Evaluating Indian Banks:Camel Model and Discriminant Analysis

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ABSTRACT

The expansion and stability of any economy are directly correlated with the banking sector's success. Private Banks are becoming a greater rival to India's state sector banks. This study utilizes the CAMEL rating system to analyse ten banks, including both public and private, over five years from 2019 to 2023. Based on financial reforms, improved recovery processes, and contemporary technology, private banks outperform public ones, according to the findings. According to linear discriminant analysis, the distinction between banks that are functioning well and those that are not can be made using just four ratios. These findings help regulators spot struggling banks and keep the banking system stable.

Keywords: Public Sector Banks, Private Sector Banks, CAMEL Model, Prudential Ratios, Linear Discriminant Analysis.

INTRODUCTION

Banks are vital to the smooth operation of the economy because they provide financial services to people, companies, and governments alike. As a result, they have a direct and indirect impact on a wide range of sectors. The banking industry is very important in resource allocation, financial stability, and economic development. Additionally, advancements in technology have led to the introduction of various banking products and services, making the industry more complex. During financial crises, government intervention in beleaguered financial institutions raises questions about the effectiveness of government-

owned banks in ensuring financial soundness. Moreover, studies emphasise the importance of quantifying stability scores for accurate financial analysis and suggest improvements in the efficiency of certain parameters for banks like the State Bank of India. Finally, a good capital adequacy rating signals a bank's health, particularly during crises.

REVIEW OF LITERATURE

CAMEL rating method, originated in 1979 when the US banking sector implemented the "Uniform Financial Institutions Rating System (UFIRS)". This method evaluates banks based on five dimensions to gauge their operations and performance. Studies by Siva and Natarajan (2011) have emphasised the significance of assessing banks annually to diagnose their financial health. Return on equity (ROE) and return on assets (ROA), two crucial ratios that account for both internal and external factors, can be used to assess a bank's profitability. The impact of CAMEL indicators on bank performance has been explored in research by Rostami (2015) and Baral (2005), revealing insights into factors like liquidity and risk management.

Chaudhary and Sharma (2011) and Desta (2016) examined aspects such as the management of non-performing assets and variations in CAMEL ratings among banks. Moreover, studies by Ab-Rahim et al. (2018) and Ahsan (2016) highlighted the importance of a robust banking sector for economic sustainability and attracting investors. Overall, research on the CAMEL rating framework underscores its utility for stakeholders in evaluating bank performance and making informed decisions.

Kumar et al. (2022) evaluated the financial performance of numerous private banks in India from 2017 to 2021 using the CAMEL Model. The results showed that the CAMEL framework could effectively analyse key prudential indicators, such as capital adequacy, asset quality, management efficacy, earnings quality, and liquidity, to evaluate the overall performance of banks. According to Raja et al. (2023), there aren't many publicly owned commercial banks in Guyana, which makes it difficult to compare them with privately owned ones, and there aren't many prudential ratios accessible for examination. There were also

discrepancies in the outcomes obtained from the CAMEL method and linear discriminant analysis.

RESEARCH METHODOLOGY

Publicly and privately held commercial banks' annual reports included secondary data. In a five-year period spanning 2019 to 2023, a sample of ten banks-five privately held and five publicly owned-was chosen. A conscious choice was made when choosing these banks. Throughout the course of the inquiry, banks who submitted comprehensive financial accounts were given precedence. An additional focus of the selection criterion was on the top-performing large-cap banks with the highest market capitalisation on the Indian stock market. Utilising the CAMEL grading system, a total of 15 ratios were computed, as seen in Table 1.

Table 1: Ratios Computed Using CAMEL Model

Capital Adequacy	Asset Quality	Management Efficiency	Earnings Quality	Liquidity
Capital Adequacy Ratio (CAR)	Net NPA To Net advances	Return on equity (ROE)	Net Interest Margin	Cash - Deposit Ratio
Capital adequacy ratio - Tier I	Secured advances to total advances	Business per employee	Non-approved securities to total investments	Credit - Deposit Ratio
Capital adequacy ratio - Tier II	NET NPA	Profit per employee	Return on assets (ROA)	Investment - Deposit Ratio

The purpose of the hypothesis was to determine whether the financial performance of commercial banks that are privately held vs those that are publicly owned differs noticeably.

Hypotheses:

H_{01}: There is no significant difference in the financial performance of public sector banks

based on the overall CAMEL model.

H_1: There is a significant difference in the financial performance of public sector banks based on the overall CAMEL model.

H_{02}: There is no significant difference in the financial performance of private sector banks based on the overall CAMEL model.

H_2: There is a significant difference in the financial performance of private sector banks based on the overall CAMEL model.

The authors also wish to identify a combination of financial ratios that differentiate between well-performing and poorly-performing banks. A linear discriminant analysis (LDA) has been employed for this purpose. Altman (1968) employed this method for the first time to forecast business failures, while Mous (2005) used it to forecast bank failures. The definition of the discriminant function is:

$$ = \beta_0 + T_1\beta_1 + T_2\beta_2 + T_3\beta_3 + \cdots + T_p\beta_p \quad \ldots (1)$$

Where, T is the grouping variable, T_1, T_2, $T_3, \ldots, T_p$ are the financial ratios, and $\beta_0, \beta_1, \beta_2, \beta_3, \ldots, \beta_p$, are the discriminant coefficients

The financial ratios used are:

T_1: Risk-weighted assets divide eligible the capital.

T_2 : Non-performing loans are divided by total loans

T_3 : Total income divides operating expenses.

T_4 : Operating income is divided by total assets

T_5 : Liquid assets are divided by total assets

Wilks' Lambda test checks if the discriminant analysis is valid. If Wilks' Lambda is statistically significant and close to zero, it means the analysis effectively separates well-performing banks from poorly performing ones. Predictors with p-values less than 10% are considered important, while those above 10% are discarded. High eigenvalues and strong canonical correlations indicate a strong link between the discriminant score and groups. The discriminant score for each bank is calculated using unstandardized coefficients and compared

with group centroid scores. Banks with scores above the centroid are labelled as well-performing, while those below are labelled as poorly performing.

Predictors should not be highly correlated, and the Variance Inflation Factor (VIF) checks this. Values less than 10 indicate no multicollinearity issues. The Box's M test checks for equality of covariance matrices, with an alpha value above 0.001 indicating no violations. The normality of predictors is tested using normal P-P plots. Finally, the function is evaluated for its accuracy in correctly classifying each group.

DATA ANALYSIS

CAPITAL ADEQUACY (C)

Capital adequacy measures how well a bank manages its resources and its ability to stay financially stable during crises. They calculate it by dividing Tier 1 capital and Tier 2 capitals by risk-weighted assets. This ratio indicates how well the bank can handle losses, which is important for maintaining depositor trust and preventing bankruptcy, as Reddy (2012) explains. Meeting RBI's requirement of 8% capital adequacy, based on Basel III guidelines, is very important. A high Capital Adequacy Ratio (CAR) means the bank follows safe banking practices, while a low ratio may indicate higher risk. To avoid bank failures, maintaining strong capital adequacy is crucial, as pointed out by Chen (2003). This study calculates three ratios CAR, CAR Tier I, and CAR Tier II to assess the capital adequacy of the banks, as shown in Table 2.

Table 2: Capital Adequacy Assessment

Public Sectors Bank								
Details	CAR		CAR I		CARII		Combined Average	
Bank	Average %	Rank	Average %	Rank	Average %	Rank	Average %	Rank
Bank of Baroda	14.73	7	12.42	5	2.31	5	5.67	4
Bank of India	15.00	6	12.25	6	2.75	3	5.00	7
Punjab National Bank	13.64	8	11.06	9	2.58	4	7.00	3
State Bank of	13.61	9	11.31	8	2.29	6	7.67	2

India								
Union Bank of India	13.54	10	11.34	7	2.20	7	8.00	1
Private Sectors Bank								
Axis Bank	17.73	4	14.88	4	2.85	2	3.33	10
HDFC Bank	18.52	2	17.11	2	1.40	8	4.00	9
ICICI Bank	17.92	3	16.76	3	1.16	9	5.00	6
Kotak Mahindra Bank	20.42	1	19.61	1	0.81	10	4.00	8
Yes Bank	15.56	5	10.78	10	4.78	1	5.33	5

INTERPRETATION

Table 2 shows the Capital Adequacy Ratio (CAR), CAR I, and CAR II for different banks, along with their rankings and combined average scores. The table helps analyze each bank's capital adequacy based on these metrics. The Bank of Baroda has an average CAR of 14.73%, ranking 7th, with CAR I at 12.42% (5th) and CAR II at 2.31% (5th), giving it a combined average rank of 4th. The Union Bank of India ranks 10th with an average CAR of 13.54%, CAR I at 11.34% (7th), and CAR II at 2.20% (7th), with a combined average rank of 1st. Among private sector banks, “Kotak Mahindra Bank” ranks highest with an average CAR of 20.42%, CAR I at 19.61% (1st), and CAR II at 0.81% (10th), with a combined average rank of 8th. Lower rankings indicate weaker capital adequacy, while higher rankings suggest stronger performance. When it comes to capital sufficiency, private sector banks typically outperform public sector banks. Kotak Mahindra Bank demonstrates the best capital adequacy, while lower rankings are held by State Bank of India and Union Bank of India. Overall, the analysis shows differences in capital adequacy, with private banks generally showing better results than public banks.

ASSET QUALITY (A)

Asset quality is important for checking how well a bank is doing, according to RBI rules. Bad debts are sorted into four categories: Standard, Sub-Standard, Doubtful, and Loss assets. Looking at asset quality helps us understand

a bank's financial strength. Three key ratios NPA Ratio, Net NPA, and the Ratio of Secured Advances to Total Advances are used to measure asset quality. These ratios provide insights into the level of non-performing assets, helping stakeholders assess the bank's risk exposure and its ability to manage credit effectively. By tracking these metrics, stakeholders can make informed decisions about the bank's stability and viability.

Table 3: Asset Quality

Public Sectors Bank								
Details	NPA Ratio		Net NPA		Ratio of secured advances to total advances		Combined Average	
Bank	Average %	Rank	Average %	Rank	Average %	Rank	Average %	Rank
Bank of Baroda	2.43	5	2.43	5	84.60	2	4.00	7
Bank of India	3.37	4	3.37	3	77.01	6	4.33	6
Punjab National Bank	5.12	1	5.12	1	80.15	3	1.67	10
State Bank of India	1.69	6	1.69	6	74.30	7	6.33	5
Union Bank of India	4.47	2	4.47	2	86.59	1	1.67	9
Private Sectors Bank								
Axis Bank	1.19	8	1.19	8	73.12	8	8.00	2
HDFC Bank	0.35	10	0.35	10	70.78	10	10.00	1
ICICI Bank	1.28	7	1.28	7	72.97	9	7.67	4
Kotak Mahindra Bank	0.90	9	0.90	9	77.16	5	7.67	3
Yes Bank	3.63	3	3.63	4	78.52	4	3.67	8

INTERPRETATION

Table 3 offers a comprehensive overview of asset quality metrics for both public and private sector banks. Punjab National Bank (PNB) emerges with the highest NPA Ratio among public sector banks, securing the 1st rank at 5.12%,

while HDFC Bank leads the private sector with the lowest NPA Ratio at 0.35%. Notably, the Union Bank of India (UBI) excels in the ratio of secured advances to total advances with 86.59%, while HDFC Bank demonstrates the lowest ratio at 70.78%. Overall, HDFC Bank exhibits the best performance with a combined average rank of 10.00%, while Axis Bank shows the poorest performance with an average rank of 8.00%. Private sector banks tend to outperform public sector banks in terms of asset quality, with HDFC Bank leading the pack in this analysis.

MANAGEMENT EFFICIENCY (M)

Management efficiency in banking is a nuanced evaluation that encompasses both qualitative and quantitative factors. While qualitative assessments delve into aspects like management systems, organizational culture, and control mechanisms, quantitative measures, particularly off-site valuation ratios, offer concrete insights into managerial effectiveness. These ratios, including Return on Equity (ROE), Business per employee, and Profit per employees, provide stakeholders with a snapshot of how efficiently management is utilizing resources, generating profits, controlling costs, and managing risks. By scrutinizing these metrics, stakeholders can gauge the bank's operational performance, risk management practices, and overall effectiveness of managerial decisions, aiding in informed decision-making and ensuring the bank's long-term sustainability.

Table 4: Management Efficiency

Public Sectors Bank								
Details	Return on equity (ROE)		Business per employee		Profit per employee		Combined Average	
Bank	Average %	Rank	Average %	Rank	Average %	Rank	Average %	Rank
Bank of Baroda	5.44	6	2,118.60	2	7.40	6	4.67	7
Bank of India	-0.53	8	2,018.20	4	0.23	8	6.67	3
Punjab National Bank	-2.81	9	1,896.80	5	-1.00	10	8.00	2
State Bank of India	8.72	4	2,381.40	1	9.71	4	3.00	9

Union Bank of India	0.54	7	2,034.00	3	1.20	7	5.67	4
Private Sectors Bank								
Axis Bank	7.28	5	1,777.06	7	9.03	5	5.67	5
HDFC Bank	16.62	1	1,873.00	6	25.80	1	2.67	10
ICICI Bank	10.87	3	1,473.06	9	15.94	2	4.67	8
Kotak Mahindra Bank	12.80	2	929.20	10	13.60	3	5.00	6
Yes Bank	-13.69	10	1,601.58	8	-14.44	9	9.00	1

INTERPRETATION

Table 4 shows the performance of public and private sector banks across various metrics. HDFC Bank stands out with top rankings, achieving 1st place in Return on Equity (ROE) at 16.62% and Profit per Employee at 25.80%. The State Bank of India leads in Business per Employee with “2,381.40%”. Among public sector banks, Punjab National Bank has the highest overall average at 8.00%, while the Bank of India and the Union Bank of India also perform well. In contrast, Yes Bank faces difficulties, with the smallest overall average of 9.00% among private banks. The ICICI Bank and the Axis Bank show strong performance with competitive percentages. Overall, the data highlights differences in performance across banks, with HDFC Bank and the State Bank of India leading in their respective sectors.

EARNINGS QUALITY (E)

Earnings quality as a critical dimension in assessing a bank's ability to generate consistent profits, defining its profitability, sustainability, and growth potential. The three key ratios-Return on Assets (ROA), Non-approved securities to total investments and Net Interest Margin (NIM) are pivotal in evaluating earnings quality. ROA measures profitability relative to total assets, the ratio tells us how much of a bank's money is invested in risky things, compared to safe ones and NIM reflects profitability from core lending and borrowing activities. Strong performance across these metrics not only indicates financial health but also enhances investor confidence and ensures the bank's ability to navigate market

challenges. Overall, earnings capabilities serve as a cornerstone in evaluating a bank's viability and resilience in the dynamic financial landscape.

Table 5: Earnings Quality

Public Sectors Bank								
Details	Return on Assets (ROA)		Non-approved securities to total investments		Net Interest Margin (NIM)		Combined Average	
Bank	Average %	Rank	Average %	Rank	Average %	Rank	Average %	Rank
Bank of Baroda	0.36	6	12.75	9	2.62	5	6.67	4
Bank of India	-0.01	8	12.16	10	2.24	10	9.33	1
Punjab National Bank	-0.12	9	14.44	8	2.31	9	8.67	2
State Bank of India	0.50	5	21.82	5	2.59	6	5.33	5
Union Bank of India	0.06	7	26.16	1	2.35	7	5.00	6
Private Sectors Bank								
Axis Bank	0.71	4	24.02	2	3.09	4	3.33	9
HDFC Bank	2.00	2	18.15	7	3.96	2	3.67	7
ICICI Bank	1.32	3	22.07	4	3.45	3	3.33	8
Kotak Mahindra Bank	2.00	1	21.52	6	4.17	1	2.67	10
Yes Bank	-1.14	10	23.40	3	2.46	8	7.00	3

INTERPRETATION

Table 5 provides information on the earnings quality of various banks by considering key metrics such as Return on Assets (ROA), the percentage of non-approved securities to total assets, and Net Interest Margin (NIM). Among public sector banks, the State Bank of India emerges with a notable ROA of 0.50%, while Union Bank of India demonstrates the highest percentage of non-approved securities to total investments at 26.16%. In the private sector, HDFC Bank stands out with an impressive ROA of 2.00%, while the Axis Bank exhibits the highest

NIM at 24.02%. Yes Bank faces challenges with a negative ROA of -1.14% and ranks highest in non-approved securities to total investments, indicating potential profitability and risk management issues. Overall, private sector banks tend to show stronger performance in earnings quality metrics compared to public sector banks, with HDFC Bank and the Kotak Mahindra Bank leading the pack.

LIQUIDITY (L)

Liquidity is crucial for the seamless operation of banks, ensuring they can meet financial obligations promptly. It encompasses the ability to swiftly convert assets into cash to address unexpected payment needs. Key indicators of liquidity include the Credit Deposit Ratio, Cash Deposit Ratio, and Investment Deposit Ratio. These ratios gauge a bank's liquidity position and its ability to respond effectively to changing financial demands. Liquid assets, such as investments in highly liquid securities, enable banks to react promptly to sudden payment requirements. Thus, maintaining optimal levels of liquidity is vital for the stability and efficiency of the banking sector.

Table 6: Liquidity

Public Sectors Bank								
Details	Cash - Deposit Ratio		Credit - Deposit Ratio		Investment - Deposit Ratio		Combined Average	
Bank	Average %	Rank	Average %	Rank	Average %	Rank	Average %	Rank
Bank of Baroda	4.60	10	74.37	6	28.98	10	8.67	1
Bank of India	6.71	3	65.96	9	29.01	9	7.00	3
Punjab National Bank	5.55	8	64.83	10	32.59	5	7.67	2
State Bank of India	6.09	6	70.63	7	34.86	1	4.67	8
Union Bank of India	4.51	9	67.49	8	32.82	3	6.67	4
Private Sectors Bank								
Axis Bank	9.10	1	88.58	2	30.56	8	3.67	9
HDFC Bank	6.64	4	86.60	3	31.16	6	4.33	7
ICICI Bank	6.28	5	83.85	5	30.83	7	5.67	5
Kotak Mahindra Bank	5.99	7	85.93	4	32.66	4	5.00	6
Yes Bank	8.50	2	111.30	1	33.85	2	1.67	10

INTERPRETATION

Table 6 provides a detailed look at liquidity metrics for both public and private sector banks, expressed as percentages. The Axis Bank has the highest cash-deposit ratio at 9.10%, indicating strong liquidity reserves. Yes Bank leads with the highest credit-deposit ratio at 111.30%, showing a significant reliance on credit for funding. Punjab National Bank has a weaker liquidity position compared to other public sector banks, while State Bank of India has the highest investment-deposit ratio at 34.86%. In the private sector, HDFC Bank and ICICI Bank show competitive liquidity performance across various metrics. Overall, the Axis Bank and Yes Bank are noted for their strong liquidity management, while Punjab National Bank faces liquidity challenges. This analysis highlights the importance of effective liquidity management for the stability and resilience of banking institutions.

Table 7: Overall Ranking of Selected Banks Using CAMELS Parameters

Public Sectors Bank							
Bank	Capital Adequacy (C)	Asset Quality (A)	Management Efficiency (M)	Earnings Quality (E)	Liquidity (L)	Average %	Rank
Bank of Baroda	4	7	7	4	1	4.6	8
Bank of India	7	6	3	1	3	4.0	9
Punjab National Bank	3	10	2	2	2	3.8	10
State Bank of India	2	5	9	5	8	5.8	5
Union Bank of India	1	9	4	6	4	4.8	7
Private Sectors Bank							
Axis Bank	10	2	5	9	9	7.0	1
HDFC Bank	9	1	10	7	7	6.8	2
ICICI Bank	6	4	8	8	5	6.2	4
Kotak Mahindra Bank	8	3	6	10	6	6.6	3
Yes Bank	5	8	1	3	10	5.4	6

The CAMELS parameters—Capital Adequacy (C), Asset Quality (A), Management Efficiency (M), Earnings Quality (E), and Liquidity (L)—are used to

rate some institutions. An overview of these rankings is given in Table 7. With the greatest average rank of 5.8 among public sector banks, State Bank of India (SBI) has excellent performance in Capital Adequacy and Asset Quality. In terms of capital adequacy and liquidity, Axis Bank leads the private sector banks with an average ranking of 7.0. In terms of asset quality and earnings quality, HDFC Bank performs well, coming in close second with an average rating of 6.8. The superior performance of private commercial banks over public commercial banks can be attributed to their excellent capital adequacy, effective management, and ample liquidity.

Table 8:ANOVA (Public Sectors Bank)

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5531950.875	4	1382987.719	6.594	.069
Within Groups	14680370.163	70	209719.574		
Total	20212321.038	74			

Based on the general CAMEL model parameters for the financial performance of public sector banks, the one-way ANOVA shows a statistically significant difference between the groups. This demonstrates that the financial performance of public sector banks varies significantly depending on the several characteristics that the CAMEL model assesses.

Table 9:ANOVA (Private Sectors Bank)

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2931827.978	4	732956.994	6.171	.092
Within Groups	8314296.965	70	118775.671		
Total	11246124.943	74			

A statistically significant difference between groups is evident from the one-way ANOVA test findings, which are dependent on the overall CAMEL parameters for the prudential performance of private sector banks. This suggests that the

prudential performance of private commercial banks varies significantly amongst the many CAMEL metrics.

RESULTS: DISCRIMINANT ANALYSIS APPROACH

Using the CAMEL model, the ANOVA test did not reveal any significant variations in the prudential ratios. The authors then grouped ten banks (five public and five private) into good and poor performers and conducted a discriminant analysis. The results are shown below. Wilks' Lambda was used to check the effectiveness of the analysis. The Wilks' Lambda value was 0.263, which is highly significant at the 1% level. This indicates that the analysis is very effective at distinguishing between good and poor-performing banks.

Table 10: Wilks' Lambda Statistics

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	0.263	26.015	5	0.000

Table 11 indicates that well-performing banks typically exhibit higher average CAMEL ratios than poorly performing banks. In particular, good-performing banks show superior average ratios for Capital Adequacy, Earnings Quality, and Liquidity. However, their Asset Quality and Management Efficiency ratios are lower compared to those of poor-performing banks.

Table 11: Group Statistics

Performance of the Banks		Mean	Std. Deviation	Valid N (list wise)	
				Unweighted	Weighted
Good Performance	Capital Adequacy	11.758	7.706	15	15.000
	Asset Quality	25.276	35.441	15	15.000
	Management Efficiency	570.939	865.317	15	15.000
	Earning Quality	8.758	9.463	15	15.000
	Liquidity	40.650	33.100	15	15.000
Bad Performance	Capital Adequacy	9.662	5.152	15	15.000
	Asset Quality	29.660	37.920	15	15.000
	Management Efficiency	643.434	950.640	15	15.000
	Earning Quality	6.669	8.919	15	15.000
	Liquidity	38.071	32.117	15	15.000
Total	Capital Adequacy	10.710	6.528	30	30.000

	Asset Quality	27.468	36.132	30	30.000
	Management Efficiency	607.187	893.931	30	30.000
	Earning Quality	7.713	9.098	30	30.000
	Liquidity	39.361	32.072	30	30.000

We computed the discriminant function using particular CAMEL ratios to rank commercial banks after establishing that discriminant analysis was appropriate. Since Asset Quality failed the tolerance test, we limited the variables we considered in our additional research and modelling to Capital Adequacy, Management Efficiency, and Liquidity (all with p-values below 0.01) and Earnings Quality (p-value below 0.05) (see Table 12).

Table 12: Group Means Equality Tests

Items	Wilk's Lambda	F	df1	df2	Sig.
Capital Adequacy	.973	15.39	1	28	.005*
Asset Quality	.996	10.17	1	28	.004*
Management Efficiency	.998	11.81	1	28	.006*
Earning Quality	.986	8.39	1	28	.036**
Liquidity	.998	11.14	1	28	.003*

Note: * indicates significant at the 1% level and ** indicates significant at 5% level.

An eigenvalue greater than one indicates a strong function, and a Canonical Correlation of 0.827 indicates the efficacy of the discriminant function (see Table 13).

Table 13: Eigenvalues Analysis

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.223[a]	100.0	100.0	.827

a. First 1 canonical discriminant functions were used in analysis.

Table 14 demonstrates that there is no multicollinearity in the model since each variable's Variance Inflation Factor (VIF) is less than 10. Additionally, the Box's M Test results in Table 15 show a Box's M value of 16.832 with an F value of 2.5356, which is not significant at the 1% level (p-value = 0.089). This confirms that the variance-covariance matrices are uniform.

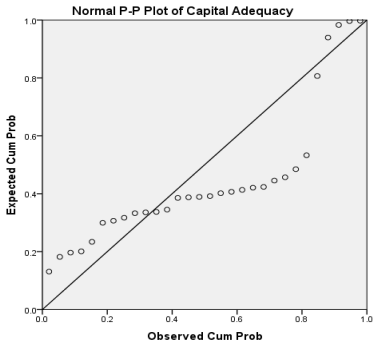
Table 14: Collinearity Statistics and VIF

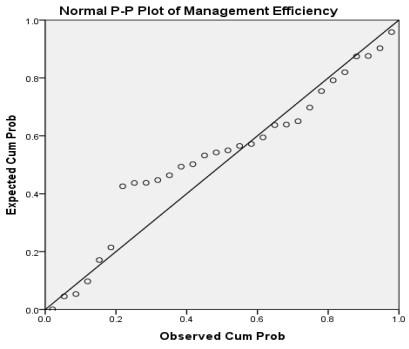
Model	Unstandardizd Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.345	.819		2.863	.009		
Capital Adequacy	-.053	.049	-.682	-1.089	.287	.087	8.004
Asset Quality	-.009	.010	-.657	-.896	.379	.063	6.205
Management Efficiency	.000	.000	.433	.783	.441	.112	4.784
Earning Quality	-.052	.036	-.933	-1.45	.159	.083	4.906
Liquidity	.006	.010	.370	.584	.565	.085	4.510

Table 15: Box's M Test Results

Box's M		16.832
F	Approx.	2.5356
	df1	15
	df2	2187.63
	Sig.	.089

The Normal P-P plot for each predictor shows that the data approximately follows a Normal distribution. Hence, the Normality assumption for each predictor is valid. (see Figure 1)





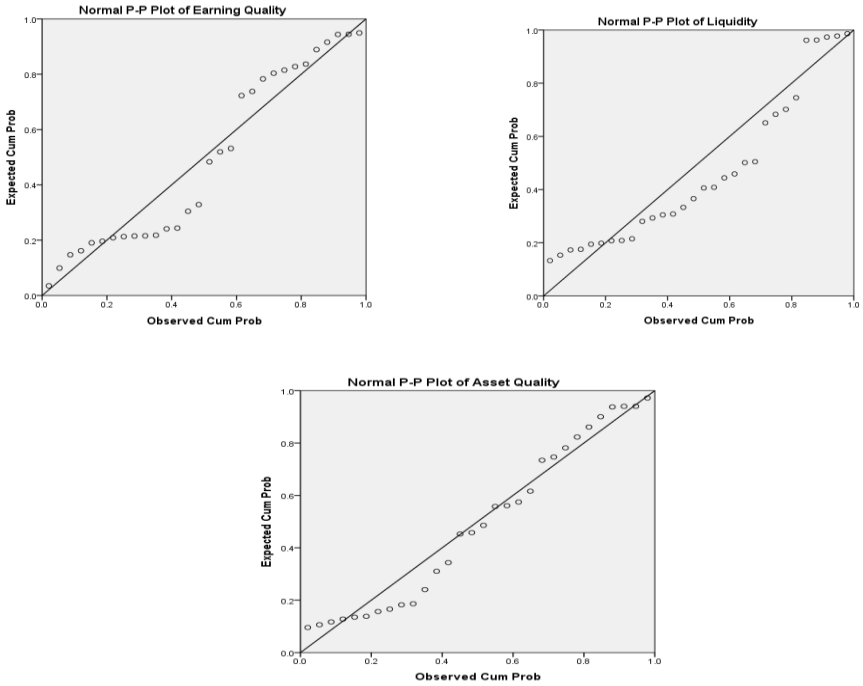


Figure 1: Normal P-P Plots of Covariates

The function correctly classifies 80% of the original cases, i.e., 73.3% of banks that perform well and 86.7% of banks that do poorly (refer to Table 16). Inferred from this are a Type I error probability of 26.7% and a Type II error probability of 13.3%.

Table 16: Classification Outcomes

		Performance of the Banks	Predicted Group Membership		Total
			Good Performance	Bad Performance	
Original	Count	Good Performance	11	4	15
		Bad Performance	2	13	15
	%	Good Performance	73.3	26.7	100.0
		Bad Performance	13.3	86.7	100.0

80% of original grouped cases correctly classified.

The following equation will be used to calculate the discriminant score for each bank, based on the coefficients from Table 17.

Table 17: Coefficients of Canonical Discriminant Functions

					95% Confidence Interval	
		Coefficient	Bias	Std. Error	Lower	Upper
Asset Quality	1	.266	.02	.12	-.16	.31
Capital Adequacy	1	.046	.01	.07	-.01	.27
Earning Quality	1	-.001	.13	.53	-.15	2.08
Liquidity	1	.261	.00	.07	-.10	.21
Management Efficiency	1	-.029	.00	.12	-.30	.29
(Constant)	1	-4.227	-.95	8.47	-12.87	7.89

$$D - 4.227 + 0.046 * \text{Capital Adequacy} + 0.261 * \text{Liquidity} - 0.001 * \text{Earning Quality} - 0.029 * \text{Management Efficiency} + 0.266 * \text{Asset Qualit} \quad \ldots (2)$$

A comparison is made between the discriminant score for each bank with the Group Centroid, calculated as ((0.456 - 0.456)/2 = 0). If a bank's discriminant score is above zero, it is classified as a good performer. If the score is below zero, the bank is classified as a poor performer (see Table 18).

Table 18: Group Centroid Functions

Performance of the Banks	Function
	1
Good Performance	0.456
Bad Performance	-0.456

Unstandardized canonical discriminant functions evaluated at group means.

Table 19 shows overall Discriminant Scores, rankings, and group classifications. The top-performing banks, with scores above 0, are HDFC, the Axis, Kotak Mahindra, ICICI, and SBI. The poorly performing banks, with scores below 0, are the Union Bank of India, Yes Bank, the Bank of India, the Bank of Baroda, and Punjab National Bank. HDFC leads with the highest score (0.73292), followed by the Axis Bank (0.56839), Kotak Mahindra (0.55809), ICICI (0.43967), and SBI (0.31529). The Union Bank of India has a score of -0.04625, Yes Bank -0.37099, Bank of India -0.42611, Bank of Baroda -0.56056, and Punjab National Bank -0.59252.

Table 19: Discriminant Score, Bank Classification and Rankings

Bank	Discriminant Score	Bank Classification	Ranking
Bank of Baroda	-0.56056	Poor Performing	9
Bank of India	-0.42611	Poor Performing	8
Punjab National Bank	-0.59252	Poor Performing	10
State Bank of India	0.31529	Good Performing	5
Union Bank of India	-0.04625	Poor Performing	6
Axis Bank	0.56839	Good Performing	2
HDFC Bank	0.73292	Good Performing	1
ICICI Bank	0.43967	Good Performing	4
Kotak Mahindra Bank	0.55809	Good Performing	3
Yes Bank	-0.37099	Poor Performing	7

RESULTS AND DISCUSSION

The analysis of various banking metrics shows that private commercial banks generally perform better than public sector banks in capital adequacy, asset quality, earnings quality, and liquidity management. HDFC Bank is a top performer, with strong financial results and operational efficiency.The Axis Bank and ICICI Bank also perform well, reflecting the competitiveness of the private banking sector. Among public sector banks, the State Bank of India performs best in capital adequacy and asset quality but still trails behind leading the private banks. Overall, private sector banks show better performance due to their agility, strategic decisions, and effective risk management compared to public sector banks.

CONCLUSION

As highlighted in Table 7, Axis Bank stands out as the leading performer, achieving an impressive average score of 7.0%. The bank excels particularly in the areas of Capital Adequacy, Asset Quality, and Liquidity. HDFC Bank follows closely with an average score of 6.8%, particularly strong in Asset Quality and Earnings Quality. Among public sector banks, the State Bank of India is the best performer, ranking third with a 5.8% average score, showing strengths in Capital Adequacy and Asset Quality despite some challenges in Management Efficiency. Punjab National Bank ranks lowest, indicating a need for improvement, especially in Asset Quality and Management Efficiency. Overall, the data highlights better performance of private commercial banks and underscores the importance of

strong prudential management and operational efficiency in the competitive banking sector.

Linear Discriminant Analysis (LDA) shows that financial ratios effectively distinguish between good and poor-performing banks. The Wilks' Lambda test confirms the suitability of LDA. The results show that the function correctly classifies 80% of the original cases, with 73.3% accuracy for good-performing banks and 86.7% accuracy for poor-performing banks. This indicates a 26.7% chance of a Type I error and a 13.3% chance of a Type II error. The discriminant scores identify HDFC as the best-performing bank and Punjab National Bank as the worst. Diagnostic tests confirm that the discriminant function meets the assumptions of normality, homogeneity, and no multicollinearity.

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