

Financial Health Prediction Of Indian Private Sector Banks By Using Altman Z- Score

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Abstract

In the Indian banking industry, maintaining profitability is essential for sustainability, while avoiding bankruptcy is critical for financial stability. Effective risk management, strong governance, regulatory compliance, and technological innovation are key to balancing both. This study is aiming to identify the relationship among the profitability matrix of banking sector to evaluate the bankruptcy performance by using Z- score model, for this purpose top 5 private sector banks are taken as sample over the period of 5 years from 2020-21 to 2024-25. Statistical tools like descriptive statistics, correlation matrix and t- test is applied to justify the objectives. It found that there is a stable and robust financial health of five major Indian banks like HDFC, ICICI, KOTAK, AXIS, and IDBI over the period of 5 years from 2020–21 to 2024–25 and all the factors are also positively responsible for financial stability of the banking sectors. Some factors are not explored in this study to evaluate the bankruptcy of banking sectors. Sample sizes and longitudinal research can be considered to extend the future research.

Keywords: Bankruptcy, Profitability, Risk Management, Strong Governance, Banking Sector.

Introduction

Banks, as the oldest institutions within the financial system, play a vital role in mobilizing deposits and providing credit across various economic sectors, thereby fostering innovation, infrastructure development, job creation, and overall prosperity. Financial sector has an essential part of our society, serving both industries and individual consumers. The financial sector is crucial for the economic development of any nation, with banks being the primary and most dynamic institutions within it. Consequently, the banking industry serves as the backbone of the financial sector [\(1\)](#). The development of finance, particularly the banking system, is essential for fostering economic growth. Banks are pivotal to the economy, especially during downturns and financial crises. The industrial, agricultural, and commercial progress of a country is unimaginable without an efficient banking system.

The banking sector in India holds significant importance in connection with profitability, as it directly impacts the overall economic health and growth of the country. Profitability in banks ensures their sustainability, ability to absorb losses, and capacity to extend credit to businesses and consumers, which in turn fuels economic activities. Profitable banks contribute to higher investor confidence, enabling them to raise capital efficiently and invest in technology and innovation for better services. Moreover, profitability allows banks to maintain adequate capital buffers, comply with regulatory norms, and reduce dependency on government bailouts. In Indian context, profitable banking institutions support financial inclusion by expanding

access to credit and banking services across urban and rural areas. Therefore, the profitability of the banking sector is crucial not only for the institutions themselves but also for fostering economic stability, growth, and inclusive development in India.

The banking industry in India operates within a complex framework where profitability, corporate governance, and bankruptcy are closely interlinked. Profitability is a key indicator of a bank's financial health, influenced by factors such as interest income, credit risk, cost efficiency, and asset quality. However, weak corporate governance practices—such as poor risk management, inadequate internal controls, and lack of accountability—can lead to inefficient lending practices and rising non-performing assets (NPAs), ultimately eroding profitability. Several Indian banks, especially in the public sector, have experienced governance failures that contributed to financial distress and the need for regulatory intervention. Bankruptcy risks in the sector are further intensified by large corporate defaults and delayed recovery of loans. The Insolvency and Bankruptcy Code (IBC) and measures by the Reserve Bank of India (RBI) aim to enhance transparency, strengthen governance, and streamline resolution mechanisms. Strengthening corporate governance is essential for improving profitability and reducing the risk of bankruptcy, thereby ensuring long-term stability and public trust in the Indian banking system.

Review Of Literature

The evaluation of a company's operations and strategies in fiscal terms is known as financial performance (2). Investors and stakeholders use financial performance to assess their investments and expectations, while banks use it to assess their operational health, profitability, and market position. The economy as a whole, individual consumers of bank deposit and loan services, shareholders, employees, government regulators, and management all depend on banks' profitability (3); (4). The firm's strengths and weaknesses in terms of its financial position in local and international markets can be determined via financial analysis, especially performance (5). In order to determine the banks' earnings and profits, an analysis of their financial performance focuses on a specific time frame, usually the most recent fiscal quarter or year. (6). Profit is the primary goal of commercial banks. Every strategy and activity is intended to accomplish this crucial objective. Banks may also have other financial and social objectives. There are macroeconomic and bank-specific components to the content that influences bank performance (7). The board and management's internal decisions have a big impact on various choices. External factors that affect banks' profitability in the interest of the country are beyond their control. The overall financial performance of banks has improved within the past 20 years. All banks are not always successful, though, as some do declare losses. Internal components are particular characteristics of the bank that affect how well it performs (8). Analyzing the level of economic and financial performance using both qualitative and quantitative data is part of performance evaluation. Quantitative analysis is one possible approach to this inquiry. (9). As per the (10) the purpose of this research is to suggest numerous models for projecting the financial status of businesses. This study assesses the financial health of a collection of non-financial companies that, based on their net turnover, roughly represent the whole electrical engineering sector in Slovakia between 2012 and 2016 using the Taffler, Springate, and Aspect Global Rating models. It has been found that it is feasible to track which businesses are the most financially stable and which are becoming less competitive, which poses a risk. (11) With an emphasis on industrialized Asian nations and the US financial system, this study examines the effects of bank assets, bank liquidity, and credit risk on the profitability of commercial banks in the post-crisis era. They found that, similar to commercial banks in the United States, bank capital and credit risk significantly affect profitability in developed Asian

nations. In the post-crisis era, liquidity was important and helpful in a number of industrialized Asian nations, but it had a negative effect on the profitability of big commercial banks in the US. (12) studied the financial performance analysis of Syndicate bank using CAMEL model. Earnings capacity having least ROA should use assets in efficient manner to increase earning capacity. Earning quality was good. Liquidity ratio decreased due to increase the liquidity of Syndicate bank. (13) OBS exposure, determinants, and impact on the financial performance of Indian and Jordanian banks have investigated. They discovered that OBSA helps banks generate revenue. (14) concluded that Capital regulation acts as an external force to determine bank capital and the level of risk. Bank actions may be impacted by modifications to the regulatory environment. Since capital and risk decisions seem to be successfully impacted by regulation, the article looks at risk to evaluate bank behavior. The outcome, however, can differ and rely on a number of additional variables, including the time period, the nation, and the economic sector. (15) studied the financial performance of commercial banks in India using CAMEL model. The liquidity ratios indicate better liquidity of all the bank Kotak Mahindra bank performed throughout well. Additionally, (16) analyzed banks in South Africa during the global financial crisis and demonstrated that the Z-score effectively captured declining stability in the sector.

Research Problem

The banking industry faces complex and interrelated research problems concerning corporate governance, profitability, and bankruptcy. Weak corporate governance—characterized by ineffective board oversight, lack of transparency, and poor accountability—can lead to mismanagement, excessive risk-taking, and failure to implement sound financial practices, all of which adversely impact profitability. Very few research studies have addressed the critical analysis of financial stability and financial factor responsible for financial stability of Indian banking industries. There is a critical need for research to examine how governance systems evaluate financial performance in order to face the bankruptcy in banking industry. Such studies can help identify governance strategy that enhance profitability while mitigating the risk of bankruptcy, contributing to a more resilient and sustainable banking sector.

Research Objectives

- To study the financial health of the sample private sector banks in India
- To establish the relationship among the financial factors of sample private sector banks in India

Research Questions

- Are the sample private sector banks financially stable?
- Are there any differences in financial factors of sample banks?

Hypothesis Of The Study

- H_0 = There is no significant difference in financial factors of sample private sector banks.
- H_1 = There is significant difference in financial factors of sample private sector banks.

Methodology

The present study is predicated on an examination of secondary data sources, primarily bank websites, yearly reports, money control, screener etc. In this comparative analysis, top five private sector banks have been studied as per their market capitalization i.e. HDFC Bank, ICICI Bank, Axis Bank, Kotak Mahindra Bank, and IDBI Bank. The analysis covers from 2021 to

2025. In addition to using the Z score Model to evaluate the study, statistical tools such as t-test, descriptive statistics, correlation matrix etc, tools are also employed to draw conclusions. Ratios considered for measuring financial performance through Z- score model are as follows:

Financial Performance Model

For analyzing the financial performance of sample bank, this study considers the Altman Z-score. The following model is explained as follow.

$$\text{Modified Altman Z-Score} = 6.56(X1) + 3.26(X2) + 6.72(X3) + 1.05(X4)$$

Where:

X1 = Working Capital (Current Assets – Current Liabilities) / Total Assets

X2= Retained Earnings / Total Assets

X3= Earnings Before Interest & Taxes (EBIT) / Total Assets

X4= Book Value of Equity /Total Liabilities

Here X1 is considered as liquidity factor, X2 as profitability factor, X3 as efficiency factor and X4 as net worth.

Table No-1
Guideline for Z-Score

Z-Score value	Decision Zone	Description
$Z > 2.6$	Safe Zone	Strong financial health firm
$1.1 < Z < 2.6$	Grey Zone	Moderate risk firm
$Z < 1.1$	Distress Zone	High risk of financial distress/bankruptcy firm

Source: Own's Compiled

Table No-1 indicates that the Z- score model for non-manufacturing firms uses four key financial ratios to assess a company's risk of bankruptcy. Here it shows the decision zone and description of model according to the Z score.

Analysis And Interpretation

This research is comprises of five private sector banks in India over the period of 5 years from 2020-21 to 2024-25.

Table No-2
Working Capital to Total Assets

	HDFC	ICICI	KOTAK	AXIS	IDBI
2020-21	0.71	0.59	0.61	0.73	0.65
2021-22	0.74	0.62	0.63	0.72	0.65
2022-23	0.75	0.62	0.63	0.74	0.62
2023-24	0.70	0.58	0.62	0.73	0.61
2024-25	0.68	0.60	0.62	0.71	0.63

Source: Own's Compiled

Table No-2 highlights that the Working Capital to Total Assets (WCTA) ratio from 2020–21 to 2024–25 indicates stable and healthy liquidity positions across all five banks. HDFC consistently leads with the highest WCTA values, ranging from 0.68 to 0.75, reflecting strong short-term financial health and efficient management of current assets and liabilities. AXIS also demonstrates a solid liquidity profile, maintaining values between 0.71 and 0.74, closely linked with HDFC. KOTAK shows steady performance with a narrow range of 0.61 to 0.63, indicating reliable liquidity management. ICICI exhibits slight fluctuations between 0.58 and 0.62, remaining stable though on the lower end compared to its peers. IDBI maintains a consistent WCTA ratio between 0.61 and 0.65 throughout the period, with a slight dip in 2022–23 but recovering by 2024–25.

Table No-3
Retained Earnings to Total Assets

	HDFC	ICICI	KOTAK	AXIS	IDBI
2020-21	0.12	0.10	0.17	0.10	0.09
2021-22	0.12	0.10	0.18	0.10	0.11
2022-23	0.11	0.11	0.18	0.10	0.11
2023-24	0.11	0.11	0.17	0.10	0.11
2024-25	0.12	0.12	0.18	0.11	0.11

Source: Own's Compiled

Table No-3 shows that the Retained Earnings to Total Assets ratio for the five banks over the period 2020–21 to 2024–25 reflects stable long-term profitability and internal capital generation. KOTAK consistently exhibits the highest ratio, ranging from 0.17 to 0.18, indicating strong profit retention and a healthy financial foundation. HDFC maintains a steady ratio around 0.11 to 0.12, showing reliable earnings accumulation over time. ICICI demonstrates a gradual improvement from 0.10 to 0.12, suggesting strengthening internal profitability. IDBI, which initially had the lowest ratio at 0.09 in 2020–21, improves to 0.11 by 2021–22 and sustains this level through 2024–25, reflecting positive retention of earnings and growing financial resilience. Overall, all five banks show stable to improving trends in retained earnings, with KOTAK clearly leading in long-term profitability, while IDBI shows notable progress in strengthening its internal reserves.

Table No-4
EBIT to Total Assets

	HDFC	ICICI	KOTAK	AXIS	IDBI
2020-21	0.03	0.03	0.03	0.03	0.02
2021-22	0.03	0.02	0.03	0.02	0.03
2022-23	0.03	0.03	0.03	0.02	0.03
2023-24	0.03	0.03	0.03	0.03	0.03
2024-25	0.03	0.03	0.03	0.03	0.03

Source: Own's Compiled

Table No-4 indicates that The EBIT to Total Assets ratio data for the five banks over the period 2020–21 to 2024–25 indicates a consistent level of operational efficiency relative to asset utilization. All banks, including HDFC, ICICI, KOTAK, AXIS, and IDBI, maintain an EBIT/Total Assets ratio primarily at 0.03, reflecting steady operational profitability. There is only slight variation observed in ICICI and AXIS during 2021–22 and 2022–23, where the ratio temporarily dips to 0.02, suggesting a minor reduction in operating efficiency for those years. IDBI, which starts at a slightly lower ratio of 0.02 in 2020–21, aligns with its peers in subsequent years, improving to 0.03. Overall, the data reflect stable and uniform performance across all banks, with no significant fluctuations, indicating controlled cost management and consistent earnings before interest and taxes in proportion to total assets over the five-year.

Table No-5
Book Value of equity to Total Liability

	HDFC	ICICI	KOTAK	AXIS	IDBI
2020-21	0.13	0.11	0.22	0.11	0.14
2021-22	0.13	0.12	0.22	0.11	0.16
2022-23	0.13	0.14	0.22	0.11	0.16
2023-24	0.13	0.12	0.20	0.12	0.16

2024-25	0.13	0.13	0.22	0.13	0.18
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Source: Own's Compiled

Table No-5 shows that the Book Value of Equity to Total Liability ratio over the five-year period from 2020–21 to 2024–25 reflects the capital structure and financial leverage of the five banks. KOTAK consistently maintains the highest ratio, averaging around 0.22, indicating a stronger equity position relative to its liabilities and suggesting a more conservative financial structure. HDFC shows stable performance at 0.13 across all five years, reflecting steady capital strength. AXIS maintains a lower but gradually improving ratio, rising from 0.11 to 0.13 during the study period, suggesting modest strengthening of its equity base. ICICI shows slight year-to-year variation, moving between 0.11 and 0.14, indicating moderate fluctuations in its equity-to-liability. IDBI demonstrates a clear upward trend, starting at 0.14 and rising to 0.18 by 2024–25, suggesting an improving equity position and reduced financial risk over time. Overall, KOTAK stands out for its consistently strong ratio, while IDBI shows the most significant improvement, and the other banks maintain relatively stable capital structures.

Table No-6
Z score of Sample Banks

	HDFC	ICICI	KOTAK	AXIS	IDBI
2020-21	5.41	4.48	5.05	5.40	4.89
2021-22	5.61	4.71	5.15	5.30	4.95
2022-23	5.66	4.73	5.16	5.36	4.74
2023-24	5.29	4.43	5.04	5.44	4.68
2024-25	5.18	4.63	5.11	5.34	5.83
AVG.	5.43	4.60	5.10	5.37	5.61

Source: Own's Compiled

Table No-6 indicates that the Z-score data for the sample banks from 2020–21 to 2024–25 reveals a consistently strong financial performance across all five banks, with each maintaining Z-scores well above the critical standard, indicating a low risk of bankruptcy and placing all banks firmly in the "Safe Zone." HDFC leads with an average Z-score of 5.43, followed by AXIS at 5.37 and KOTAK at 5.10, showing stable and robust financial health over the five-year period. ICICI, with a slightly lower average of 4.60, remains safely within the secure range, though with slightly more fluctuation. Notably, IDBI, which initially had slightly lower Z-scores compared to its peers, shows significant improvement in 2024–25, rising to 5.83, the highest individual score in the dataset. This extreme contributes to IDBI achieving the highest average Z-score overall (5.61), indicating a strong turnaround or improvement in its financial condition. Overall, the trend reflects sound financial management and stability among all five banks.

Table No-7
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HDFC	20	.03	.75	.2480	.28031
ICICI	20	.02	.62	.2155	.23221
KOTAK	20	.03	.63	.2610	.22541
AXIS	20	.02	.74	.2425	.28864
IDBI	20	.02	.65	.2065	.22415

Source: Own's Compiled

Table No- 7 indicates that the descriptive statistics for the five banks i.e. HDFC, ICICI, KOTAK, AXIS, and IDBI, based on a financial variable over 20 observations. KOTAK records

the highest average mean value of 0.2610, indicating stronger overall performance in this metric, followed by HDFC 0.2480 and AXIS 0.2425, both also showing relatively high averages. ICICI and IDBI trail behind with means of 0.2155 and 0.2065 respectively, suggesting slightly weaker performance. In terms of variability, AXIS and HDFC exhibit the highest standard deviations 0.28864, 0.28031 respectively, indicating more fluctuation in their values over the observed period. The minimum and maximum values further confirm the wide range of performance, with HDFC and AXIS reaching peaks of 0.75 and 0.74, while IDBI and ICICI show lower minimums at 0.02, suggesting occasional weak performance. Overall, KOTAK shows the most consistent and strong performance, while IDBI and ICICI appear more modest, with AXIS showing the greatest variability.

Table No-8
Correlation Matrix of Financial Ratios

		WCTA	RETA	EBITTA	BVTL
WCTA	Correlation	1			
	Sig.				
RETA	Correlation	-0.349	1		
	Sig.	0.087			
EBITTA	Correlation	-0.186	0.380	1	
	Sig.	0.373	0.061		
BVTL	Correlation	-0.463*	0.908**	0.339	1
	Sig.	0.020	0.000	0.098	

Source: Own's Compiled

****.** 1% level of significant.

***.** 5% level of significant

Table No-8 reveals that the correlation matrix of financial ratios provides insight into the relationship among key indicators of financial health. The Working Capital to Total Assets (WCTA) ratio has a negative but statistically insignificant correlation with Retained Earnings to Total Assets (RETA) ($r = -0.349$, $p = 0.087$), suggesting a mild inverse relationship. WCTA also shows a weak and insignificant negative correlation with EBIT to Total Assets (EBITTA) ($r = -0.186$, $p = 0.373$), indicating that changes in liquidity may not significantly influence operating profitability. However, WCTA has a moderate negative and statistically significant correlation with Book Value of Equity to Total Liabilities (BVTL) ($r = -0.463$, $p = 0.020$), implying that higher working capital may be associated with a lower equity-to-liability ratio, potentially due to asset structure differences. Whereas, RETA and BVTL show a very strong positive and highly significant correlation ($r = 0.908$, $p = 0.000$), suggesting that banks with higher retained earnings tend to have stronger equity positions relative to their liabilities. RETA also has a moderate positive but borderline significant correlation with EBITTA ($r = 0.380$, $p = 0.061$), indicating that profitability tends to support earnings retention. EBITTA's correlations with other variables are generally weaker and not statistically significant. Overall, the matrix highlights that retained earnings play a crucial role in strengthening a bank's capital structure, while liquidity and capital structure are inversely related, potentially reflecting different financial strategies.

Table No-9
T- Test Statistics

VARIABLE	T- VALUE	P-VALUE	CRITERIA
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WCTA	60.173	0.000	Rejected
RETA	21.237	0.000	Rejected
EBITTA	37.951	0.000	Rejected
BVTL	19.429	0.000	Rejected

Source: Own's Compiled

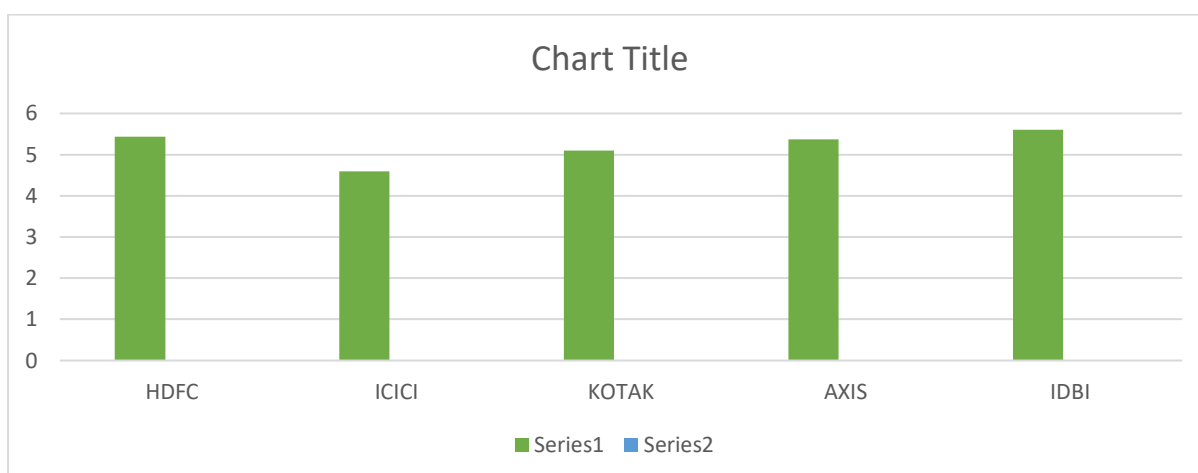
Table No-9 shows that the t-test statistics for the financial variables like WCTA (Working Capital to Total Assets), RETA (Retained Earnings to Total Assets), EBITTA (EBIT to Total Assets), and BVTL (Book Value of Equity to Total Liabilities) which indicate that all four variables are highly statistically significant, with p-values of 0.000 across the board. This means the null hypothesis is rejected in every case, confirming that each variable has a meaningful and significant impact within the context of the analysis on financial health or bankruptcy prediction using the Z-score model. Among them, WCTA shows the highest T-value (60.173), suggesting it is the most influential predictor in the dataset. EBITTA also demonstrates strong significance with a T-value of 37.951, followed by RETA (21.237) and BVTL (19.429). The high T-values combined with zero p-values underline that all these financial ratios are not only important individually but also statistically robust in explaining differences or effects in the study. This reinforces their validity and usefulness in financial performance analysis.

Table No-10
Z- score Decision Zone Table

Name of the Bank	Average	Decision Zone
HDFC	5.43	Safe Zone
ICICI	4.6	Safe Zone
KOTAK	5.1	Safe Zone
AXIS	5.37	Safe Zone
IDBI	5.61	Safe Zone

Source: Own's Compiled

Table No- 10, indicates that the Z-score Decision Zone Table reflects the average financial health of the five sample banks based on the Altman Z-score model. All banks like HDFC, ICICI, KOTAK, AXIS, and IDBI are fall within the "Safe Zone," indicating a low risk of financial distress or bankruptcy. IDBI, with the highest average Z-score of 5.61, stands out for its improved financial stability, possibly due to strengthened earnings or capital structure. HDFC and AXIS also demonstrate strong and consistent financial positions with average scores of 5.43 and 5.37, respectively. KOTAK maintains a solid score of 5.10, while ICICI, although slightly lower at 4.60, remains comfortably within the safe threshold. Overall, the data suggest that all five banks are financially sound and well-managed, with no immediate signs of financial stress, reinforcing their stability and investor confidence.



Source: Own's Compiled

Figure No-1
Z- score point table

Figure No-1 depict that all the banks are coming under the safe zone due to the z scores value ranges between 4.6 to 5.61 which is coming under the safe zone standard i.e. more than 2.6.

Conclusion

In this research, it found that there is a stable and robust financial health of five major Indian banks like HDFC, ICICI, KOTAK, AXIS, and IDBI over the period of 5 years from 2020–21 to 2024–25. Liquidity analysis i.e. Working Capital to Total Assets (WCTA) ratio reveals strong short-term financial positions, with HDFC and AXIS leading in efficiency and consistency. In terms of long-term profitability, the Retained Earnings to Total Assets (RETA) ratio shows KOTAK at the leading position, while IDBI demonstrates notable improvement. Operational efficiency, measured by EBIT to Total Assets (EBITTA), remains stable across all banks, with minimal fluctuations, indicating consistent earnings relative to asset base. The Book Value of Equity to Total Liabilities (BVTL) ratio reflects a strong capital structure, with KOTAK consistently maintaining the strongest equity position, and IDBI showing significant progress. Z-score analysis confirms that all five banks fall in the "Safe Zone," with IDBI achieving the highest average Z-score, suggesting significant enhancement in financial stability. Descriptive statistics confirm KOTAK's leadership in performance, while HDFC and AXIS show wider variability in financial outcomes. Correlation analysis indicates strong interdependence between retained earnings and equity structure, and a notable inverse relationship between liquidity and capital leverage. Finally, the t-test results establish that all examined financial ratios are statistically significant predictors of financial health, with WCTA emerging as the most influential. Overall, the analysis underscores a picture of sound financial management and low bankruptcy risk across all five banks, with IDBI's improvement particularly impressive one.

Scope For Further Study

In this study some areas like public sector banks in India is unexplored and this research is focussed only in Indian context. Here the sample size is also limit to five banks over five years. At last, this study is select only four factors of bank which indicates the performance of

bankruptcy status as per the Z score models where other factors are also responsible for bankruptcy like stress assets management, NPA management etc. can be included in future study.

Abbreviations

HDFC: Housing Development Finance Corporation, ICICI: Industrial Credit and Investment Corporation of India, IDBI: Industrial Development Bank of India, CAMEL: Capital Adequacy, Asset Quality, Management, Earnings, Liquidity, OBS: Off-Balance Sheet, ROA: Return on Assets, EBIT: Earnings Before Interest and Taxes, NPAs: Non-Performing Assets.

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Author Contributions

The authors have contributed equally to the manuscript.

Conflict Of Interest

The authors declare that there is no conflict of interest regarding this research project.

Ethics Approval

Ethical approval is not required for this study, and informed consent is obtained from all participants.

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