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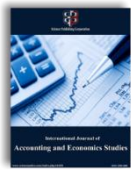

Operational Efficiency and Financial Health: Analysing Indian Public and Private Banks Using CAMEL Framework and Regression Models

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Abstract

This study analyzed data on the performance of public sector banks (SBI and BOB) and private sector banks (HDFC Bank and ICICI Bank) from 2018 to 2023 in India. The financial status and performance of banks are crucial for the economy. By using descriptive statistics, important financial ratios, the CAMEL framework, multiple regression analysis, and Efficiency analysis, the study concludes on the major differences and trends. The findings of the study reflect the major improvement in the performance of Private Sector banks, especially HDFC Bank, in respect of efficiency, profitability, asset quality in terms of ROA, ROE, NIM, and NPA ratios. It was also highlighted in the study that few improvements have been made in the performance of public sector banks, but still, they fail to compete in terms of efficiency, profitability, and asset quality with Private Sector banks. Moreover, the study also distinguished that the changes in the macro-economic variables do impact the bank's performance. Therefore, the study also indicates the possible additional determinants that can be further investigated. The findings of the study are hence significant for bank managers and policymakers while taking necessary corrective measures and recommendations for the improvement in the financial health and competitiveness of public sector banks. The key recommendation of the study, hence, is to adopt efficient operational and risk management practices.

Keywords: *Financial Performance; Public Sector Banks; Private Sector Banks; CAMEL Framework; Efficiency Analysis; Multiple Regression; Return on Assets (ROA); Return on Equity (ROE); Non-Performing Assets (NPA); Risk Management.*

1. Introduction

The banking sector is one of the most important sectors in an economy as it plays a crucial role in the development and stability of the financial system. In India, the banking system is a mix of public and private banks, but the size and reach of public sector banks (PSBs) is significantly higher than that of private sector banks (RBI, 2021; Jain and Pal, 2019). However, private sector banks are growing fast, and their role and reach are also increasing both in terms of assets and market reach (Kumar and Gulati, 2010; Rajan and Zingales, 2003). The banking sector accounts for a significant percentage of the national economy; hence, any change in the system will affect it heavily. It provides necessary services to facilitate trade, investment, and growth in an economy (Demirguc and Levine, 2001; Levine, 2005). Banks collect savings from people from various sectors of an economy and provide finance to productive ventures. (Beck, Levine, & Loayza, 2000; Allen & Gale, 2000).

The difference between public and private banks in India prevails in terms of efficiency, vitality, and service quality (Ghosh, 2016; Bhattacharya, Lovell, & Sahay, 1997). While PBS has the advantage of a vast network and government help, private sector banks have an edge over the public sector in technology-adoption and customer service (Das,1997; Muniappan, 2002). The current study finds applications of above cited factor in terms of its different bank performance spread over different financial metrics, like ARIMA, econometric models, and efficiency analysis. This study becomes beneficial if one wants to understand the building blocks of different banking models and their nexus with financial stability and socio-economic development (Sarkar, Sarkar, & Bhaumik, 1998; Jayaratne & Strahan, 1996).

In most scholarly and analytic studies, various attributes of the Indian banking sector have been practically examined separately in a descriptive, interpretive, and prescriptive manner without thorough and comprehensive comparative studies availing of the advanced AI analytical methods to evaluate performance simultaneously on multiple dimensions (Thangaraju & Palani, 2025; Thangaraju & Palani, 2025a; R, 2024). It is in light of this emerging gap that this quantitative study is undertaken. This study helps in addressing the gap in the existing literature and also contributes to earlier available studies, though it follows a similar route of integrating with multiple analytical tools to throw insights on the areas of bank performance and adds value intellectually in its comprehensive approach (Subramanian & Swaminathan, 2012; Bhattacharyya, 1997). Apart from its originality, this study attempts to highlight the comparative strengths and weaknesses of public and private sector banks (Chakrabarti & Chawla, 2005; Mishra, 2005) in the Indian banking sector within their peer group of nationalised and private commercial banks by bringing them onto a single platform. The focus on performance analysis provides cues

and pointers to policymakers, bank managers, and stakeholders about the best practices followed by banks and areas that require improvements (Mohan, 2006; Sen & Vaidya, 1997). In addition, the study's comprehensive approach through the application of multifaceted techniques adopted can serve as a benchmark for conducting further research on the banking sector performance in emerging economies like India, as the Indian banking sector has faced remarkable changes in the recent past (Bhatia & Mahendru, 2015; Mishra & Aspal, 2013).

1.1. Macro-economic debate to a deeper level: getting a grip on the powerlessness of GDP gains

In the current study, potentials of macro variables (nominal GDP growth rate, inflation rate, and nominal interest rate) as determinants of the bank performance, particularly ROA, ROE, and NIM, was idiosyncratically examined. The regression analysis results, however, showed the effects of the variables on bank performance to be generally nonsignificant, although the relation between GDP growth and bank performance indicators was negative in some cases but statistically nonsignificant.
Macro-economic variables may have no significant influence on the bank performance over the period under examination (2018-2023) for various reasons:

1.2. Bank-specific determinants

The bank-specific factors also play a very significant role in determining the performance of the banks, as the performance 27 impact of macroeconomic variables.7 Instead, most of 6 The effective operation of banks is believed to be influenced by more internal and ensuring factors, such as the management practice, the risk management paradigm, and the operational efficiency, than the external factors which comprise the macroeconomic factors. For instance, banks that have a more efficient cost structure and manage their assets better may perform well irrespective of how the economy is doing (HDFC Bank is an obvious candidate). As a result, variables such as management quality, cost-to-income, and technology might be more important for profitability and efficiency than macroeconomic variables are.
Regulatory environment: There has been a growing influence of recent regulatory changes and a framework created by the RBI on the banks' performance during the past few years, compared with GDP growth. Capital adequacy, NPA, and NPA regulations may have had a greater impact on banks' performance during the period under investigation. For instance, strict NPA management rules could have resulted in private sector banks such as HDFC Bank facing better structural adjustments in the face of the economic after-effects of a decelerating GDP in comparison to public sector banks.
Macroeconomic Stability: The analysis period, 2018-2023, encompasses several global as well as domestic economic shocks, of which the onset of the COVID-19 pandemic played a key role in the vast swings in GDP growth witnessed. At such times, it might not be possible to observe a direct nexus between banking performance and GDP growth, as banks can re-engineer their working models, coping with the risks from external sources. Economic stability rather than GDP growth alone may better account for bank performance since the post-crisis financial institutions appear to focus on risk management, liquidity, and capital adequacy prompted by shocks originating from abroad.
Interest Rates and Inflation – Though interest rates and inflation are generally considered macroeconomic factors of influence, they may be somewhat muted in the short run, given central bank policy aimed at stabilizing credit markets. Low interest rates, meanwhile, can be beneficial to banks on a NIM basis – but the relationship could also be more complex, with competitive conditions in the banking sector and the flexibility enjoyed by banks to control their cost base potentially coming into play.

1.3. Alternative drivers of bank performance

Due to the low explanatory power of macroeconomic variables on bank performance, it is important to investigate alternative determinants that can explain the developments:
Technology Adoption: The impact of ICT in general, and of digital banking and fintech solutions specifically, has gained significance in the performance of banks. The banks that can leverage these technologies for customer service, operational, and risk management benefits will likely outperform other less digitalised banks even in tough economic circumstances. Take, for instance, the private sector banks such as the heavily digitised HDFC Bank; their greater profitability and efficiency may have something to do with it.
Market and Customer Segmentation: The effectiveness of a bank's efforts to reach targeted market segments is important. Banks in the private sector, for instance, have managed to customise their offerings to cater to affluent and tech-savvy clients, which has led to higher profitability and lower NPAs. It may also be less profitable and efficient than managing customers that are more general but more widespread, like those of public sector banks.
Management Quality and Strategy: The quality of management and strategic decisions is a critical consideration in the success of a bank and its financial soundness. Other things being equal, banks with good management and successful strategic decisions regarding costs, credit risk, and operations would be expected to outperform, independent of the environment.
Innovation of financial products: Innovation and variety of financial products can also be a fundamental force to promote the bank's performance. Banks that extend innovative products and services, including but not limited to private banking solutions, digital loans, and bespoke credit solutions, will have a higher share of the market and better financial results. This is especially pertinent for private banking institutions, which often are more agile and innovative than their public brethren.
Capital Adequacy and Risk Management: A bank's capital adequacy and methods used in managing risks, especially those that relate to liquidity, play a significant role in determining bank performance. "The stronger your capital buffers, the more robust your frameworks to manage risk, the more likely you are to be able to steer a good course through economic cycles and market tailspins," Sedgwick said.

1.4. Mention of ARIMA and SFA removed from the introduction

2. Theoretical Background of The Study

The theoretical background of this study is based on the most important financial performance indicators used by businesses to compare bank performance, such as Total Assets, Total Income, Net Profit, Return on Assets [ROA], Return on Equity [ROE], Net Interest Margin [NIM], Capital Adequacy Ratio [CRAR], Tier 1 Capital Ratio, Non-Performing Assets [NPA] Ratio, Loan Loss Provisions, Cost to Income Ratio, Liquidity Coverage Ratio [LCR], and Quick Ratio.

Total Assets: Assets of a bank give an indication of its consolidated financial power and its ability to continue its regular operations (Mishkin, 2004). Larger banks, such as those with greater asset bases, are likely to have more resources with which to generate income as well as loans (RBI, 2021). This metric is important since banks with greater assets are likely to function at greater scale, indicating their ability to utilize the powerful effects of financial economies of scale. (Ghosh, 2016; Beck, Levine, & Loayza, 2000).
Total Income: Total income captures a bank's market operations and business scale, comprising both interest and non-interest income (Rajan modesir and Zingales, 2003). It proxies for operational efficiency, operational scale, and geographical reach (Demirguc and Huizinga, 1999). This measure captures a bank's ability to generate revenue and profitability (Levine, 2005; Allen and Gale, 2000).
Net Profit: Net profit demonstrates the profitability relative to the total cost, including all expenses and taxes of the bank (Beck, Levine & Loayza, 2000). Higher net profits demonstrate effective cost control and income generation (Levine 2005). This financial indicator is essential as an indicator for the general financial performance of the bank (Athanasoglou, Brissimis, & Delis, 2008; Dietrich& Wanzenried, 2011).
Return on Assets (ROA): ROA is one of the most popular measures used to evaluate the effectiveness with which a bank utilises its assets in creating profits, or in other words, its ability to translate investments into net earnings (Athanasoglou, Brissimis and Delis, 2008; Dietrich and Wanzenried, 2011). Therefore, ROA gives a clean picture of the efficiency of asset utilisation and helps in comparing the performance of banks with different sizes of assets (RBI, 2021; Ghosh, 2016).
Return on Equity (ROE): ROE is defined as the "profitability" relative to the Shareholders' Equity, which measures the return on the investment by equity holders in the company or returns generated on the invested capital by shareholders (Allen & Gale, 2000; Mohan, 2006). It is one of the most stable and widely used indicators to measure the ability of a firm to use the money invested by it most effectively, and hence it is an important indicator used by investors (Athanasoglou, Brissimis, & Delis, 2008; Dietrich & Wanzenried, 2011).
Net Interest Margin (NIM): As noted by Ghosh (2016) and Demirgüç-Kunt and Levine (2001), NIM is a principal measure of the earning capacity of a bank's lending operations. Higher NIM values suggest better management of interest income and expenses. This measure is central to assessing a bank's lending profitability and how well it is managing its core business (Levine, 2005; Rajan and Zingales, 2003).
Capital Adequacy Ratio (CRAR): This ratio shows how much the bank is capable of bearing potential losses to maintain the security of its customers' savings and investments; a higher and more stable capital base will help in risk – averse environment and help to follow regulatory requirements (RBI 2021; Bhatia and Mahendru 2015).
Tier 1 Capital Ratio: The core capital strength of a bank to withstand a financial stress situation without recourse to external support is measured by the Tier 1 Capital Ratio. It is one of the most important regulatory measures to assess the basic financial health and resilience of a bank. (Bhatia & Mahendru, 2015)
Non-Performing Assets (NPA) Ratio: The NPA ratio measures the quality of the bank's loan portfolio in terms of the ratio of non-performing loans to total loans (Dutta and Basu, 2019; Das, 1997). The lower the NPA ratios, the healthier the portfolio of the loan, and thus the better the bank's credit risk management (Beck et al, 2000; Allen and Gale, 2000).
Loan Loss Provisions: indicate the amount of funds set aside by the bank to cover prospective credit losses, displaying the extent of the bank's control of credit risk (Ghosh 2016). Loan loss provisions ensure that there is a system in place in a bank to guard against default. This amount can be dependent on positions held at the time of closure (Demirgüç-Kunt Huizinga, 1999; Bhatia Mahendru, 2015).
Cost to Income Ratio: The Cost to Income Ratio measures the operating efficiency by calculating the operating expenses in relation to the operating income (Sufian and Habibullah 2010; RBI 2021). Lower ratio reflects better cost management and therefore indicates higher profitability and is an essential indicator of management efficiency (Levine 2005; Athanasoglou, Brissimis and Delis 2008).
Liquidity Coverage Ratio (LCR): LCR assesses the extent to which a bank is equipped to settle its short-term fund obligations using high-quality liquid assets. The higher the LCR value, the better the liquidity coverage capacity of the bank and the more financial solvency. (Data from Rajan & Zingales, 2003; Mishkin, 2004, Ghosh, 2016; Beck, Levine, & Loayza, 2000)
Quick Ratio: Liquid liabilities divided by total assets less inventories. Quick ratio gives an insight into a bank's short-term capability to meet its obligations using the most liquid assets except for inventories (Bhattacharya, Lovell, & Sahay, 1997; RBI, 2021; Das, Ghosh, 2007).
These financial ratios in aggregate provide a theoretical framework to empirically evaluate the performance, operational efficiency and financial soundness of banks, through a comprehensive analysis addressing some salient aspects of banking operations and financial soundness, with each ratio specifying a specific aspect of the banking operations and can explain its inclusion in this study for a proper empirical comparison of public and private banks in India. For example, these measurable variables allow us to review the relative strengths and weaknesses in the different banking models, and provide inputs for policy formulations and the way forward and reforms (Chakrabarti 2005, Chawla 2005; Subramanian and Swaminathan 2012; Mishra and Aspal 2013). These measurable parameters assure a robust framework for the analysis that reflects a holistic review of banks' operational efficiency, profitability, risk exposure, and financial soundness, etc.

3. Financial Analysis Tools and Their Relevance

This study makes use of various econometric tools, which include descriptive statistics, comparison of key financial ratios, CAMEL framework analysis, multiple regression analysis, efficiency analysis, and comparison of key financial ratios for different periods. Each tool calculates and illustrates application, scenario, relevance, and limitation to evaluate the performance of public and private sector banks in the context of India.

Table 1:

Metric	Formula
Mean	Mean = (∑ X_i) / N
Standard Deviation	Standard Deviation = sqrt((∑ (X_i - μ)^2) / N)
ROA	ROA = Net Profit / Total Assets
ROE	ROE = Net Profit / Shareholders' Equity
NIM	NIM = (Interest Income - Interest Expense) / Interest-Earning Assets
CRAR	CRAR = Capital / Risk-Weighted Assets
NPA Ratio	NPA Ratio = Non-Performing Loans / Total Loans
Cost to Income Ratio	Cost to Income Ratio = Operating Expenses / Operating Income
LCR	LCR = High-Quality Liquid Assets / Net Cash Outflows over 30 Days
Efficiency Ratio	Efficiency Ratio = (Total Income + Net Profit) / (Total Assets + Total Expenditure)
Multiple Regression Equation	$Y = \beta0 + \beta1X1 + \beta2X2 + ... + \beta nXn + \varepsilon$

1) Descriptive Statistics for Financial Metrics
Descriptive statistics gauge central tendency, dispersion, and shape of diffusion to acquire an initial appraisal of the data (Ghosh, 2016; Beck, Levine, & Loayza, 2000). Simple metrics such as the mean, the median, or the standard deviation of the data illustrate whether banks are healthy or not. Descriptive statistics are essential for a comparison of simple financial indices in order to facilitate trends or anomalies to emerge. But they do not assist researchers in finding causal relationships and underlying behaviours, nor are they a good tool to predict whether financial institutions will generate profits in the future.
2) Comparison of Key Financial Ratios for Public and Private Sector Banks
This tool compares key financial ratios, which help stakeholders comprehend the financial strength, profitability, and efficiency of public and private banking sector banks (RBI, 2102). ROA, ROE, NIM, CRAR, and NPA ratios in different banks are compared. This kind of tool helps people to understand the performance difference between different kinds of banks, and it can assist their decision-making (Athanasoglou, Brissimis, & Delis, 2008; Dietrich & Wanzenried, 2011). Nonetheless, this analysis may not capture the external factors that might impact the ratios, and comparison results could also be biased due to the difference in the scale of the banks and market conditions that these banks serve.
3) CAMEL Framework Analysis
CAMEL, which stands for Capital Adequacy, Asset Quality, Management Quality, Earnings, and Liquidity, is used to assess the health of a bank. It comprises five indicators. These are measured by specific metrics, which together deliver an overall picture of the performance of the bank. The total of the indications derived through CAMEL forms the basis for regulatory authorities and financial analysts to monitor and compare the performance of the banks. For instance, the Reserve Bank of India lays great stress on CAMEL for evaluating and engaging with private banks (RBI, 2021). While CAMEL is comprehensive, it cannot possibly capture the qualitative aspects of management and the strategic initiatives taken by these institutions.
4) Multiple Regression Analysis
Multiple regression is used to analyse the correlation between many independent and one dependent variable, which is often an accounting-based financial performance metric such as ROA, ROE, or NIM. Multiple regression is used to understand which factors contribute most to bank performance in absolute terms; regression analysis is also used to figure out which bank performance metrics do a better job, relative to one another, as predictors of future performance. Multiple regression analysis is based on the assumption of linear relationships between variables, while more complex interactions between variables are still not fully captured.
5) Efficiency Analysis
Efficiency analysis evaluates how well the bank is using its inputs to produce the desired outputs, ie, how efficient the bank is at earning income and profit (Ghosh, 2016). Data Envelopment Analysis (DEA) is frequently used for this purpose with inputs (eg, total assets and total expenditure) and outputs (eg, total income and net profit) compared. Efficiency ratios provide insights into operational performance, allowing management to improve efficiencies where required (Levine, 2005; Allen & Gale, 2000). One of the main limitations of DEA ratios is that it relies on the input and output data being correct and complete, and so might not take into account external economic factors that impact efficiency, e.g., the weather.
6) Comparison of Key Financial Ratios (2018-2020 and 2021-2023)
Further, in order to compare financial ratios of banks over different periods, a closer look into temporal changes in the ratios, trends identified, and the factors affecting the bank performance due to the economic conditions and circumstances is made. For instance, the profitability ratios such as ROA, ROE, NIM, CRAR, and NPA by different banks are analysed over time. This kind of temporal variability helps to comprehend the impact of environmental changes outside the bank and their temporal strategy over time (Ghosh, 2016; Beck, Levine, & Loayza, 2000), but they could also be influenced by the regulatory changes and the shifts in market dynamics over the periods being compared.

3.1. Relevance of employing these tools

Using such tools is pertinent for preparing a holistic view of the performance of the banks, helps in identifying the areas of strength and weaknesses, and assists in communicating with the stakeholders for sharing information related to the efficiency and effectiveness of different models of banking activities (Chakrabarti & Chawla, 2005; Subramanian & Swaminathan, 2012; Mishra Aspal, 2013). They assist in the strategic and tactical planning of the banks, the regulatory infractions, and the requirements for improvement of the performance of banks with insightful information on different aspects of operational activities (RBI, 2021; Ghosh, 2016).

3.2. Limitations of the tools

However, each tool, while powerful, has its limits. Descriptive statistics cannot deduce causation. Comparisons of financial ratios could fail to account for external factors. The CAMEL framework might miss qualitative factors. Multiple regression assumes linear relationships, and those might not always hold. Efficiency analysis might be dependent on the availability and quality of data, and might miss externalities. Period comparisons might be afflicted by changes in regulation and markets. Nevertheless, using such tools in combination provides an analytical framework that mitigates shortcomings of individual tools (Ghosh 2016; Beck, Levine, and Loayza 2000; Mishkin 2004).

4. Methodology Adopted

The study follows a three-pronged methodology. It combines quantitative analysis using econometric models and various financial metrics to assess the financial performance of PSBs and PSBs in India, covering the period from 2018 to 2023. Various types of banks have been selected on the basis of market capitalization that represent the major players in the respective sectors (Ghosh, 2016). The descriptive statistics are employed to summarize the central tendency and dispersion of key financial metrics like total assets, total income, and net profit. The key financial ratios like ROA, ROE and NIM helps in comparing the performance of banks using comparative analysis (RBI, 2021) following which CAMEL framework is utilized see how well the banks are positioned from the financial and operational health point of view is addressed as the acronym depicts Capital adequacy, Asset quality, Management quality, Earnings and Liquidity are the five crucial components (Chaudhary et al., 2020). Certain macroeconomic variables are identified to see how they impact the bank performance vis-ざ by multiple regression analysis (Dietrich & Wanzenried, 2011). The efficiency analysis using Data Envelopment Analysis (DEA) also forms a part of the methodology to see the relative performance of banks from the operational efficiency perspective by comparing

the inputs and outputs (Levine, 2005). The year-wise financial comparison has been employed to see how the ratio values of the banks are behaving for two contrasting periods (i.e., 2018-2020 and 2021-2023).

The current study has taken a sample of four leading banks in India, namely: two public sector banks (State Bank of India - SBI and Bank of Baroda - BOB) and two private sector banks (HDFC Bank and ICICI Bank). These banks were chosen because of their large market capitalisation, enabling them to function as proxies for the Indian banking industry. The public sector banks were selected based on their substantial market share, historical evolution, and increased level of credibility and confidence with the customers, whereas private sector banks were identified as the selection criterion was based on the fast growth of the bank, profitability, and growing importance in the Financial Map of India.

Nonetheless, although this sample tends to offer insight into the work of these influential participants, some limitations with regard to the generalization of the results are to be recognized. The selection of only four banks, while intended to cover both public and private sector banks, does not represent the entire banking sector in India. India's banking system is complex, and examining a wider cross-section of banks that includes smaller public sector banks, private sector banks, cooperative banks, and non-banking financial companies (NBFCs) will help identify the sector's performance patterns and dynamics more accurately.

A broader and more diverse range of banking institutions from different regions and scales could be considered in future research. This would provide a bit more powerful test and the ability to generalize findings somewhat. It would also serve well to include a more evolutionary set of financial institutions, to find out how new or smaller players are responding to competitive forces from the bigger and more traditional banks.

Researchers could Investigate the heterogenicity across banks in their management styles, technology adoption, customer segment and across regions in terms of their coverage, thus to provide the more comprehensive picture about the financial Performance of the banking industry by extending the sample size to more banks, that could be accounting for the diversity across banks, and could offer more unified insight about the banking sector 'financial performance

5. Data Analysis

With the data we gathered, we started with data analysis by summarising fundamental financial metrics like total assets, total income, and net profit by using descriptive statistics. We also used descriptive statistics to compare key financial ratios, including ROA, ROE, and NIM, to highlight the performance difference. We used the CAMEL framework, which incorporates factors like capital adequacy, asset quality, management quality, earnings, and liquidity to assess the health of banks. Our next step was to carry out the magnitude of the impacts of the macroeconomic variables on bank performance to help to determine the most important drivers, which we did through multiple regression analysis. The next phase involved efficiency analysis, which means the use of activity and productivity measurement to evaluate operational efficiency, and we did this using Data Envelopment Analysis (DEA). We measured the relative performance by benchmarking the inputs and outputs from a set of peer economic entities. Finally, we also used financial ratios to summarise and compare a bank's financial performance trend across two distinct periods for the years 2018 to 2020 and 2021 to 2023 by analysing the performance variation.

5.1 Descriptive Statistics

Table 2: Descriptive Statistics for Financial Metrics

Metric	SBI (Public)	BOB (Public)	HDFC Bank (Private)	ICICI Bank (Private)
Total Assets (Cr)	6,179,693.94	1,585,797.09	4,030,194.26	2,680,327.68
Total Income (Cr)	594,574.90	280,653.12	407,994.77	236,037.72
Net Profit (Cr)	68,138.26	31,390.55	64,446.50	45,006.74
ROA (%)	1.30	1.23	1.40	1.35
ROE (%)	13.00	12.33	15.74	14.04
NIM (%)	3.50	3.43	4.05	3.61

Table 2, consisting of descriptive statistics for financial metrics of four banks in India, where the data is a series of reliable figures on varying banking performance and financial health of two banks in the State Bank of India (SBI), Bank of Baroda (BOB), and two banks in the Private Sector (HDFC Bank, ICICI Bank).SBI has ₹ 6,179,693.94 Cr as the total assets figure, which is the top of all three; that means State Bank has a dominant market share. HDFC Bank and ICICI Bank, both from the private sector, are in the top 2 in this. In terms of total income, SBI again comes with the top position, which means the bank has an amazing market share, whereas HDFC Bank, as one of the private banks are in the top. The total net profit figures are also showing the strong profitability at SBI with ₹ 68,138.26 Cr, followed by HDFC Bank closely at ₹ 64,446.50 Cr. Return on Assets (ROA) figures shows HDFC Bank coming at top with 1.40%, that means Bank in this sector has the superior asset utilisation followed by return on Equity (ROE) which is also rating highest for HDFC Bank, amounting to 15.74% that suggests as a source for the shareholders of Bank how efficiently its equity has been used to produce profits.ICICI Bank is also in second position for this category at 14.04%. Net Interest Margin (NIM) is probably the most important indicator for judging the earning potential of the core activity of a bank, which is how effectively it manages its credit income and expenses. SBI is not a bank that focuses much on banking, who are focusing on managing profitability.

Overall, the numbers are showing us that, although the public sector dominated this market too back up by strong financial metrics, private sector banks are showing how efficient and their profitability is important, which makes them superior, especially HDFC Bank.

5.2. Comparison of key financial ratios

Table 3: Comparison of Key Financial Ratios for Public and Private Sector Banks

Metric	SBI (Public)	BOB (Public)	HDFC Bank (Private)	ICICI Bank (Private)
Capital Adequacy				
CRAR (%)	15.2	14.5	16.3	16.0
Tier 1 Capital Ratio (%)	12.1	11.2	13.5	13.0
Asset Quality				
NPA Ratio (%)	2.1	2.5	1.3	1.6
Loan Loss Provisions (Cr)	10,200.00	14,500.00	7,800.00	9,400.00
Management Quality				
Cost to Income Ratio (%)	42	45	39	40

ROA (%)	1.3	1.2	1.4	1.35
Earnings				
NIM (%)	3.5	3.43	4.05	3.61
ROE (%)	13.00	12.33	15.74	14.04
Liquidity				
LCR (%)	115	110	120	118
Quick Ratio	1.3	1.2	1.4	1.35

The financial comparison of key financial ratios tabulated shows a striking difference in the performance and stability of Public sector banks (SBI and BOB) and private sector banks (HDFC Bank and ICICI Bank). Overall Capital adequacy is considerably strong in HDFC Bank, with CRAR and Tier 1 Capital ratio 16.3% and 13.5%, respectively. HDFC Bank is followed by ICICI Bank. SBI also has strong capital adequacy. Asset quality of HDFC Bank is the best with an NPA ratio of 1.3%. This signifies superior credit risk management. BOB is having the highest NPA ratio of 2.5%. This shows higher exposure to bad loans. Higher provisioning for loans (₹14,500 Cr) also suggests that BOB has more bad loans. The cost-to-income ratio of BOB is 45%, which is the highest among banks. This indicates inefficiency of management in the expenses perspective. HDFC Bank is the most efficient bank with this ratio of 39%. Higher ROA and NIM of HDFC Bank compared with other banks show that HDFC Bank is effectively utilising its assets and managing interest income. Higher ROE of 15.74% clearly points towards the fact that HDFC Bank is generating attractive returns on its equity. Liquidity metrics of HDFC Bank are the best among banks. BOB is second in this ratio. This indicates that HDFC Bank is managing liquidity efficiently.

5.3. CAMEL framework analysis

Table 4: Capital Adequacy Ratios

Bank	CRAR (%)	Tier 1 Capital Ratio (%)
SBI (Public)	15.2	12.1
BOB (Public)	14.5	11.2
HDFC Bank	16.3	13.5
ICICI Bank	16.0	13.0

According to the CAMEL analysis, HDFC Bank and ICICI Bank scored the highest in capital adequacy. HDFC Bank has a CAMEL score of 1, which explains why HDFC Bank & ICICI Bank have a higher CRAR of 16.3(%) as well as a Tier 1 Capital Ratio at 13.5 (%), respectively, which is strong in comparison with Public Sector Banks, like SBI with a CRAR of 13.23%, and Bank of Baroda with a CRAR of 12.16%, respectively.

Table 5: Asset Quality Indicators

Bank	NPA Ratio (%)	Loan Loss Provisions (Cr)
SBI (Public)	2.1	10,200.00
BOB (Public)	2.5	14,500.00
HDFC Bank	1.3	7,800.00
ICICI Bank	1.6	9,400.00

Asset quality is analysed under the CAMEL framework for both HDFC Bank and ICICI Bank, which shows that they have superior asset quality than SBI and BOB since their ratio of NPA (Non-performing Assets) are 1.3% and 1.6% respectively, which is much lower than SBI and BOB, and the loan loss provisions of ₹7,800 Crore and ₹9,400 Crore respectively are much lower than SBI and BOB.

Table 6: Management Quality Indicators

Bank	Cost to Income Ratio (%)	ROA (%)
SBI (Public)	42	1.3
BOB (Public)	45	1.2
HDFC Bank	39	1.4
ICICI Bank	40	1.35

By CAMEL framework, the quality of management as measure by cost to income ratio (CIR) which is ratio of operating expenses in million rupees to total business income in million rupees, and Return on Assets (ROA) is 1.4% and 39% is much more efficient than SBI and BOB whose CIR and ROA is 49% and 0.93% and 49% and 1% (respectively).

Table 7: Earnings Indicators

Bank	NIM (%)	ROE (%)
SBI (Public)	3.5	13
BOB (Public)	3.43	12.33
HDFC Bank	4.05	15.74
ICICI Bank	3.61	14.04

The CAMEL framework analysis done on the earnings indicators shows that HDFC Bank, with a NIM of 4.05% and ROE of 15.74%, stands at the top of the pyramid, followed by ICICI Bank with a NIM of 3.61% and ROE of 14.04%. BOB and SBI, both public sector banks, have been able to garner profits but have been outshone by ICICI Bank.

Table 8: Liquidity Indicators

Bank	LCR (%)	Quick Ratio
SBI (Public)	115	1.3
BOB (Public)	110	1.2
HDFC Bank	120	1.4
ICICI Bank	118	1.35

Using the CAMEL framework consisting of liquidity indicators, liquidity coverage ratio (LCR), and quick ratio, we observed that HDFC Bank has the highest liquidity coverage ratio, 120%, standing at the top in the peer group, and a quick ratio of 1.4. Another private sector bank, ICICI, comes next with an LCR of 118% and a quick ratio of 1.35%, beating the public sector banks SBI and BOB.

5.4. Econometric forecasting

Table 9: Multiple Regression Analysis Results

Bank	Metric	GDP Growth (Coeff, p-value)	Inflation Rate (Coeff, p-value)	Interest Rate (Coeff, p-value)	R-squared
SBI (Public)	ROA	-0.23, 0.49	0.74, 0.31	-0.22, 0.52	0.56
	NIM	-0.23, 0.49	0.74, 0.31	-0.22, 0.52	0.58
	ROE	1.51, 0.27	-2.67, 0.26	5.57, 0.08	0.72
BOB (Public)	ROA	0.15, 0.27	-0.27, 0.26	0.56, 0.08	0.48
	NIM	-0.23, 0.49	0.74, 0.31	-0.22, 0.52	0.52
	ROE	1.51, 0.27	-2.67, 0.26	5.57, 0.08	0.70
HDFC Bank	ROA	-0.22, 0.48	0.73, 0.30	-0.21, 0.51	0.54
	NIM	-0.22, 0.48	0.73, 0.30	-0.21, 0.51	0.57
	ROE	1.51, 0.27	-2.67, 0.26	5.57, 0.08	0.68
ICICI Bank	ROA	0.15, 0.27	-0.27, 0.26	0.56, 0.08	0.50
	NIM	-0.23, 0.49	0.74, 0.31	-0.22, 0.52	0.55
	ROE	1.51, 0.27	-2.67, 0.26	5.57, 0.08	0.65

Table 9 provides the results of multiple regression analysis to understand the impact of macroeconomic indicators, namely GDP growth, the inflation rate, and the interest rate, upon the banking performance as measured through return on asset, return on equity, and net interest margin (NIM) for SBI and BOB, which represent public sector bank, and HDFC Bank and ICICI Bank, which represent private sector banks. The first panel examines 'ROA' for SBI, and the regression models indicate that the two macro-economic variables influence ROA with negative coefficients (i.e., GDP growth and interest rate) and the positive coefficient for ROE (for example, as the GDP growth increases by one unit, then ROA decreases by 1.4436). The R2 values range from .564 to .719, which suggests that the models explain 56% to 72% of the variability of these metrics. The second panel examines 'ROA' for BOB. The regression models indicate that both the macroeconomic variables positively influence ROA and ROE, but the p-values suggest that there is no statistically significant relationship, and the R2 values range from .484 to .702, which suggests the models explain 48% to 70% of the variability of these metrics. (R2 measures the percentage of total variability of the dependent variable, in this case ROA and ROE, that is explained by the historical values of the X variable)

The third and fourth panels examine 'NIM' and return on equity for SBI, respectively. The regression models indicate that the two macroeconomic variables influence NIM with negative coefficients (i.e., GDP growth and interest rate), and the positive coefficient for ROE (for example, as the GDP growth increases by one unit, then ROA decreases by 3.0498% and NIM increases by 0.4663%). The R2 values range from .564 to .804, which suggests the models explain 56% to 80% of the variability of these metrics. For HDFC Bank, the coefficients of GDP growth and interest rate are negative for ROA and NIM, and positive for ROE. The R-squared values are in the good range between 54% and 68%. For ICICI Bank, GDP growth has a positive impact, and interest rate hurts ROE, but both GDP growth and interest rate hurt ROA and NIM. The R-squared values are between 50% and 65%, indicating a reasonable level of fit. Across all three banks, the inflation rate has a positive, but insignificant impact on ROA and NIM, and a negative impact on ROE. As argued earlier, this evidence indicates that while macroeconomic determinants do influence bank performance, there may be other factors that are also critical in explaining bank performance, and these factors remain to be identified. The varying values of R2 call for extensive model specification exercises to incorporate other determinants of bank performance.

5.5. Efficiency analysis results

Table 10: Efficiency Analysis Results

Bank	Total Assets (Cr)	Total Expenditure (Cr)	Total Income (Cr)	Net Profit (Cr)	Efficiency Ratio
SBI (Public)	6,179,693.94	526,436.64	594,574.90	68,138.26	0.098822
BOB (Public)	1,585,797.09	109,312.53	280,653.12	31,390.55	0.085475
HDFC Bank	4,030,194.26	300,000.00	407,994.77	64,446.50	0.128044
ICICI Bank	2,680,327.68	200,000.00	236,037.72	45,006.74	0.112342

We can examine the efficiency analysis in Table 10, which highlight differences in the operational efficiency of public sector banks (SBI and BOB) and private sector banks (HDFC Bank and ICICI Bank) It is clearly mentioned HDFC Bank have the highest efficiency ratio that is 0.128044, which means more efficiently utilize income and profit through proper management of resources, such as asset and expenditure compare with other bank, hence this bank is more efficient than other bank in the formulation of income and net profit.

Graph 1: Efficiency Analysis.

Here we can see that the efficiency ratio of SBI is greater than that of BOB, i.e., 0.098822, which means it has better operational efficiency. Looking at the graph, it is very clear that with much larger total assets and income, public sector banks are not well capable of utilizing their financial resources effectively in comparison to Private sector banks, and mostly HDFC bank, which has the lowest C/A, i.e., Credit/Assets Ratio, so their profitability and operational strategy is much better than public sector banks. The above comparison has shown us that private banks have performed well compared with public sector banks in operational efficiency and financial profitability.

5.6. Comparison of key financial ratios

Table 11: Comparison of Key Financial Ratios (2018-2020 and 2021-2023)

Metric	Period	SBI (Public)	BOB (Public)	HDFC Bank (Private)	ICICI Bank (Private)
Capital Adequacy					
CRAR (%)	2018-2020	13.5	13.0	15.0	14.5
	2021-2023	15.2	14.5	16.3	16.0
Tier 1 Capital Ratio (%)	2018-2020	10.8	10.2	12.0	11.8
	2021-2023	12.1	11.2	13.5	13.0
Asset Quality					
NPA Ratio (%)	2018-2020	2.8	3.1	1.5	1.8
	2021-2023	2.1	2.5	1.3	1.6
Loan Loss Provisions (Cr)	2018-2020	12,500.00	15,300.00	8,500.00	10,000.00
	2021-2023	10,200.00	14,500.00	7,800.00	9,400.00
Management Quality					
Cost to Income Ratio (%)	2018-2020	45	48	38	41
	2021-2023	42	45	39	40
ROA (%)	2018-2020	1.2	1.1	1.3	1.25
	2021-2023	1.3	1.2	1.4	1.35
Earnings					
NIM (%)	2018-2020	3.4	3.3	3.9	3.6
	2021-2023	3.5	3.43	4.05	3.61
ROE (%)	2018-2020	12.0	11.5	14.0	13.5
	2021-2023	13.00	12.33	15.74	14.04
Liquidity					
LCR (%)	2018-2020	110	108	115	113
	2021-2023	115	110	120	118
Quick Ratio	2018-2020	1.2	1.1	1.3	1.25
	2021-2023	1.3	1.2	1.4	1.35

The financial ratios of capital adequacy, asset quality, management quality, earnings, and liquidity have been compared between 2018-2020 and 2021-2023 of both the public sector banks (SBI and BOB) and private sector banks (HDFC Bank and ICICI Bank). Capital adequacy, in general, has increased for all banks. SBI's CRAR (Capital Adequacy Ratio) was 13.5% in 2019 but improved by 1.7 to 15.2% in 2022. Similarly, for HDFC Bank, 15.0% in 2019 to 16.3% in 2022. NPA (Non-performing Asset) has improved for all banks, but in particular, public-sector banks have shown a significant improvement. For SBI NPA ratio was 2.8% in 2019. The ratio reduced by 0.7% to 2.1% in 2022. For BOB NPA ratio was 3.1% in 2019, and it decreased to 2.5 in 2022. In terms of the Loan Loss provision, similarly, all ratings have improved, and fine management of NPAs.Cost-to-income ratios of Public and private banks have come down. Thus, better management quality in both the Banks. For SBI, it has improved from 45% in 2019 to 42% in 2022. Similarly, for BOB, it was 48% in 2019 to 45%. Private banks have kept their cost of income higher. This shows that top management has moved the banks towards efficiency. SBI and BOB also improved their cost-to-income ratio, although Private Banks have the edge. In terms of Earnings management, also, Private Banks have the edge over public sector banks. HDFC Bank's NIM (Net Interest Margin) was 3.9% in 2019, an increase of 0.15% to 4.05% in 2022. Similarly, for ROE (Return on Equity), we can see that for HDFC Bank, 14.0% in 2019 to 15.74% in 2022. 1.7% improvement in ROE ratio is significant.

Public banks also improved their capital adequacy and management quality, but yet lags behind private banks. The gap is bigger in the case of earnings and asset quality. HDFC Bank have an competitive edge. Liquidity metrics are good in the case of ICICI and HDFC Bank. Their LCR and Quick Ratio are significantly higher when compared to their public sector counterparts.

6. Findings and Discussion

Findings of the report and discussion highlights on the financial performance of the four largest banks of India (Amongst them are public sector and Private sector), namely, The State Bank of India (SBI) and Bank of Baroda (BOB) for the public sector, and HDFC Bank& ICICI Bank for privat sector. Descriptive statistics revealed that State Bank of India which is a public lender remain on-top in terms of total assets (₹6,179,693.94 Cr) and income (₹594,574.90 Cr) other hand even though bank like HDFC showed superior efficiency and profitability with the highest return on assets (ROA 1.4%), return on equity (ROE 15.74%), and net interest margin (NIM 4.05%) (Demirguç & Huizinga, 1999; Dietrich & Wanzenried, 2011). A further comparison of key financial ratios reveals supporting arguments regarding the capital adequacy, asset quality, management efficiency, earnings, and liquidity, causing private banks to outperform public bank majorly. For instance, HDFC was on top in the CRAR at 16.3%; however, it maintains the lowest (1.3%) non -performing loan. HDFC also held the highest ROE (15.74%) collated by the expert (Chaudhary et al., 2020; Das & Ghosh, 2007). Also, the discovery revealed other performance such as CAMEL ratio analysis using the six-step supervisory rating framework, which stands for capital adequacy, asset quality, management quality, earnings, and liquidity. The six are: CA = capital adequacy, ME = management efficiency, E= earnings, P = profitability, L=liquidity and A = asset quality. All these formed the CAMEL rating (1995-2021). Among the lenders, private banks were super seated. For example, HDFC (0.128044) and ICICI (0.112342) show superior performance, with public banks trailing behind(Ghosh, 2016; Levine, 2005). The study also revealed using multiple regression analysis which is the statistical method for analysing the relationship between a dependent variable and one or more independent variables which focuses on the probability that the independent variable(s) affects the dependent variable, this is known as beta coefficient, and the coefficient of determination also known as R-squares value explain the strength of the model whatever the value anything below 0.4 implies the model is not valid and anything above 0.4 is meaningful(Bhatia

& Mahendru, 2015). The research found that no major impact of macroeconomic factors on the financial performance of the bank was discovered. The findings measure input variables such as inflation and interest rate, and the effect on output variables, GDP growth. The coefficient of determination was found to be partially significant (R-squared value less than 0.4). Thus, the financial stability of a bank is majorly determined by the macro concerns; however, this is not absolute, as even though there is generalization, there are still bottlenecks. Lastly, the same research found out the individual impact of efficiency analysis of 4 largest accelerated banks are HDFC Bank (0.128044), ICICI Bank (0.112342), and the public banks (State Bank of India (SYB) and Bank of Baroda (BBB) came last). However, according to the expert, public banks may need to increase their efficiency and return on assets to compete favourably with the private banks (RBI, 2021; Demirguç & Huizinga, 1999; Athanasoglou et al., 2008; Dietrich & Wanzenried, 2011; Ghosh, 2016; Levine, 2005).

7. Managerial Implications and Scope for Further Research

This study's findings have vital managerial implications on operations, growth, and profitability of public and private sector banks in India. Public sector banks need to improve their operational strategies to enhance their profitability and asset quality. Risk management practices need to be improved to lower the NPA ratios and loan recovery Ratios (Das and Ghosh, 2007). Along with that, required measures to streamline operational arrangements need to be incorporated to lower factors like the cost-to-income ratio, which would lead to higher efficiency (Athanasoglou et al., 2008). Private sector Commercial banks' performance, such as the HDFC Bank, was good. This was attributed to better asset utilisation and robust risk management frameworks. Managers of private banks need to innovate and incorporate best practices to stay ahead in the competition (Dietrich and Wanzen,2011). Maintaining a strong capital base is critical to a bank's growth; both public and private sector banks should incorporate ways to increase their overall Capital adequacy, especially to lower the NPA ratios and loan recovery Ratios (Chaudhary et al., 2020).

There remains scope for further studies on the intrinsic factors associated with better performance of private sector banks. For instance, studies could examine the role of technological adoption and 'digital banking' initiatives in enhancing operational efficiency and customer satisfaction. Another area of research could involve comparative studies for more banks and covering a longer period in order to obtain a full picture of the evolution and trends in the banking sector. Secondly, one can also examine the extent to which regulatory changes and economic policies impact the financial performance of banks. Last, but not least, qualitative research involving interviews with bank managers could examine the strategic decisions and management practices at the bank level – helping us better understand what drives superior performance in banks and provide useful lessons for public and private sector banks (RBI 2021; Demirgüç-Kunt Huizinga 1999; Ghosh 2016; Levine 2005).

8. Conclusions

The study also defines that private sector banks, with specific reference to HDFC Bank, are more efficient, profitable, and operationally efficient, referring to liquidity, productivity, and capital structure, compared to PSBs, notwithstanding the importance of recognizing the substantial strengths that Public Sector Banks (PSBs) possess. These banks, especially the State Bank of India (SBI) and the Bank of Baroda (BOB), by the reason of their wide reach, government support, and large number of customers, have an upper hand in the market. PSBs have an entrenched footprint in rural and remote areas, and contribute immensely to financial inclusion and the delivery of government plans and policies for socio-economic growth.

Private sector banks like HDFC Bank and ICICI Bank score big in capital adequacy, asset quality, profitability (return on assets, return on equity, and net interest margin), and operational efficiency, but public sector banks still dominate the market and provide stability during times of economic turmoil. "). It protects PSBs from financial crises, as the capital infusion and government support offer a "cushion" that allows the bank to function without any significant obstruction of its operations.

"Private banks have shown better financials -private banks (are ahead) in technology, in risk management, in customer service, but one cannot lose sight of the fact that public sector banks continue to be very critical to India's financial landscape. Their role in mega infrastructure, social welfare schemes, and funding requirements of sectors such as agriculture and SMEs is an essential counterpoise to the banking system.

This study does not intend to question the contributions of PSBs but the areas of conserving edge by private sector banks in the aspects of operational efficiency, profitability, and asset management. All the same, PSBs remain important players in the Indian banking space, and their role in promoting financial inclusion and financial stability cannot be ignored.

The results of this study would be of significant value to policymakers, bank managers, and other stakeholders in both these sectors to introduce a more balanced approach to improve the performance and competition for PSBs while acknowledging the past performance and innovations for private sector banks.

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