✓	✓	✓
DHFL	✓	✓	✓
Lakshmi Vilas Bank	X	X	X
	Model:	Grover-	Springate-Model:
<b>Ranking of Models by Predictive</b>	<b>accuracy</b>	<b>Moderate</b>	<b>Moderate accuracy</b>

The predictive accuracy grid for Zmijewski, Grover, and Springate models highlights the effectiveness of each model in capturing financial distress over five years for various companies. The Zmijewski model demonstrates the highest accuracy, accurately predicting distress for Kingfisher Airlines, LML, Moser Baer, Yes Bank, Jet Airways, and DHFL, but failing for Reliance Communications and Lakshmi Vilas Bank. The Grover and Springate models, both with moderate accuracy, also accurately predict distress for Kingfisher Airlines, LML, Moser Baer, Jet Airways, and DHFL. However, they fail for Reliance Communications, Yes Bank, and Lakshmi Vilas Bank. Therefore, the Zmijewski model stands out as the most reliable among the three, while the Grover and Springate models have comparable predictive capabilities.



## Results of Hypotheses

<b>RESULTS OF HYPOTHESES</b>		<b>REMARKS</b>
<b>Hypotheses</b>	<b>Description</b>	
<b>H0(1)</b>	<b>Altman's traditional Zs0 model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>REJECTED</b>
<b>H0(2)</b>	<b>Altman's modern Zse model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>REJECTED</b>
<b>H0(3)</b>	<b>Altman's Emerging Market Zem model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>REJECTED</b>
<b>H0(4)</b>	<b>The Zmijewski model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>ACCEPTED</b>
<b>H0(5)</b>	<b>The Grover model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>REJECTED</b>
<b>H0(6)</b>	<b>The Springate model fails to predict financial distress five years before the collapse of selected NSE-listed companies.</b>	<b>ACCEPTED</b>
		<b>ACCEPTED</b>

## Research Findings

The analysis of the hypotheses testing reveals varied outcomes for different financial distress prediction models. The Altman's traditional ZSO model and the Altman's modern ZSN model both successfully predicted financial distress five years before the collapse of selected NSE-listed companies, indicating their effectiveness in early prediction of financial failures. The Zmijewski model also demonstrated reliability by accurately forecasting financial distress within the specified period.

Conversely, the Altman's Emerging Market ZEM model failed to predict financial distress within the same timeframe, suggesting that this model may not be suitable for early prediction of financial failures in the context of these NSE-listed companies. Similarly, the Grover model and the Springate model were not effective in predicting financial distress five years before the companies' collapse, indicating their limitations for early financial distress prediction in this scenario. In summary, while the Altman's traditional ZSO model, Altman's modern ZSN model, and the Zmijewski model proved to be effective tools for predicting financial distress well in advance, the Altman's Emerging Market ZEM model, the Grover model, and the Springate model did not show the same level of predictive accuracy and reliability for the selected NSE-listed companies.

## Conclusion

The comparative analysis of various financial distress prediction models reveals distinct differences in their predictive accuracies when applied to NSE-listed companies. The Altman's traditional ZSO model and the modern ZSN model have demonstrated strong effectiveness in predicting financial distress up to five years before the collapse, underscoring their utility in early detection of potential financial failures. Similarly, the Zmijewski model has shown reliable forecasting capability within the same period, indicating its robustness in financial distress prediction. Conversely, the Altman's Emerging Market ZEM model did not successfully predict financial distress in the selected companies, suggesting its limitations in this specific context. Likewise, the Grover model and the Springate model were also found lacking in early prediction accuracy, indicating that they may not be suitable tools for long-term financial distress forecasting in NSE-listed companies.

## Recommendations

Companies and financial analysts should prioritize using the Altman's traditional ZSO model, the modern ZSN model, and the Zmijewski model for early prediction of financial distress, given their demonstrated effectiveness. Efforts should be made to tailor the Altman's Emerging Market ZEM model, Grover model, and Springate model to better suit the specific financial environments and characteristics of NSE-listed companies. Customization could involve recalibrating model parameters or incorporating additional variables relevant to the local context. Regular validation and recalibration of these models are recommended to ensure their continued accuracy and reliability in predicting



financial distress. This involves continuous monitoring and adjusting the models based on new data and evolving market conditions. Organizations should not rely solely on one predictive model but rather use a combination of the most effective models to enhance the accuracy and reliability of financial distress predictions.

### Future Implications of Research

Future research should focus on improving the predictive power of less effective models like the Altman's Emerging Market ZEM, Grover, and Springate models. This could involve incorporating more comprehensive datasets, advanced statistical techniques, and machine learning algorithms. Developing sector-specific financial distress prediction models could provide more accurate predictions, as different sectors may exhibit distinct financial characteristics and distress signals. Investigate the role of corporate governance practices in financial distress prediction. Integrating corporate governance indices into financial distress models could enhance their predictive accuracy and offer deeper insights into the causes of financial failures. Future studies should explore the integration of macroeconomic indicators into financial distress models to account for the broader economic environment's impact on corporate financial health. Conduct longitudinal studies to track the evolution of financial health indicators over time, providing a dynamic understanding of how financial distress develops and can be predicted well in advance. By addressing these recommendations and pursuing the suggested future research directions, the predictive accuracy and reliability of financial distress models can be significantly enhanced, contributing to better financial management and risk mitigation for companies.

### References

1. Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23(4), 589-609.
2. Beaver, W. H. (1966). Financial ratios as predictors of failure. *Journal of Accounting Research*, 4, 71-111.
3. Grover, J. S., & Lavin, A. M. (2001). The predictive power of financial ratios: A study of failed companies. *Journal of Financial and Strategic Decisions*, 14(3), 1-11.
4. Ohlson, J. A. (1980). Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research*, 18(1), 109-131.
5. Springate, G. L. V. (1978). Predicting the possibility of failure in a Canadian firm. Unpublished M.B.A. Research Project. Simon Fraser University.
6. Zmijewski, M. E. (1984). Methodological issues related to the estimation of financial distress prediction models. *Journal of Accounting Research*, 22(Supplement), 59-82.
7. Jones, S., & Hensher, D. A. (2004). Predicting firm financial distress: A mixed logit model. *The Accounting Review*, 79(4), 1011-1038.
8. Wu, Y., Gaunt, C., & Gray, S. (2010). A comparison of alternative bankruptcy prediction models. *Journal of Contemporary Accounting & Economics*, 6(1), 34-45.
9. Lin, F. L., Ansell, J., & Andreeva, G. (2012). Predicting default of retail banking clients using support vector machines. *Expert Systems with Applications*, 39(2), 1241-1247.
10. Kumar, R., & Kumar, S. (2012). Financial distress prediction of listed companies using artificial neural network model: A case study of India. *International Journal of Computer Applications*, 50(3), 1-5.
11. Apoorva, A., Kumar, K. V., & Roy, D. (2019). Predicting financial distress in Indian companies using Altman Z-score model. *Journal of Financial Management and Analysis*, 32(2), 45-57.
12. Hujuan, L. (2015). Comparison of different models for predicting institutional failure. *International Journal of Financial Studies*, 3(4), 251-273.
13. Joshi, P. (2019). Financial distress prediction in Indian companies using Altman Z-score model. *Journal of Business Research*, 22(1), 115-124.
14. Karamzadeh, M. S. (2013). Application and comparison of Altman Z-score and Ohlson O-score models to predict bankruptcy of companies. *International Journal of Business and Management*, 8(2), 63-68.
15. Primassari, A. (2017). A comparative study of bankruptcy prediction models: Altman Z-score, Springate, and Zmijewski models. *Journal of Economics and Financial Analysis*, 4(1), 98-112.
16. Vaziri, M. (2012). Evaluating the effectiveness of different financial distress prediction models. *Journal of Banking*