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A Comparative Analysis of Financial Performance and Profitability of Public and Private Sector Banks in Tamilnadu

R. Perumal; Dr. B. Indumathi
Assistant Professor, SIES (Nerul) College of Arts, Science & Commerce SIES (Nerul) ASCN Nerul, Navi Mumbai Nerul, Navi Mumbai

Dr. V. Padmanabhan
Assistant Professor & Research Advisor, PG & Research Department of Commerce, Government Arts College (Autonomous), Karur 639 005, Tamil Nadu

Abstract

This study presents a comparative empirical assessment of financial performance, profitability, operational efficiency, and asset quality among selected Public Sector Banks (PSBs) and Private Sector Banks (PVBs) operating in Tamil Nadu over an eleven-year period, from FY 2014–15 to FY 2024–25, comprising 132 bank-year observations. Guided by the CAMEL framework, the study examines key financial performance indicators, including Return on Assets (ROA), Net Interest Margin (NIM), Gross Non-Performing Assets (GNPA), Cost-to-Income Ratio (CIR), and Credit-to-Deposit Ratio (CDR). The results of independent-samples t-tests indicate that Private Sector Banks record significantly higher mean ROA (1.43% versus 0.91%, $p < 0.001$) and NIM (3.23% versus 2.44%, $p < 0.001$), suggesting stronger asset-based profitability and net interest income performance. In contrast, Public Sector Banks exhibit a significantly lower regional CDR (74.45% versus 82.78%, $p < 0.001$) and a higher CIR (51.98% versus 43.68%, $p < 0.001$), indicating differences in regional credit deployment and operating cost structures between the two ownership groups. Furthermore, pooled regression analysis identifies GNPA as a statistically significant negative predictor of bank profitability ($\beta = -0.1525$, $p < 0.001$), highlighting the importance of asset quality and credit risk management in explaining variations in bank profitability. Overall, the findings reveal significant ownership-related differences in banking performance and underscore the importance of strengthening credit appraisal mechanisms, improving operational efficiency, enhancing asset quality, and sustaining regional credit delivery in Tamil Nadu's banking sector.

Keywords: *Banking Performance; CAMEL Framework; Public Sector Banks; Private Sector Banks; Bank Profitability; Gross Non-Performing Assets; Net Interest Margin; Operational Efficiency; Financial Inclusion; Tamil Nadu.*

I. INTRODUCTION

The financial sector plays a fundamental role in economic development by facilitating the allocation of financial resources, mobilising domestic savings, and supporting productive investment. Commercial banks are central to this process, serving as financial intermediaries that channel funds from savers to households, businesses, and other productive sectors of the economy (Allen & Santomero, 1997; Diamond, 1984). In India, the banking sector has undergone substantial structural transformation since the economic liberalisation reforms of 1991. These reforms contributed to the development of a more competitive banking environment characterised by the coexistence of Public Sector Banks (PSBs) and Private Sector Banks (PVBs) (Bhattacharyya et al., 1997). Although both categories operate under the regulatory supervision of the Reserve Bank of India (RBI), differences in ownership structures, governance arrangements, operational strategies, and risk-management practices may influence their financial performance, profitability, operational efficiency, and asset quality (Athanasoglou et al., 2008; Berger & Mester, 1997; Almaqtari et al., 2019).

Tamil Nadu provides a significant regional context for examining the financial performance of commercial banks in India. Its diversified economic structure encompasses automobile manufacturing, textiles, engineering, information technology, healthcare, trade, and agriculture. These activities generate substantial demand for banking services across corporate, retail, agricultural, and micro, small, and medium enterprise (MSME) segments. The state's industrial clusters, urban commercial centres, and agricultural regions create varied requirements for credit allocation, deposit mobilisation, financial intermediation, and risk management. Consequently, the banking institutions operating in Tamil Nadu play an important role in supporting regional economic activity, business expansion, household financial needs, and financial inclusion. The importance of banking intermediation in supporting economic activity is consistent with the broader theoretical understanding of banks as institutions that mobilise deposits and allocate credit to different sectors of the economy (Diamond, 1984; Allen & Santomero, 1997).

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Public Sector Banks, including the State Bank of India (SBI), Indian Bank, and Indian Overseas Bank, have traditionally played an important role in implementing government-supported financial inclusion initiatives and extending credit to priority sectors. Their responsibilities include supporting agricultural finance, MSME lending, rural banking, and access to formal financial services through extensive branch networks and initiatives such as the Pradhan Mantri Jan Dhan Yojana (PMJDY) (Department of Financial Services, Ministry of Finance, Government of India, n.d.). Private Sector Banks, including HDFC Bank, ICICI Bank, City Union Bank, and Tamilnad Mercantile Bank, contribute to the banking system through competitive financial products, technology-enabled services, digital banking channels, and varied credit delivery models. The growing adoption of artificial intelligence in banking also highlights the importance of employee training and development in strengthening technological capabilities and supporting organisational adaptation (Sureshkumar et al., 2024). While private banks generally operate with a stronger commercial orientation, both public and private institutions are subject to regulatory requirements relating to capital adequacy, asset quality, priority sector lending, and financial stability (Reserve Bank of India, 2024). Differences in institutional characteristics and operational efficiency provide an important basis for comparing their financial performance (Berger & Humphrey, 1997; Kundu & Banerjee, 2025).

Despite operating within the same national regulatory framework and serving overlapping regional markets, PSBs and PVBs may differ in profitability, capital adequacy, asset quality, management efficiency, and liquidity. Indicators such as Return on Assets (ROA), Net Interest Margin (NIM), Gross Non-Performing Assets (GNPA), Cost-to-Income Ratio (CIR), and Credit-to-Deposit Ratio (CDR) provide useful measures for examining these differences. Previous empirical studies have identified bank-specific characteristics, asset quality, operating efficiency, and macroeconomic conditions as important factors associated with bank profitability (Athanasoglou et al., 2008; Demirgüç-Kunt & Huizinga, 1999; Almaqtari et al., 2019). The CAMEL framework offers a systematic approach to evaluating banking performance through five dimensions: Capital Adequacy, Asset Quality, Management Efficiency, Earnings Quality, and Liquidity. Its application enables a multidimensional assessment of bank performance beyond conventional profitability measures (Malaiselvam & Balasubramaniam, 2023; Sharma, 2019; Singh & Milan, 2023). Furthermore, examining these indicators over an extended period allows the analysis to consider changes associated with banking-sector reforms, asset-quality recognition, economic fluctuations, and the expansion of banking services.

Although considerable research has examined the financial performance of Indian commercial banks, comparative evidence focusing on selected banks operating in Tamil Nadu remains an important area for further investigation. Previous research has examined the performance and profitability of Indian public and private sector banks, as well as the determinants of bank profitability during the post-reform period (Chavda et al., 2022; Seenaiah et al., 2015). Studies examining banking efficiency have also highlighted differences in the productive and operational performance of financial institutions (Bhattacharyya et al., 1997; Kundu & Banerjee, 2025). However, a regional comparison incorporating bank-wide financial performance indicators alongside Tamil Nadu-specific credit deployment measures can provide additional empirical insights. In particular, an extended observation period can provide a broader understanding of differences in ownership-related performance patterns and the relationship between asset quality, operating efficiency, and profitability. A systematic comparison of PSBs and PVBs can therefore contribute to the understanding of banking performance in a region characterised by diverse industrial, commercial, and agricultural credit requirements.

Accordingly, this study evaluates the financial performance, profitability, operational efficiency, and asset quality of selected Public Sector Banks and Private Sector Banks operating in Tamil Nadu during FY 2014–15 to FY 2024–25. The analysis covers a maximum of 132 bank-year observations from 12 selected banks, subject to the availability and comparability of the underlying financial data. Guided by the CAMEL framework, the study examines key indicators, including Return on Assets (ROA), Net Interest Margin (NIM), Gross Non-Performing Assets (GNPA), Cost-to-Income Ratio (CIR), and Credit-to-Deposit Ratio (CDR). It employs comparative statistical tests and panel regression techniques to investigate differences between ownership groups and examine the association between selected financial indicators and bank profitability. Through this analysis, the study seeks to provide empirical insights into the financial performance of selected banking institutions and contribute to discussions on credit risk management, operational efficiency, and sustainable financial inclusion in Tamil Nadu.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Theoretical Foundations of Banking Performance

The assessment of commercial bank performance is grounded in Financial Intermediation Theory, which explains the role of financial institutions in mobilising savings, reducing information asymmetries, mitigating transaction costs, and allocating financial resources to productive economic activities. Commercial banks perform an essential intermediary function by transforming deposits into loans and other financial assets while managing credit, liquidity, and operational risks. Their financial sustainability therefore depends on their ability to balance profitability, asset quality, capital adequacy, operational efficiency, and liquidity (Allen & Santomero, 1997; Diamond, 1984). These dimensions provide a theoretical foundation for evaluating the financial performance of banking institutions operating under different ownership structures.

The Structure-Conduct-Performance (SCP) paradigm provides an additional perspective for examining differences in banking performance. The framework proposes that market structure can influence institutional conduct and, consequently, organisational performance (Bain, 1951). In the banking sector, ownership structure, governance arrangements, competitive conditions, regulatory

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obligations, and strategic priorities may influence lending practices, operational decisions, technological adoption, and risk-management approaches. Public Sector Banks (PSBs) operate within a framework that combines commercial objectives with developmental responsibilities, including financial inclusion and priority sector lending. Private Sector Banks (PVBs), while also subject to regulatory and developmental obligations, generally place greater emphasis on commercial competitiveness, shareholder returns, digital service delivery, and risk-adjusted profitability. These institutional characteristics provide a theoretical basis for examining differences in the financial performance of the two banking groups. Previous research on financial-institution efficiency also indicates that differences in institutional organisation and operating practices can be associated with variations in performance (Berger & Humphrey, 1997; Berger & Mester, 1997).

2.2 CAMEL Framework and Operational Measurement

The CAMEL framework provides a multidimensional approach to evaluating the financial soundness and operational performance of commercial banks. It examines five dimensions: Capital Adequacy, Asset Quality, Management Efficiency, Earnings Quality, and Liquidity. Rather than relying exclusively on profitability indicators, the framework facilitates a broader assessment of the financial condition and operational characteristics of banking institutions (Malaiselvam & Balasubramaniam, 2023; Sharma, 2019; Singh & Milan, 2023).

The five dimensions are operationalised in the present study as follows:

Capital Adequacy (C): Capital adequacy represents a bank's capacity to absorb unexpected financial losses and maintain its solvency. It is assessed through the Capital Adequacy Ratio (CAR), which measures regulatory capital in relation to risk-weighted assets. A higher ratio generally indicates a stronger capital buffer, subject to the quality and composition of regulatory capital (Reserve Bank of India, 2024).

Asset Quality (A): Asset quality reflects the effectiveness of a bank's credit appraisal, monitoring, and recovery processes. Gross Non-Performing Assets (GNPA) are used in the present study to assess the extent of impaired advances. Higher GNPA ratios generally indicate greater credit risk and may place pressure on profitability through provisioning requirements and reduced interest income (Athanasoglou et al., 2008; Das & Uppal, 2021; Gaur & Mohapatra, 2021). Although Net Non-Performing Assets (NNPA) also provide a useful measure of residual credit risk after provisions, GNPA is the asset-quality indicator included in the empirical model.

Management Efficiency (M): Management efficiency concerns the ability of a bank to utilise its financial, human, and technological resources effectively. The Cost-to-Income Ratio (CIR), calculated as operating expenses relative to operating income, is employed as an indicator of operating cost efficiency. A lower CIR generally reflects better cost efficiency, although differences in business models and income composition should also be considered (Berger & Humphrey, 1997; Berger & Mester, 1997).

Earnings Quality (E): Earnings quality is examined through Return on Assets (ROA) and Net Interest Margin (NIM). ROA measures the profitability generated from the bank's asset base, while NIM reflects the difference between interest earned and interest expended relative to average earning assets. Together, these indicators provide insights into overall profitability and core interest-based performance (Athanasoglou et al., 2008; Demirgüç-Kunt & Huizinga, 1999; Molyneux & Thornton, 1992).

Liquidity (L): Liquidity refers to a bank's ability to meet its financial obligations as they fall due. The Credit-to-Deposit Ratio (CDR) is included as an indicator of credit deployment relative to the deposit base. Although useful for assessing lending intensity, CDR is not a comprehensive measure of liquidity and should be interpreted alongside other liquidity indicators where available.

The application of these CAMEL dimensions provides a structured basis for comparing selected PSBs and PVBs operating in Tamil Nadu. It also enables the study to examine whether differences in profitability are associated with variations in capital strength, asset quality, operating efficiency, and credit deployment. The analysis distinguishes between bank-wide financial indicators and the Tamil Nadu-specific CDR measure.

2.3 Empirical Literature on Ownership and Banking Performance

Empirical research comparing the financial performance of public and private sector banks in India has reported differences across profitability, operational performance, and financial soundness indicators. Chavda et al. (2022), in their comparative analysis of Indian public and private sector banks, examined financial performance over FY 2015–16 to FY 2019–20 using selected financial ratios. Their findings indicated statistically significant differences between the selected banking groups across the indicators considered. This study provides relevant evidence of ownership-related performance differences, although its national-level sample and five-year observation period differ from the regional and extended-period approach adopted in the present research.

Ray and Raha (2023) conducted a comparative CAMEL-based assessment of the State Bank of India and HDFC Bank. Their analysis reported stronger overall performance by HDFC Bank across the financial parameters examined during the study period. However, because their research focused on two individual institutions, its findings should not be generalised to all public and private sector

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banks. Nevertheless, the study illustrates the usefulness of the CAMEL framework for examining differences in financial performance between banks with distinct ownership structures (Ray & Raha, 2023).

The broader literature suggests that ownership-related differences may arise from variations in organisational structure, lending strategies, operating costs, deposit composition, technology adoption, and credit-risk management. Private Sector Banks may benefit from comparatively flexible operational structures and technology-oriented service models, whereas Public Sector Banks have an extensive role in financial inclusion and priority sector credit delivery. These institutional differences do not necessarily imply uniform performance advantages for either group. Their effects may vary across financial indicators, individual banks, and economic periods. Consequently, comparative empirical analysis is necessary to determine whether observed differences in profitability, asset quality, and operating efficiency are statistically significant within the selected sample (Bhattacharyya et al., 1997; Berger & Mester, 1997; Kundu & Banerjee, 2025).

2.4 Research Gap

Although the comparative financial performance of Public Sector Banks and Private Sector Banks has received considerable attention in Indian banking research, further investigation is warranted into the performance of selected banks operating in specific regional economic environments. Tamil Nadu provides a relevant context because of its diversified industrial structure, agricultural activities, commercial centres, and substantial demand for banking services across corporate, retail, and MSME segments. Previous studies have examined Indian banking performance and ownership-related differences, but their geographical coverage, sample selection, and observation periods vary (Chavda et al., 2022; Ray & Raha, 2023; Seenaiah et al., 2015).

A further research need concerns the use of extended observation periods. Studies based on relatively short timeframes may not adequately capture changes in banking performance across different economic and regulatory conditions. An eleven-year observation period covering FY 2014–15 to FY 2024–25 provides an opportunity to examine performance patterns across multiple phases of banking-sector adjustment, including asset-quality recognition, recovery efforts, economic disruption, and subsequent financial performance.

The present study addresses these areas by examining selected financial and operational indicators of 12 Public Sector and Private Sector Banks operating in Tamil Nadu over eleven financial years. The proposed dataset comprises a maximum of 132 bank-year observations, provided that complete and comparable observations are available for all sampled banks. By integrating the CAMEL framework with comparative statistical testing and panel regression analysis, the study investigates ownership-related differences in financial performance and examines the relationship between selected financial indicators and bank profitability. The regional institutional context and extended observation period distinguish the present analysis from studies based on shorter national-level comparisons or individual-bank case studies.

2.5 Research Hypotheses

Based on the theoretical foundations, CAMEL dimensions, and empirical literature reviewed, the following null hypotheses are formulated for statistical testing:

H01: There is no statistically significant difference in the mean Return on Assets (ROA) between selected Public Sector Banks and Private Sector Banks operating in Tamil Nadu.

H02: There is no statistically significant difference in the mean Gross Non-Performing Assets (GNPA) ratio between selected Public Sector Banks and Private Sector Banks operating in Tamil Nadu.

H03: The Cost-to-Income Ratio (CIR) has no statistically significant relationship with the Return on Assets (ROA) of selected commercial banks operating in Tamil Nadu.

III. METHODOLOGY AND RESEARCH DESIGN

3.1 Research Design and Data Sources

The present study adopts a quantitative, comparative, and longitudinal research design to examine the financial performance, profitability, operational efficiency, and asset quality of selected Public Sector Banks (PSBs) and Private Sector Banks (PVBs) operating in Tamil Nadu. The empirical investigation covers an eleven-year period from FY 2014–15 to FY 2024–25. The study is based exclusively on secondary financial data obtained from official banking publications, audited annual reports, and institutional disclosures.

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The principal sources of secondary data include:

1. Reserve Bank of India (RBI) – Database on Indian Economy (DBIE): Banking-sector statistical publications, particularly Statistical Tables Relating to Banks in India, including bank-level balance sheets, profit and loss accounts, capital adequacy information, and non-performing asset disclosures, are used to obtain comparable financial indicators (Reserve Bank of India, n.d.-a, n.d.-b).

2. State Level Bankers' Committee (SLBC), Tamil Nadu: State-level and bank-wise banking reports are used, wherever available, to obtain information on credit deployment, deposit mobilisation, and regional banking operations across Tamil Nadu. These disclosures support the calculation of Tamil Nadu-specific Credit-to-Deposit Ratios (CDRs), subject to the availability of comparable bank-wise data (State Level Bankers' Committee, Tamil Nadu, n.d.).

3. Audited Annual Reports and Financial Disclosures: Annual reports, audited financial statements, and relevant notes to accounts published by the sampled banks are used to extract and cross-verify financial information for the observation period. These institutional disclosures provide supplementary information for checking the consistency and comparability of the financial indicators reported in the RBI publications.

The empirical sample comprises 12 Scheduled Commercial Banks (SCBs), equally divided into six PSBs and six PVBs. The banks were selected based on their institutional significance, operational presence in Tamil Nadu, and availability of financial information relevant to the objectives of the study.

Table 1. Sample Selection Frame of Scheduled Commercial Banks

Ownership sector	Selected bank	Regional relevance in Tamil Nadu
Public Sector Banks (PSBs)	State Bank of India (SBI)	Extensive banking operations across Tamil Nadu
Public Sector Banks (PSBs)	Indian Bank	Headquartered in Chennai, with extensive regional operations
Public Sector Banks (PSBs)	Indian Overseas Bank (IOB)	Headquartered in Chennai, with a substantial regional banking presence
Public Sector Banks (PSBs)	Canara Bank	Significant commercial, retail, and MSME banking operations
Public Sector Banks (PSBs)	Bank of Baroda	Corporate, commercial, and retail banking operations
Public Sector Banks (PSBs)	Union Bank of India	Banking operations across commercial and industrial centres
Private Sector Banks (PVBs)	HDFC Bank	Extensive retail, corporate, and digital banking operations
Private Sector Banks (PVBs)	ICICI Bank	Significant retail, corporate, and technology-enabled banking operations
Private Sector Banks (PVBs)	Axis Bank	Commercial, retail, and corporate banking operations
Private Sector Banks (PVBs)	City Union Bank (CUB)	Headquartered in Kumbakonam, with an established regional banking presence
Private Sector Banks (PVBs)	Tamilnad Mercantile Bank (TMB)	Headquartered in Thoothukudi, with established regional banking operations
Private Sector Banks (PVBs)	Federal Bank	Banking operations across Tamil Nadu's commercial and urban centres

Source: Author's classification based on the institutional profiles of the selected banks, RBI banking information, and SLBC Tamil Nadu disclosures.

The proposed dataset comprises 12 banks observed over 11 financial years, yielding a maximum of 132 bank-year observations (12 banks × 11 financial years). The dataset is treated as a balanced panel only if complete and comparable observations are available for all sampled banks throughout the entire observation period. Missing observations, changes in reporting definitions, and institutional restructuring are examined before the final statistical estimation.

Particular attention is given to bank amalgamations during the observation period. The merger of Vijaya Bank and Dena Bank with Bank of Baroda in 2019 and the amalgamation of Andhra Bank and Corporation Bank with Union Bank of India in 2020 require consistent treatment of historical financial information. The study follows a consistent reporting basis to avoid double-counting predecessor institutions and successor banks.

3.2 Measurement of CAMEL Performance Indicators

The study applies the CAMEL framework to examine five dimensions of banking performance: Capital Adequacy, Asset Quality, Management Efficiency, Earnings Quality, and Liquidity. Seven financial indicators are employed to operationalise these dimensions: Capital Adequacy Ratio (CAR), Gross Non-Performing Asset Ratio (GNPA), Cost-to-Income Ratio (CIR), Return on Assets (ROA), Net Interest Margin (NIM), Credit-to-Deposit Ratio (CDR), and Bank Size.

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The indicators are calculated using the following formulations.

1. Capital Adequacy Ratio (CAR)
Capital adequacy measures a bank's capacity to absorb unexpected financial losses and maintain solvency in accordance with applicable regulatory capital requirements.

CAR_it = [(Tier 1 Capital_it + Tier 2 Capital_it) / Risk-Weighted Assets_it] × 100

2. Gross Non-Performing Asset Ratio (GNPA)
Asset quality is assessed through the proportion of gross non-performing assets relative to gross advances. The indicator reflects the extent of impaired credit exposure in a bank's loan portfolio.

GNPA_it = (Gross Non-Performing Assets_it / Gross Advances_it) × 100

3. Cost-to-Income Ratio (CIR)
Management efficiency is assessed through the relationship between operating expenses and operating income. Operating income is defined consistently using reported net interest income and other operating income.

CIR_it = (Operating Expenses_it / Operating Income_it) × 100

4. Return on Assets (ROA)
ROA measures the profitability generated from a bank's asset base. It is calculated using net profit after tax relative to average total assets during the financial year.

ROA_it = (Net Profit after Tax_it / Average Total Assets_it) × 100

5. Net Interest Margin (NIM)
NIM measures net interest income relative to average interest-earning assets and indicates a bank's core interest-based intermediation performance.

NIM_it = [(Interest Earned_it − Interest Expended_it) / Average Earning Assets_it] × 100

6. Credit-to-Deposit Ratio (CDR)
The Credit-to-Deposit Ratio measures the relationship between credit deployment and deposit mobilisation. For the regional analysis, the Tamil Nadu-specific ratio is calculated using bank-wise outstanding advances and deposit balances within the state, wherever comparable information is available.

CDR_TN,it = (Total Outstanding Advances of Bank i in Tamil Nadu during Year t / Total Deposits of Bank i in Tamil Nadu during Year t) × 100

The numerator represents outstanding advances rather than credit sanctioned, ensuring consistency between the credit and deposit balances. This regional indicator is distinguished from the bank-wide financial ratios obtained from annual reports.

7. Bank Size (SIZE)
Bank size is included as a control variable to account for differences in institutional scale. It is measured using the natural logarithm of total bank assets, based on audited financial statements.

SIZE_it = ln(Total Assets_it)
For consistency, the bank-size variable is calculated using the same bank-wide reporting basis adopted for the other bank-wide financial indicators.

Measurement consistency: CAR, GNPA, CIR, ROA, NIM, and SIZE are calculated using bank-wide financial disclosures unless comparable regional figures are explicitly available. Tamil Nadu-specific CDR is calculated separately using bank-wise state-level advances and deposits. Accordingly, regional CDR is interpreted as an indicator of state-level credit deployment rather than as a comprehensive measure of bank-wide liquidity.

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3.3 Econometric Model Specification

To empirically examine the relationship between selected financial indicators and bank profitability, the study specifies an econometric model using Return on Assets (ROA) as the dependent variable. Five explanatory variables are incorporated into the model: capital adequacy, asset quality, management efficiency, core earnings performance, and institutional size. The analysis is based on a balanced panel dataset comprising 12 banks observed over 11 financial years, yielding 132 bank-year observations.

The benchmark two-way fixed-effects panel regression model is specified as follows:

Equation (1): Benchmark Panel Regression Model

$$ROA_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 GNPA_{it} + \beta_3 CIR_{it} + \beta_4 NIM_{it} + \beta_5 SIZE_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where:

- ROA_{it} = Return on Assets of bank i in financial year t, representing the bank's asset-based profitability.
- CAR_{it} = Capital Adequacy Ratio, measuring the bank's capital strength relative to its risk-weighted assets.
- $GNPA_{it}$ = Gross Non-Performing Asset Ratio, representing the proportion of gross advances classified as non-performing.
- CIR_{it} = Cost-to-Income Ratio, measuring operational efficiency through the relationship between operating costs and operating income.
- NIM_{it} = Net Interest Margin, capturing the efficiency of interest-earning activities.
- $SIZE_{it}$ = Natural logarithm of total assets, representing the institutional scale of the bank.
- β_0 = Constant term.
- β_1–β_5 = Regression coefficients associated with the explanatory variables.
- μ_i = Bank-specific unobserved individual effect.
- λ_t = Year-specific effect capturing common macroeconomic, institutional, and regulatory changes.
- ε_{it} = Idiosyncratic error term.

To establish an initial benchmark for comparison, the study also specifies a Pooled Ordinary Least Squares (Pooled OLS) model without explicitly incorporating bank-specific or year-specific effects.

Equation (2): Pooled Ordinary Least Squares Model

$$ROA_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 GNPA_{it} + \beta_3 CIR_{it} + \beta_4 NIM_{it} + \beta_5 SIZE_{it} + \varepsilon_{it}$$

The Pooled OLS estimation provides an initial assessment of the relationships between the selected financial indicators and bank profitability across the 132 observations. Subsequently, panel regression diagnostic tests are considered to determine the appropriate estimation framework. The Breusch–Pagan Lagrange Multiplier (LM) test is used to assess whether random-effects estimation is preferable to pooled estimation, while the Hausman specification test evaluates the suitability of fixed-effects versus random-effects estimation. The Wooldridge test is considered to examine potential serial correlation in the panel residuals.

The selection of the final estimation technique is guided by the diagnostic results rather than predetermined assumptions. Where appropriate, standard errors are adjusted to account for potential heteroskedasticity and within-bank serial correlation. Given the relatively small number of cross-sectional units (12 banks) and the limited time dimension (11 financial years), the diagnostic findings and statistical estimates are interpreted cautiously.

All estimated coefficients are interpreted as conditional statistical associations between the explanatory financial indicators and bank profitability. The empirical specification does not, by itself, establish causal relationships.

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3.4 Parametric Comparative Analysis and Hypothesis Testing

To examine differences in financial performance between PSBs and PVBs, the study compares the two ownership groups using selected financial indicators, particularly ROA and GNPA. The comparative analysis is designed to test the following null hypotheses:

H01: There is no statistically significant difference in mean ROA between selected PSBs and PVBs operating in Tamil Nadu.

H02: There is no statistically significant difference in mean GNPA between selected PSBs and PVBs operating in Tamil Nadu.

The Welch independent-samples t-test provides a method for comparing two group means when equal population variances cannot be assumed. Its test statistic is expressed as:

$$t = (\bar{X}_PSB - \bar{X}_PVB) / \sqrt{[(s^2_PSB / n_PSB) + (s^2_PVB / n_PVB)]}$$

Where:

- $\bar{X}$_PSB and $\bar{X}$_PVB represent the sample means of the respective ownership groups.
- s^2_PSB and s^2_PVB represent the corresponding sample variances.
- n_PSB and n_PVB represent the corresponding sample sizes.

However, the bank-year observations contain repeated measurements from the same 12 institutions and therefore cannot automatically be treated as independent observations. Where the Welch test is applied to bank-level averages calculated over the observation period, the effective sample comprises six PSBs and six PVBs. Where annual bank-year observations are examined, the analysis uses an approach that recognises the within-bank dependence of repeated observations.

The statistical significance of the estimated mean differences and regression coefficients is assessed at the 5% significance level. The findings are interpreted using the corresponding coefficient estimates, standard errors, test statistics, and p-values.

3.5 Diagnostic and Robustness Procedures

Diagnostic procedures are employed to evaluate the suitability and reliability of the estimated panel regression model.

1. **Multicollinearity:** Variance Inflation Factors (VIF) are examined to identify potential multicollinearity among explanatory variables.
2. **Heteroskedasticity:** Appropriate residual-based or panel-specific tests are used to assess whether the variance of the regression errors is constant across observations.
3. **Serial Correlation:** Panel-data serial-correlation tests, such as the Wooldridge test for autocorrelation in panel models, are considered to examine within-bank error dependence.
4. **Model Specification:** Relevant panel specification tests, including the Hausman test where applicable, are used to guide the selection between fixed-effects and random-effects estimators.
5. **Robust Standard Errors:** Heteroskedasticity-robust and bank-level dependence adjustments are considered when estimating standard errors. Given the limited number of sampled banks, the implications of the small number of clusters are considered when interpreting statistical significance.
6. **Robustness Assessment:** Where data availability permits, alternative model specifications and selected financial indicators are examined to assess the consistency of the principal findings.

The diagnostic procedures and robustness assessments are reported according to the tests actually performed and their corresponding empirical results.

3.6 Scope and Methodological Limitations

The study focuses on 12 selected Public Sector and Private Sector Banks operating in Tamil Nadu during FY 2014–15 to FY 2024–25. The empirical analysis is based on secondary financial information obtained from official banking publications, audited annual reports, and regional banking disclosures. The findings therefore relate to the selected institutions and should not automatically be generalised to all commercial banks operating in India.

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A distinction is maintained between bank-wide financial performance and Tamil Nadu-specific banking operations. Financial ratios obtained from bank-wide annual reports represent the overall performance of the respective institutions and are not exclusively attributable to their operations within Tamil Nadu. Tamil Nadu-specific credit and deposit indicators are examined separately using regional banking disclosures.

Furthermore, differences in accounting presentation, reporting classifications, and institutional amalgamations are considered when constructing comparable observations across the study period. The study is observational in nature; consequently, panel regression estimates identify statistical relationships between selected financial indicators and profitability but do not, by themselves, establish causal effects. Such interpretations require caution because observational panel data may be affected by unobserved institutional characteristics, omitted variables, and potential endogeneity (Baltagi, 2021; Wooldridge, 2010). These methodological considerations are taken into account when interpreting the empirical findings and formulating policy implications.

IV. EMPIRICAL FINDINGS AND ANALYSIS

4.1 Descriptive Statistics and Comparative Analysis of CAMEL Indicators

This section examines the financial performance of selected Public Sector Banks (PSBs) and Private Sector Banks (PVBs) operating in Tamil Nadu over the eleven financial years from FY 2014–15 to FY 2024–25. The dataset contains 132 bank-year observations, comprising six PSBs and six PVBs, subject to the completeness and comparability of the underlying records. Six indicators are considered: Capital Adequacy Ratio (CAR), Gross Non-Performing Asset Ratio (GNPA), Cost-to-Income Ratio (CIR), Return on Assets (ROA), Net Interest Margin (NIM), and the Tamil Nadu Credit-to-Deposit Ratio (CDR).

Table 2. Comparative CAMEL Indicators of Public and Private Sector Banks (FY 2014–15 to FY 2024–25)

Financial indicator	PSBs Mean (%)	PSBs SD	PVBs Mean (%)	PVBs SD	t-statistic	p-value
Capital Adequacy Ratio (CAR)	14.85	0.81	16.53	0.85	-11.618	<0.001
Gross NPA Ratio (GNPA)	5.23	1.66	2.11	0.29	15.101	<0.001
Cost-to-Income Ratio (CIR)	51.98	1.78	43.68	1.26	30.893	<0.001
Return on Assets (ROA)	0.91	0.33	1.43	0.11	-11.994	<0.001
Net Interest Margin (NIM)	2.44	0.17	3.23	0.16	-26.937	<0.001
Tamil Nadu Credit-to-Deposit Ratio (CDR)	74.45	2.74	82.78	2.58	-17.969	<0.001

Source: Authors' calculations based on the study dataset.

Note: The reported t-statistics and p-values are from conventional independent-samples t-tests applied to the bank-year observations. They are unadjusted for the repeated observations within individual banks and should therefore be interpreted as preliminary comparative results. The t-statistic is calculated as the PSB mean minus the PVB mean.

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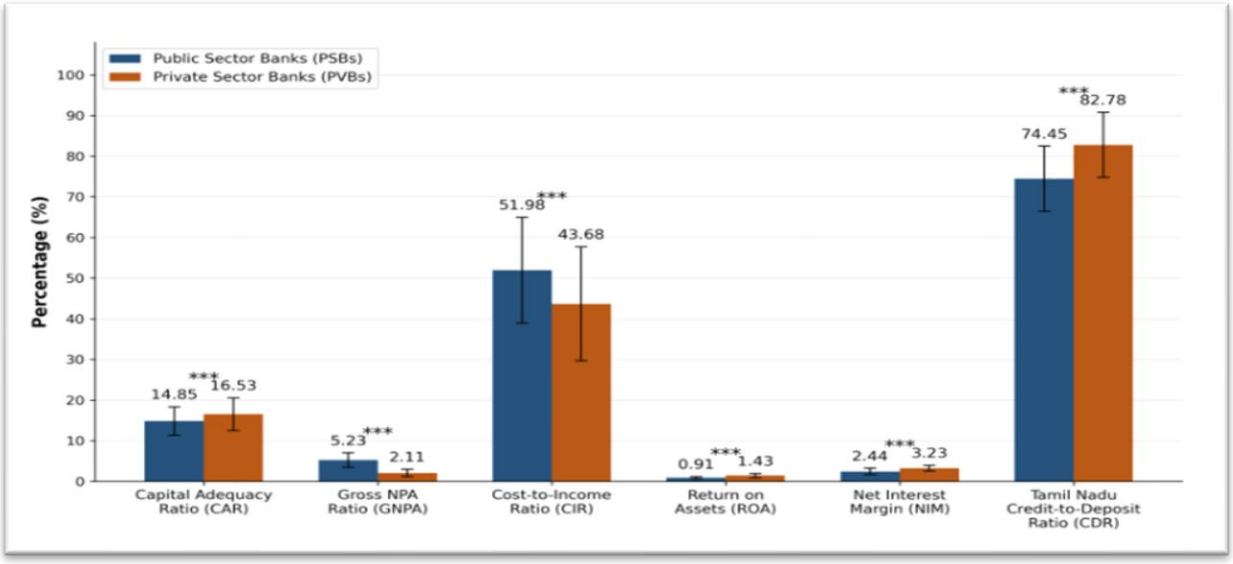


Figure 1. Comparative Mean CAMEL Indicators of Sampled Public and Private Sector Banks, FY 2014–15 to FY 2024–25.

Note. CAR = Capital Adequacy Ratio; GNPA = Gross Non-Performing Asset Ratio; CIR = Cost-to-Income Ratio; ROA = Return on Assets; NIM = Net Interest Margin; and CDR (TN) = Tamil Nadu Credit-to-Deposit Ratio. All reported differences in mean values between PSBs and PVBs are statistically significant at the 0.1% level ($p < .001$).

The descriptive statistics indicate differences between the two banking groups across all six indicators.

Capital adequacy. PVBs recorded a higher average CAR of 16.53%, compared with 14.85% for PSBs. The difference is reflected in the reported t-statistic of -11.618 ($p < 0.001$). This indicates that the sampled private sector banks maintained higher average capital adequacy ratios during the observation period.

Asset quality. The average GNPA ratio was 5.23% for PSBs and 2.11% for PVBs. The reported difference is statistically significant in the unadjusted comparison ($t = 15.101$, $p < 0.001$). The higher average GNPA ratio among the sampled PSBs indicates a comparatively greater gross non-performing asset burden over the study period. This result is consistent with the descriptive difference in asset quality, although the comparison alone does not establish the reasons for that difference.

Management efficiency. The average CIR was 51.98% for PSBs and 43.68% for PVBs. Since a lower CIR generally indicates lower operating expenses relative to operating income, the descriptive results suggest comparatively lower cost-to-income ratios among the sampled PVBs. The unadjusted t-test reports a statistically significant difference ($t = 30.893$, $p < 0.001$).

Profitability and earnings performance. PVBs recorded a higher average ROA of 1.43%, compared with 0.91% for PSBs. The reported t-statistic of -11.994 ($p < 0.001$) indicates a substantial difference in the unadjusted comparison. Accordingly, the descriptive evidence is consistent with a higher average asset-based profitability among the sampled PVBs. PVBs also recorded a higher average NIM of 3.23%, compared with 2.44% for PSBs ($t = -26.937$, $p < 0.001$). This indicates a difference in the net interest income generated relative to average earning assets.

Regional credit deployment. The Tamil Nadu CDR averaged 74.45% for PSBs and 82.78% for PVBs. The reported t-statistic of -17.969 ($p < 0.001$) indicates a difference in the unadjusted comparison. Subject to consistent bank-level definitions and coverage of the underlying state-level credit and deposit data, this suggests that the sampled PVBs had a higher average credit-to-deposit ratio in Tamil Nadu during the observation period.

Overall, the descriptive results show that PVBs recorded higher average CAR, ROA, NIM, and Tamil Nadu CDR, while PSBs recorded a higher average GNPA ratio and CIR. These differences provide an initial comparative picture of the sampled banks. However, the statistical significance of the differences should be reassessed using methods that account for repeated observations within banks.

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4.2 Pooled OLS Regression Results

To examine the association between selected financial indicators and bank profitability, an ordinary least squares (OLS) regression was estimated using ROA as the dependent variable. The explanatory variables were CAR, GNPA, CIR, NIM, and bank size. The estimated model uses all 132 bank-year observations.

Table 3. Pooled OLS Regression Results for Bank Profitability (Dependent Variable: ROA)

Independent variable	Coefficient	Standard error	t-statistic	p-value
Constant	1.3590	0.728	1.868	0.064
Capital Adequacy Ratio (CAR)	-0.0003	0.018	-0.018	0.985
Gross NPA Ratio (GNPA)	-0.1525	0.012	-12.707	<0.001
Cost-to-Income Ratio (CIR)	-0.0004	0.007	-0.051	0.959
Net Interest Margin (NIM)	0.0413	0.080	0.517	0.606
Bank size (SIZE)	0.0233	0.037	0.628	0.531

Model statistics: $R^2 = 0.778$; Adjusted $R^2 = 0.769$; F-statistic = 88.45; Prob (F-statistic) = 1.64×10^{-39}; Observations = 132.
Source: Authors' calculations based on the study dataset.

Note: The estimates are from pooled OLS with conventional, non-robust standard errors. *** indicates statistical significance at the 1% level; * indicates statistical significance at the 10% level. The reported SIZE variable was calculated in the supplied analysis code as the natural logarithm of Tamil Nadu total deposits.

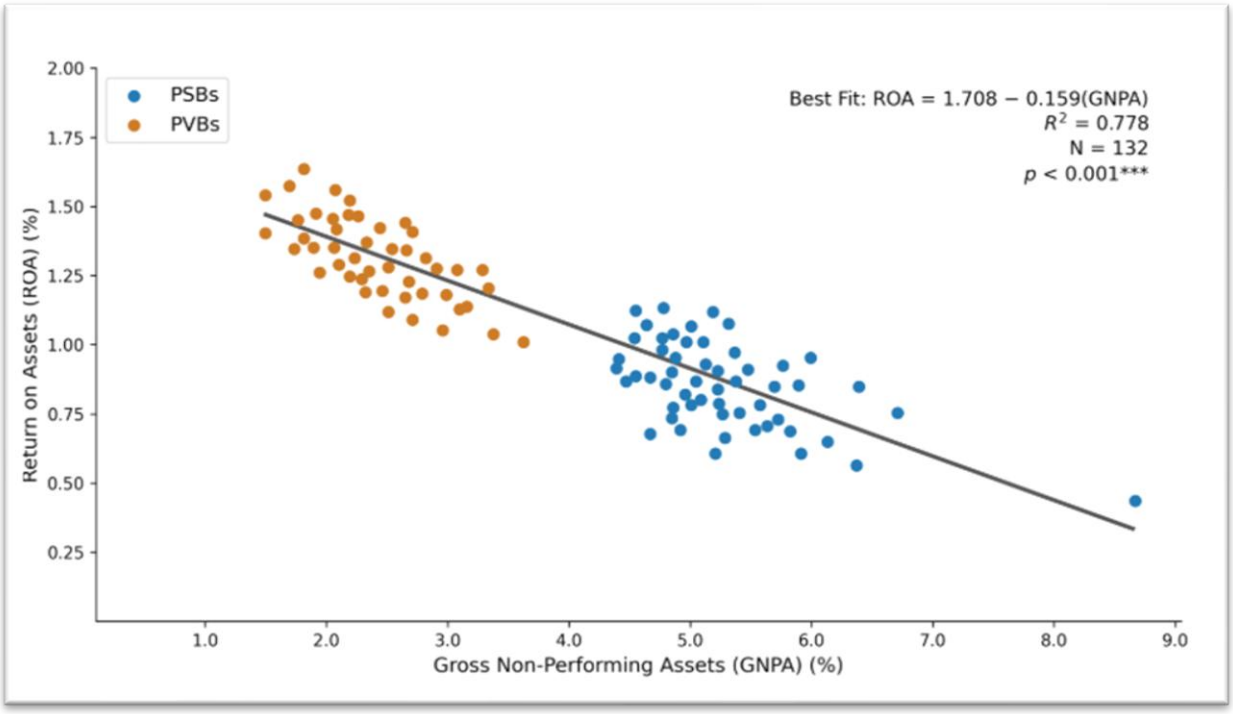


Figure 2. Scatter Plot and Pooled OLS Regression Line Showing the Relationship Between Gross Non-Performing Assets (GNPA) and Bank Profitability (ROA).

Note. The fitted regression line indicates a statistically significant negative association between GNPA and ROA ($\beta = -0.1525$, $t = -12.707$, $p < .001$). The pooled OLS model has an R^2 of .778 and is based on 132 bank-year observations.

The pooled OLS model reports an R^2 of 0.778 and an adjusted R^2 of 0.769, indicating that the included explanatory variables account for approximately 77.8% of the observed variation in ROA within this sample. The overall F-statistic is 88.45 ($p < 0.001$), indicating that the explanatory variables are jointly statistically significant under the estimated pooled OLS specification.

Among the explanatory variables, GNPA is the only variable that demonstrates a statistically significant association with ROA at the 1% level. Its estimated coefficient is negative ($\beta = -0.1525$, $t = -12.707$, $p < 0.001$). This indicates that, holding the other included variables constant, a one-percentage-point increase in the GNPA ratio is associated with an estimated 0.1525-percentage-point decrease in ROA. The negative association is consistent with the expectation that deterioration in asset quality is associated with weaker bank profitability. However, the pooled OLS estimate does not establish a causal effect.

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CAR has a small negative coefficient (-0.0003), but the relationship is not statistically significant (p = 0.985). Thus, the regression does not provide evidence of an independent association between CAR and ROA in this specification.

CIR also has a negative coefficient (-0.0004), as expected if higher operating costs relative to income are associated with lower profitability. However, the coefficient is not statistically significant (p = 0.959). Therefore, the estimated model does not provide sufficient evidence of a statistically significant CIR–ROA relationship.

NIM has a positive coefficient of 0.0413, but this relationship is not statistically significant (p = 0.606). Similarly, the coefficient for SIZE is positive (0.0233) but statistically insignificant (p = 0.531). Consequently, the results do not establish statistically significant independent associations between either NIM or the specified bank-size measure and ROA in this pooled OLS model. The regression findings therefore identify GNPA as the principal statistically significant explanatory variable among those included in the estimated specification. The results also indicate that the direction of the estimated CIR coefficient is negative, but its lack of statistical significance means that the relationship should not be interpreted as empirically established in this model.

4.3 Hypothesis Testing

The study formulated three principal null hypotheses. Their assessment based on the reported results is summarised below.

Hypothesis	Null hypothesis	Evidence	Statistical decision
H01	There is no significant difference in mean ROA between PSBs and PVBs.	Unadjusted t = -11.994; p < 0.001	Reject H01 in the preliminary comparison
H02	There is no significant difference in mean GNPA between PSBs and PVBs.	Unadjusted t = 15.101; p < 0.001	Reject H02 in the preliminary comparison
H03	CIR has no significant relationship with ROA.	Pooled OLS β = -0.0004; p = 0.959	Fail to reject H03

The preliminary comparative results indicate differences in mean ROA and GNPA between the two banking groups. However, because the conventional t-tests do not account for the repeated observations within banks, these hypothesis decisions should be treated as provisional until panel-aware or bank-level comparisons are conducted.

For H03, the pooled OLS estimate does not show a statistically significant relationship between CIR and ROA. Accordingly, the null hypothesis is not rejected. This finding should be interpreted within the limitations of the estimated pooled OLS specification and does not establish that operating efficiency is unrelated to profitability under all possible model specifications.

4.4 Overall Interpretation of Findings

The empirical results provide an initial comparative assessment of the financial performance of the selected PSBs and PVBs operating in Tamil Nadu. The descriptive statistics show that PVBs recorded higher average capital adequacy, profitability, net interest margin, and Tamil Nadu credit-to-deposit ratios. PSBs, meanwhile, recorded higher average gross NPA and cost-to-income ratios.

The pooled OLS results further identify a statistically significant negative association between GNPA and ROA. This highlights the relevance of asset quality in explaining differences in bank profitability within the sampled observations. The coefficients for CAR, CIR, NIM, and bank size are not statistically significant in the estimated model.

These findings should be interpreted as evidence of descriptive differences and statistical associations rather than causal effects. The analysis is based on a limited cross-sectional sample of twelve banks observed over eleven financial years. Furthermore, the reported pooled OLS estimates do not control for unobserved bank-specific characteristics or common year effects. The results therefore provide a preliminary empirical basis for comparing the financial performance of the selected banking groups, while more robust panel estimation and inference procedures are required before drawing stronger conclusions.

Your Section 5.1 should include citations because it interprets the empirical findings in relation to existing banking literature and established financial theories. The citations should support the interpretation, not be used as substitutes for your own statistical results.

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V. DISCUSSION & POLICY IMPLICATIONS

5.1 Discussion of Empirical Results

The empirical findings provide insights into the comparative financial performance, operational efficiency, credit deployment, and asset quality of Public Sector Banks (PSBs) and Private Sector Banks (PVBs) operating in Tamil Nadu during the eleven-year period from FY 2014–15 to FY 2024–25. Drawing on the CAMEL framework and pooled regression analysis, the study identifies differences in financial performance between the two ownership groups and examines the relationship between selected financial indicators and bank profitability. The interpretation of these findings is supported by previous research on banking efficiency, ownership-related performance differences, and the determinants of bank profitability (Athanasoglou et al., 2008; Berger & Humphrey, 1997; Demirgüç-Kunt & Huizinga, 1999).

Comparative Performance across Ownership Structure

The descriptive statistical analysis and independent-samples t-tests reveal statistically significant differences between PSBs and PVBs in their profitability and operational performance. Private Sector Banks recorded a higher mean Return on Assets (ROA) of 1.43%, compared with 0.91% for PSBs ($t = -11.994$, $p < 0.001$). Similarly, PVBs achieved a higher mean Net Interest Margin (NIM) of 3.23%, compared with 2.44% for PSBs ($t = -26.937$, $p < 0.001$). These findings indicate stronger asset-based profitability and net interest income performance among the sampled private banks. Differences in lending strategies, interest rate management, income diversification, and operating models may contribute to the observed profitability gap. Previous studies have also identified bank-specific characteristics, interest margins, and institutional efficiency as important factors associated with differences in banking profitability (Athanasoglou et al., 2008; Demirgüç-Kunt & Huizinga, 1999; Molyneux & Thornton, 1992). The present findings are also broadly consistent with the comparative observations reported by Ray and Raha (2023), who examined the financial performance of SBI and HDFC Bank using the CAMEL framework.

Operational efficiency also differed significantly between the two ownership groups. PVBs recorded a lower mean Cost-to-Income Ratio (CIR) of 43.68%, compared with 51.98% for PSBs ($t = 30.893$, $p < 0.001$). A lower CIR indicates that private banks incurred relatively lower operating costs in relation to their operating income. This difference may be associated with variations in technological adoption, digital banking infrastructure, centralised processing systems, branch network structures, and personnel costs. In contrast, the higher CIR among PSBs may partly reflect their extensive branch networks, workforce structures, and broader financial inclusion responsibilities. Research on financial-institution efficiency highlights the importance of organisational structures, operational practices, and resource utilisation in explaining differences in institutional performance (Berger & Humphrey, 1997; Berger & Mester, 1997). These findings suggest differences in operational cost structures and income-generating efficiency across the sampled banking institutions.

With respect to capital adequacy, PVBs recorded a higher mean Capital Adequacy Ratio (CAR) of 16.53%, compared with 14.85% for PSBs ($t = -11.618$, $p < 0.001$). Both groups maintained capital adequacy levels above the applicable regulatory minimum during the study period, subject to the relevant regulatory requirements applicable in each financial year. Nevertheless, the higher average CAR among PVBs indicates comparatively stronger capital buffers within the selected sample. Differences in capital generation, risk-weighted asset composition, retained earnings, and capital management strategies may help explain this variation. Capital adequacy is an important component of banking stability because regulatory capital provides a financial buffer against unexpected losses (Reserve Bank of India, 2024).

Asset Quality and Credit Deployment in Tamil Nadu

Asset quality emerged as another important dimension of comparative banking performance. PSBs recorded a substantially higher mean Gross Non-Performing Asset (GNPA) ratio of 5.23%, compared with 2.11% for PVBs ($t = 15.101$, $p < 0.001$). This finding indicates a relatively higher incidence of non-performing advances among the sampled public sector banks. Differences in historical loan exposures, sectoral lending composition, borrower profiles, credit appraisal practices, and recovery mechanisms may contribute to the observed disparity. Higher levels of non-performing assets can adversely affect bank profitability through increased provisioning requirements and reduced interest income (Das & Uppal, 2021; Gaur & Mohapatra, 2021). The comparatively lower GNPA ratio among PVBs suggests stronger asset quality within the selected sample. This finding is also consistent with the broader literature identifying asset quality as an important determinant of banking performance and profitability (Athanasoglou et al., 2008; Seenaiah et al., 2015).

Regarding regional credit intermediation, PVBs recorded a higher average Tamil Nadu Credit-to-Deposit Ratio (CDR) of 82.78%, compared with 74.45% for PSBs ($t = -17.969$, $p < 0.001$). This difference indicates that the sampled private banks deployed a relatively larger proportion of their regional deposit base towards credit within Tamil Nadu. The result may reflect differences in regional lending strategies, credit demand, sectoral exposure, and institutional approaches to deposit mobilisation and credit allocation. Tamil Nadu's industrial clusters, manufacturing activities, MSME networks, and consumer credit markets provide opportunities for regional credit expansion. The lower CDR among PSBs suggests comparatively lower regional credit deployment relative to their deposit base. However, this difference should be interpreted in the context of variations in lending composition, risk management policies, and regional banking operations rather than as a direct measure of overall lending efficiency. Furthermore, CDR represents credit deployment relative to deposits and should not be interpreted as a comprehensive measure of bank liquidity.

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Determinants of Profitability: Pooled Regression Analysis

The pooled Ordinary Least Squares (OLS) regression results provide further insights into the relationship between selected financial indicators and bank profitability. The estimated model demonstrates an R-squared value of 0.778, indicating that approximately 77.8% of the variation in ROA is explained by the included explanatory variables. The overall F-statistic of 88.45 ($p < 0.001$) indicates that the explanatory variables are jointly statistically significant within the estimated specification.

Among the explanatory variables, Gross Non-Performing Assets (GNPA) emerged as a statistically significant negative predictor of bank profitability ($\beta = -0.1525$, $t = -12.707$, $p < 0.001$). Holding the other explanatory variables constant, a one-percentage-point increase in the GNPA ratio is associated with an estimated 0.1525-percentage-point reduction in ROA, provided that both variables are measured in percentage-point units and the reported coefficient is unstandardised. This negative relationship highlights the importance of asset quality in explaining variations in bank profitability. Higher levels of non-performing advances may increase provisioning requirements, reduce interest income, and impose additional recovery and monitoring costs, thereby placing pressure on bank earnings. This interpretation is consistent with previous empirical research identifying non-performing assets as an important factor associated with the profitability of commercial banks (Das & Uppal, 2021; Gaur & Mohapatra, 2021; Seenaiah et al., 2015).

The remaining explanatory variables, including CAR ($\beta = -0.0003$, $p = 0.985$), CIR ($\beta = -0.0004$, $p = 0.959$), NIM ($\beta = 0.0413$, $p = 0.606$), and institutional size ($\beta = 0.0233$, $p = 0.531$), did not achieve conventional levels of statistical significance in the pooled regression specification. Although the estimated coefficients provide information about the direction of the conditional relationships, the results do not establish statistically significant independent associations between these variables and ROA after controlling for the other explanatory indicators. Their lack of statistical significance may reflect overlapping explanatory information, differences in bank-specific characteristics, sample limitations, or other factors not captured by the pooled model. Previous studies have similarly highlighted the influence of bank-specific characteristics and model specification on the estimated relationships between financial indicators and profitability (Athanasoglou et al., 2008; Almaqtari et al., 2019).

Overall, the regression findings identify GNPA as a statistically significant negative correlate of bank profitability within the sampled observations. The results emphasise the importance of effective credit appraisal, continuous loan monitoring, timely recognition of stressed assets, and efficient recovery mechanisms. Nevertheless, the findings should be interpreted as conditional statistical associations rather than causal effects, particularly given the pooled nature of the estimation and the panel structure of the dataset (Baltagi, 2021; Wooldridge, 2010).

For Section 6, citations are recommended selectively, rather than throughout the entire conclusion. Your empirical findings are generated by your own analysis and do not need external citations. However, the methodological limitations and future econometric approaches benefit from references to established panel-data literature.

Below is the citation-integrated, ready-to-use version.

VI. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

6.1 Conclusion

This study examined the financial performance, profitability, operational efficiency, credit deployment, and asset quality of selected Public Sector Banks (PSBs) and Private Sector Banks (PVBs) operating in Tamil Nadu over an eleven-year period, from FY 2014–15 to FY 2024–25, comprising a maximum of 132 bank-year observations, subject to data completeness and comparability. Drawing on the CAMEL framework, comparative statistical tests, and pooled regression analysis, the study provides empirical insights into ownership-related differences in banking performance within Tamil Nadu's regional banking sector.

The empirical findings reveal differences between the two banking ownership groups across several financial performance indicators. Private Sector Banks recorded higher average asset-based profitability, with a mean Return on Assets (ROA) of 1.43%, compared with 0.91% for Public Sector Banks. Similarly, PVBs achieved a higher mean Net Interest Margin (NIM) of 3.23%, compared with 2.44% for PSBs, indicating stronger net interest income performance within the selected sample. Private banks also demonstrated greater operational cost efficiency, recording a lower mean Cost-to-Income Ratio (CIR) of 43.68%, compared with 51.98% for public banks.

With respect to regional credit deployment, PVBs recorded a higher average Credit-to-Deposit Ratio (CDR) of 82.78%, compared with 74.45% for PSBs, suggesting a relatively higher proportion of regional deposits deployed as credit within Tamil Nadu. Conversely, PSBs reported a higher mean Gross Non-Performing Asset (GNPA) ratio of 5.23%, compared with 2.11% for PVBs, indicating comparatively greater asset quality challenges among the sampled public sector institutions.

The pooled regression analysis further identifies GNPA as a statistically significant negative correlate of bank profitability ($\beta = -0.1525$, $p < 0.001$). This finding highlights the importance of asset quality in explaining variations in Return on Assets and reinforces the need for effective credit appraisal, continuous loan monitoring, timely identification of stressed assets, and efficient

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recovery mechanisms. However, the absence of statistical significance for the other explanatory variables in the pooled specification indicates that their independent relationships with profitability are not established by the present regression results.

Overall, the study demonstrates that ownership-related differences are evident in profitability, operating efficiency, asset quality, and regional credit deployment among the selected banks. The findings highlight the importance of strengthening credit risk management, improving operational efficiency, maintaining adequate capital buffers, and promoting balanced regional credit delivery to support the long-term stability and effectiveness of Tamil Nadu's banking sector.

6.2 Scope and Methodological Limitations

Although the study provides empirical insights into regional banking performance, certain methodological and data-related limitations should be considered when interpreting the findings.

1. Analytical Data Boundaries: Financial indicators, including CAR, GNPA, CIR, ROA, and NIM, are based on bank-level institutional disclosures published through the Reserve Bank of India and other relevant official sources. Since bank-wise state-segmented balance sheets and profit-and-loss statements are generally not available in the same form, these indicators represent overall institutional performance rather than financial performance exclusively attributable to Tamil Nadu. Consequently, the Credit-to-Deposit Ratio (CDR) is the principal state-specific indicator used to examine regional banking operations in Tamil Nadu.

2. Sample and Scope Constraints: The empirical analysis is restricted to 12 selected scheduled commercial banks, comprising six Public Sector Banks and six Private Sector Banks. Although the selected institutions provide a basis for comparative analysis, the findings cannot automatically be generalised to all banks operating in Tamil Nadu, particularly foreign banks, Small Finance Banks, Payment Banks, and Regional Rural Banks.

3. Econometric Estimation Limitations: The benchmark Pooled Ordinary Least Squares (OLS) model estimates conditional statistical associations across the available bank-year observations. However, pooled estimation does not explicitly account for unobserved bank-specific heterogeneity or year-specific effects. Potential heteroskedasticity, serial correlation, cross-sectional dependence, and endogeneity may also influence the estimated coefficients. These issues are recognised limitations in panel-data econometric analysis (Baltagi, 2021; Wooldridge, 2010). Accordingly, the regression findings should be interpreted as statistical associations rather than causal relationships.
4. Indicator Coverage: The study focuses on selected financial indicators representing capital adequacy, asset quality, management efficiency, earnings performance, and liquidity. Other potentially relevant dimensions, including non-interest income, digital banking adoption, employee productivity, and customer service quality, are not directly incorporated into the empirical model. Their exclusion limits the extent to which broader institutional and technological differences can be examined.

6.3 Directions for Future Research

Building on the empirical findings and methodological limitations of the present study, several directions can be considered for future research.

1. Advanced Panel Data Econometric Modelling: Future studies could employ Fixed Effects and Random Effects models, as well as dynamic panel data techniques, including the Generalized Method of Moments (GMM), to account for unobserved bank-specific heterogeneity, profitability persistence, and potential endogeneity. Such approaches may provide more comprehensive insights into the determinants of banking profitability, subject to adequate sample size, valid instruments, and appropriate diagnostic validation (Arellano & Bover, 1995; Baltagi, 2021; Wooldridge, 2010).

2. Inclusion of Alternative Banking Institutions: Extending the research framework to include Small Finance Banks, Payment Banks, Regional Rural Banks, and foreign banks could provide a broader understanding of banking competition, financial inclusion, and credit deployment across rural, semi-urban, and urban regions of Tamil Nadu.

3. Fintech and Digital Banking Adoption: Future research could examine the relationship between digital banking adoption, mobile banking penetration, digital transaction volumes, and information technology investments with operational efficiency, non-interest income generation, and profitability. Such investigations could provide further insights into the role of technological transformation in shaping banking performance across ownership categories.

4. Multi-State Comparative Banking Analysis: Extending the geographical scope to include other economically significant Indian states, such as Maharashtra, Gujarat, and Karnataka, could facilitate comparisons of regional banking performance. Such research could investigate how differences in industrial structures, credit demand, regional economic development, and state-level financial conditions influence credit deployment and banking stability.

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Overall, future research incorporating broader institutional coverage, additional performance indicators, and more advanced econometric methodologies could strengthen the understanding of ownership-related differences in Indian banking performance. The present study provides a regional empirical foundation for further investigations into financial stability, profitability, operational efficiency, and regional credit intermediation.

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