

A Performance-Based Framework for Comparative NPA Management: Evidence from India's Top Banks

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Abstract

Non-performing assets (NPAs) are a central indicator of credit risk and asset quality in Indian banking. Despite the Reserve Bank of India's (RBI) Asset Quality Review (AQR) and the Insolvency and Bankruptcy Code (IBC), 2016, it remains debated how far NPA outcomes differ between public sector banks (PSBs) and private sector banks (PVBs), and why. This conceptual and research-design paper develops a performance-based framework to compare NPA management in the five largest PSBs and the five largest PVBs over FY2015-FY2024. The framework links corporate governance, credit risk management, digital adoption and regulatory reform to NPA outcomes (gross NPA, net NPA, recovery, write-offs) and to financial performance (return on assets and return on equity), and treats ownership as a moderating institutional variable. Four research gaps, four objectives, four research questions and five hypotheses are aligned one-to-one, and a mixed-methods testing plan is specified. Verified sector-level evidence shows that the gross NPA (GNPA) ratio of scheduled commercial banks (SCBs) fell from a peak of 11.18% in March 2018 to 1.8% in March 2026 (Press Information Bureau [PIB], 2025; Reserve Bank of India [RBI], 2026), while the write-off to GNPA ratio rose to 31.8% in FY2025 from 29.5% (RBI, 2025). Headline ratios therefore overstate recovery performance and justify a multi-indicator approach. Bank-level estimation is reserved for a follow-up empirical study; no empirical results are claimed here.

Keywords: non-performing assets; public sector banks; private sector banks; corporate governance; credit risk management; Insolvency and Bankruptcy Code; asset quality review

1. Introduction

The Indian banking system has been reshaped by the nationalisations of 1969 and 1980 and by the financial-sector liberalisation that began in 1991. These changes widened credit access and competition, but rapid credit growth was followed by a build-up of stressed loans. The RBI's AQR, initiated in 2015, was aimed at clean and fully provisioned balance sheets and revealed a high incidence of NPAs (Press Information Bureau [PIB], 2025). A non-performing asset is a loan or advance that has stopped generating income for the bank under prudential norms; such assets are classified as substandard, doubtful or loss according to the period of default.

NPAs matter because they reduce interest income, raise provisioning, constrain lending capacity and erode profitability and capital. Studies of Indian banks report that higher NPAs depress profitability (Das &

Uppal, 2021; Gaur & Mohapatra, 2021). NPAs are not caused by borrower default alone: bank-specific factors such as management quality and macroeconomic conditions both matter (Beck et al., 2015; Louzis et al., 2012; Swami et al., 2022). Ownership, governance and regulatory enforcement are further candidates for explaining why outcomes differ across banks.

Asset quality has improved sharply. According to the Government of India, the GNPA ratio rose to a high of 11.18% in March 2018 (PIB, 2025). The RBI reports that the GNPA ratio of SCBs fell to a multi-decadal low of 1.8% in March 2026 (Reserve Bank of India [RBI], 2026), compared with 2.3% in March 2025 (RBI, 2025) and 2.8% in March 2024 (RBI, 2024); the net NPA ratio was 0.4% in March 2026 (Saha, 2026). Write-offs, however, were a major component of NPA reduction over the five years to FY2025, with the write-off to GNPA ratio rising to 31.8% in FY2025 from 29.5% (RBI, 2025), and write-offs relative to GNPA remained elevated in 2025-26, particularly at PVBs and foreign banks (RBI, 2026). A lower closing ratio is therefore not, by itself, evidence of better NPA management. This paper responds by proposing a performance-based framework that evaluates NPA outcomes together with recoveries, write-offs and financial performance, and that tests whether ownership changes the strength of these relationships.

The remainder of the paper is organised so that each element follows from the previous one: scope (Section 2), theory (Section 3), literature and research gaps (Section 4), objectives, research questions and hypotheses (Section 5), conceptual framework (Section 6), methodology and analysis plan (Sections 7-8), preliminary evidence (Section 9), findings (Section 10), implications (Section 11), limitations and future research (Sections 12-13), conclusion (Section 14) and recommendations (Section 15). Table 1 maps gaps, objectives, questions and hypotheses one-to-one.

2. Scope of the Study

The study covers the five largest public sector banks and the five largest private sector banks by total assets. The PSB group comprises State Bank of India, Punjab National Bank, Bank of Baroda, Canara Bank and Union Bank of India; the PVB group comprises HDFC Bank, ICICI Bank, Axis Bank, Kotak Mahindra Bank and IndusInd Bank. The analysis period is FY2015 to FY2024 (fiscal years ending March 2015 to March 2024), giving up to 100 bank-year observations. FY2015 serves as a pre-AQR baseline; FY2016-FY2018 is treated as the AQR recognition period; and FY2019-FY2024 as the IBC-resolution period. These cut-offs are set in advance and tested for sensitivity (Section 8). Sector-wide figures up to March 2026 are used for context only. Banks are ranked by total assets as reported in their March 2024 annual reports.

Cooperative banks, regional rural banks, foreign banks and small finance banks are excluded because they differ in regulation, scale and business model from large commercial banks; the comparison is therefore confined to two groups of large commercial banks that operate under similar regulatory and market conditions.

3. Theoretical Framework

3.1 Agency theory and ownership

Agency theory (Jensen & Meckling, 1976) explains how the separation of ownership and control creates monitoring costs. In PSBs the government is the principal and pursues policy and social objectives alongside commercial ones; in PVBs, market and shareholder discipline are more direct. Cross-country evidence associates government ownership of banks with slower financial development (La Porta et al.,

2002), and studies of non-performing loans report evidence consistent with moral hazard in lending (Thomas & Thakur, 2023; Zhang et al., 2016). Indian evidence on efficiency is, however, mixed: state-owned banks were more efficient than rivals during the Global Financial Crisis, while private banks caught up by 2017 (Wanke et al., 2022). Public ownership therefore does not by itself imply poor asset quality; it shapes incentives that govern monitoring, risk appetite and recovery effort.

3.2 Credit risk theory

Credit risk depends on borrower quality, loan structure, sectoral concentration, collateral and the quality of screening and monitoring. The “bad luck” versus “bad management” distinction is central: NPAs may follow adverse shocks, or they may reflect weak underwriting and cost inefficiency (Berger & DeYoung, 1997; Podpiera & Weill, 2008; Williams, 2004). Management quality and macroeconomic variables both explain NPLs (Louzis et al., 2012), and credit risk differs across institutional regimes (Salas & Saurina, 2002). Relationship-based monitoring generates information that improves credit allocation (Petersen & Rajan, 1994). NPA management therefore begins before default, through appraisal, early-warning systems and monitoring, and NPAs in turn lower measured bank efficiency (Hafsal et al., 2020).

3.3 Regulatory and institutional perspective

The AQR and the IBC are institutional reforms for recognising and resolving stressed assets. The IBC, for example, expanded credit availability and lowered borrowing costs for distressed Indian firms (Bose et al., 2021). Formal rules, however, work only through organisations able to implement them, and banks of different ownership types show significant heterogeneity in profitability and soundness (Banerjee & Velamuri, 2015). The framework therefore expects reform effects to vary with ownership.

4. Literature Review and Research Gap

4.1 Determinants of NPAs

International evidence identifies macroeconomic drivers such as GDP growth across 75 countries (Beck et al., 2015), and both macroeconomic and bank-specific drivers of loan quality (Ghosh, A., 2015; Louzis et al., 2012). For India, studies examine leverage (Ghosh, S., 2005) and risk factors that diminish asset quality (Swami et al., 2022). Dynamic-panel work on 40 public and private banks finds that inflation, the policy repo rate, the exchange rate and bank type are significant determinants of NPAs (Mishra et al., 2021). NPAs are in turn associated with lower profitability (Das & Uppal, 2021; Gaur & Mohapatra, 2021), so managing them is closely linked with overall bank performance.

4.2 PSB versus PVB performance

Comparative studies analyse the factors behind NPAs in public and private sector banks (Kandpal, 2020) and document heterogeneity in profitability and soundness by ownership type (Banerjee & Velamuri, 2015). Ownership and efficiency have been examined for Indian banks (Wanke et al., 2022), and ownership and NPLs have been studied in other economies (Hu et al., 2004; Us, 2017), as has ownership and performance in transition countries (Bonin et al., 2005). A lower NPA ratio should not be read automatically as better performance, because NPAs interact with efficiency and capital (Berger & DeYoung, 1997; Hafsal et al., 2020; Kwan & Eisenbeis, 1997).

4.3 Corporate governance and asset quality

Information asymmetry in lending makes governance important. Using data on 45 Indian banks for 2010-2019, Gupta and Sharma (2022) find that board activity, board functioning and ownership concentration are significant determinants of asset quality, whereas board size and independence are not. A governance

index has also been related to NPLs for US commercial banks (Tarchouna et al., 2017). Governance effects may differ by ownership, which motivates the moderation design used here.

4.4 AQR and regulatory recognition

The AQR shifted banks from forbearance towards recognition. A reasonable reading is that the post-2015 rise in reported NPAs reflected recognition of existing stress rather than new deterioration alone, but this is an interpretation that the study tests by separating the AQR period (FY2016-FY2018) from later periods rather than assuming it. In the studies reviewed here, none isolates the AQR period together with the IBC period and with write-offs in a single bank-level comparison.

4.5 IBC and resolution effectiveness

Firm-level evidence shows that the IBC improved credit access and lowered the cost of debt for distressed Indian firms, using a panel of 33,845 firms for 2008-2019 (Bose et al., 2021). Bank-level evidence on how the IBC period relates to NPA ratios, recoveries and write-offs is thinner, and the RBI notes that write-offs, not only recoveries, drove NPA reduction (RBI, 2025).

4.6 Digital capability and NPA management

Better information on borrowers should improve screening and monitoring (Petersen & Rajan, 1994), and digital capability is one route to such information. At the same time, rapid automated lending without sound risk assessment can create new credit risk. None of the Indian NPA studies reviewed in this paper includes a digital-adoption variable, so the digital hypothesis (H3) is treated as exploratory.

4.7 Research gaps

Four gaps follow from the review. **G1:** NPA and profitability studies in India typically use broad bank samples and examine NPA determinants or the NPA-profitability link separately (Das & Uppal, 2021; Gaur & Mohapatra, 2021; Mishra et al., 2021; Swami et al., 2022); few compare the largest PSBs and PVBs on NPA outcomes and financial performance across the full AQR and IBC cycle. **G2:** Governance studies (Gupta & Sharma, 2022) do not jointly model governance, credit risk management and digital adoption against both NPA outcomes and performance. **G3:** IBC evidence is mainly firm-side (Bose et al., 2021), and bank-level analyses seldom separate recoveries from write-offs, which the RBI identifies as a major driver of NPA reduction (RBI, 2025). **G4:** Ownership is usually a grouping or control variable; its role as a moderator of governance, digital and regulatory effects on NPA outcomes is not tested jointly in the studies reviewed (Banerjee & Velamuri, 2015; Gupta & Sharma, 2022). These gaps are addressed one-to-one by the objectives below.

5. Objectives, Research Questions and Hypotheses

5.1 Research objectives

1. **(addresses G1).** To compare trends in NPA outcomes (GNPA, NNPA, recovery rate) and financial performance (ROA, ROE) of the five largest PSBs and PVBs over FY2015-FY2024.
2. **(addresses G2).** To examine how corporate governance, credit risk management and digital adoption relate to NPA outcomes and financial performance.
3. **(addresses G3).** To assess how the AQR and IBC periods relate to NPA recognition, resolution and asset quality, distinguishing recoveries from write-offs.
4. **(addresses G4).** To test whether ownership structure (PSB versus PVB) moderates the relationships examined in O2 and O3.

5.2 Research questions

RQ1 (O1): Do the NPA outcomes and financial performance of the selected PSBs differ significantly

from those of the selected PVBs over FY2015-FY2024?

RQ2 (O2): How are governance, credit risk management and digital adoption associated with NPA outcomes and financial performance?

RQ3 (O3): How are the AQR and IBC periods associated with NPA ratios and recovery, and how much of the decline in NPAs reflects write-offs rather than recoveries?

RQ4 (O4): Does ownership moderate the effects of governance, credit risk management, digital adoption and regulatory reform on NPA outcomes?

5.3 Hypotheses

H1 (RQ1): Mean GNPA, NNPA, ROA and ROE differ significantly between PSBs and PVBs over FY2015-FY2024.

H2 (RQ2): Governance quality and credit risk management are negatively associated with the NPA ratio.

H3 (RQ2): Digital adoption is negatively associated with NPA ratios and positively associated with ROA and ROE.

H4 (RQ3): After controlling for size and credit-deposit ratio, NPA ratios are lower and recovery rates higher in the IBC-resolution period (FY2019-FY2024) than in the AQR recognition period (FY2016-FY2018).

H5 (RQ4): Ownership moderates (changes the strength of) the effects of governance, credit risk management, digital adoption and regulatory period on the NPA ratio.

Ownership is specified as a *moderator* rather than a mediator, because it is a fixed bank characteristic that conditions the strength of other relationships (Baron & Kenny, 1986).

Table 1. Alignment of gaps, objectives, research questions, hypotheses and tests

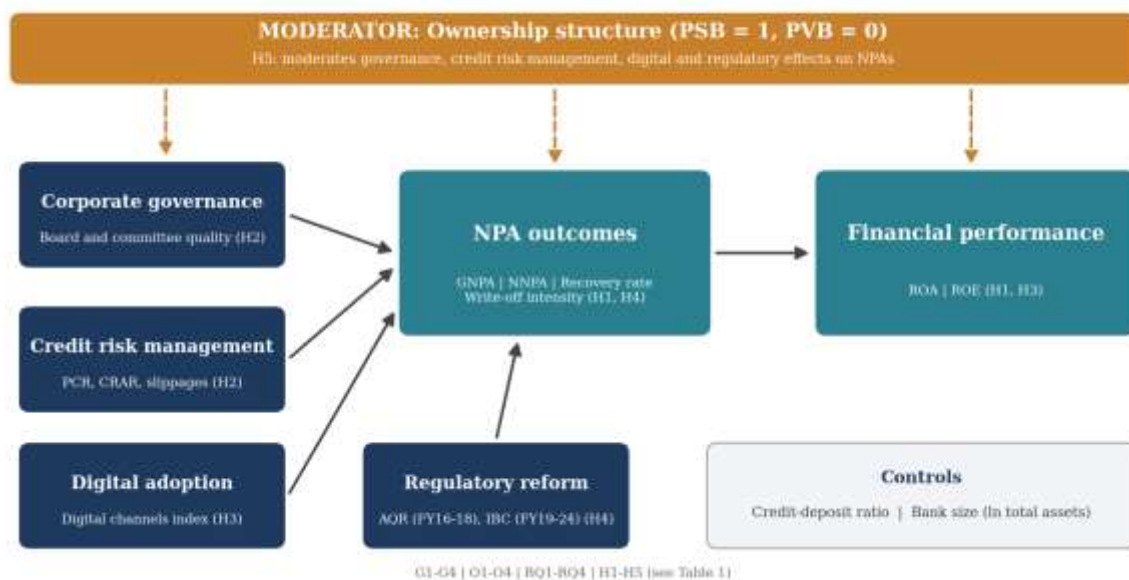
Gap	Objective	RQ	Hypothesis	Variables and test (Sections 7-8)
G1: no like-for-like comparison of largest PSBs and PVBs across the AQR-IBC cycle	O1: compare NPA outcomes and performance	RQ1	H1	GNPA, NNPA, recovery, ROA, ROE; Welch's t-test, Mann-Whitney U, trend comparison
G2: governance, credit risk management and digital adoption not modelled jointly	O2: examine their relation to NPAs and performance	RQ2	H2, H3	Governance, CRM and Digital indices; Models 1 and 3
G3: bank-level IBC/AQR effects and write-offs not separated	O3: assess AQR and IBC periods; split recoveries and write-offs	RQ3	H4	Period dummies, recovery rate, write-off intensity; Model 1
G4: ownership rarely tested as moderator	O4: test moderation by ownership	RQ4	H5	Interaction terms (Model 2); moderation per Baron and Kenny (1986)

Note. G = research gap; O = objective; RQ = research question; H = hypothesis; CRM = credit risk management.

6. Conceptual Framework

The framework places ownership structure (PSB or PVB) as the institutional condition that moderates the main explanatory mechanisms: corporate governance, credit risk management, digital adoption and regulatory reform (the AQR and IBC periods). These four mechanisms are modelled in parallel as explanatory variables, as in Models 1 and 2, and they act on NPA outcomes (gross NPA, net NPA, recovery rate and write-off intensity), which in turn affect financial performance (ROA and ROE). Ownership conditions each of these paths (H5). Figure 1 summarises the framework and the hypotheses attached to each path.

Figure 1. Performance-based framework for comparative NPA management
Performance-Based Framework for Comparative NPA Management



Note. H = hypothesis; PCR = provision coverage ratio; CRAR = capital adequacy ratio; AQR = Asset Quality Review; IBC = Insolvency and Bankruptcy Code.

7. Research Methodology

7.1 Research design

The study uses a sequential mixed-methods design. The quantitative component, a ten-bank panel, identifies trends and relationships; the qualitative component, semi-structured interviews with banking professionals, explains differences in governance, credit appraisal, recovery and regulatory implementation. The interview sample will be purposive (target 10-15 respondents, subject to saturation) and responses will be coded thematically.

7.2 Data sources

Annual data for FY2015-FY2024 will be taken from RBI statistical and supervisory publications, individual bank annual reports and investor disclosures, and Indian Banks' Association publications; macroeconomic controls will come from World Bank and RBI series. Several banks in the sample were reshaped by amalgamations: Dena Bank and Vijaya Bank merged into Bank of Baroda in 2019; Oriental Bank of Commerce and United Bank of India merged into Punjab National Bank, Syndicate Bank into Canara Bank, and Andhra Bank and Corporation Bank into Union Bank of India with effect from 1 April

2020; and the associate banks of State Bank of India had merged into it earlier (Press Trust of India, 2020). HDFC Ltd. also merged into HDFC Bank in mid-2023. Bank-level series will therefore be restated on a pro-forma basis from annual-report disclosures, and a sensitivity analysis will exclude merger years.

7.3 Variables and measurement

Table 2. Variables and measurement

Variable	Measurement	Role	Source
Gross NPA (GNPA)	Gross NPAs / gross advances $\times 100$	Dependent	Annual reports; RBI
Net NPA (NNPA)	Net NPAs / net advances $\times 100$	Dependent	Annual reports; RBI
Recovery rate	Recoveries and upgrades during the year / (opening GNPA + slippages) $\times 100$	Dependent	Annual reports (NPA movement tables)
Write-off intensity	Write-offs / opening GNPA $\times 100$ (analogous to the RBI's sector-level write-off to GNPA ratio)	Dependent (decomposition)	Annual reports; RBI
ROA	Net profit / average total assets	Performance	Annual reports
ROE	Net profit / average equity	Performance	Annual reports
Governance score	Standardised composite of disclosed board indicators (board independence, meeting frequency, committee activity, chair-CEO separation)	Independent	Annual and governance reports
Credit risk management (CRM) index	Standardised composite of provision coverage ratio, capital adequacy ratio and slippage ratio (reverse-scored)	Independent	Annual reports; Pillar 3
Digital adoption index	Standardised composite of disclosed digital indicators (for example, share of digital transactions and digital channel penetration)	Independent	Annual reports
Regulatory period	Post-AQR dummy (FY2016-FY2018) and Post-IBC dummy (FY2019-FY2024); FY2015 is the baseline	Independent	Defined ex ante
Ownership	PSB = 1; PVB = 0	Moderator	RBI classification
Credit-deposit ratio	Total advances / total deposits $\times 100$	Control	Annual reports
Bank size	Natural log of total assets	Control	Annual reports

Note. Composite indices will be built from standardised components with equal weights; alternative weights are used as robustness checks.

7.4 Ethical considerations

Financial data will be drawn only from publicly verifiable sources. Interviews will be conducted with informed consent; respondents' identities will not be disclosed and responses will be reported in pooled form so that no bank-specific confidential information is revealed. Institutional ethics approval will be obtained before fieldwork.

8. Data Analysis Plan

Analysis proceeds in five stages. (1) Descriptive statistics (mean, median, standard deviation, minimum, maximum) for all variables. (2) Trend comparison of NPA ratios and financial performance between the two groups. (3) Group-difference tests for H1: an independent-samples t-test, replaced by Welch's t-test when variances are unequal, and a Mann-Whitney U test on bank-level means as a check, because bank-year observations are serially correlated and each group contains only five banks. (4) Panel regression for H2-H4. (5) Moderation analysis for H5 using interaction terms with mean-centred predictors (Baron & Kenny, 1986).

Model 1 (NPA outcomes): $NPA_{it} = \beta_0 + \beta_1 Gov_{it} + \beta_2 CRM_{it} + \beta_3 Dig_{it} + \beta_4 AQR_t + \beta_5 IBC_t + \beta_6 Own_i + \beta_7 CD_{it} + \beta_8 Size_{it} + \varepsilon_{it}$

Model 2 (moderation): Model 1 plus $Gov \times Own$, $CRM \times Own$, $Dig \times Own$, $AQR \times Own$ and $IBC \times Own$.

Model 3 (performance): ROA_{it} (and ROE_{it}) = $\delta_0 + \delta_1 NPA_{it} + \delta_2 Gov_{it} + \delta_3 CRM_{it} + \delta_4 Dig_{it} + \delta_5 CD_{it} + \delta_6 Size_{it} + v_{it}$

Because ownership is time-invariant, bank fixed effects would absorb it; Models 1 and 3 are therefore estimated with random effects (chosen by a Hausman test) and Model 2 with bank fixed effects, in which only the interaction terms are identified. Inference uses bank-clustered standard errors with a wild-bootstrap correction, given that there are only ten clusters. NPAs are persistent, so a lagged dependent variable is added as a robustness check. Difference and system GMM (Arellano & Bond, 1991; Blundell & Bond, 1998) are designed for panels with many cross-sectional units and a short time dimension; with ten banks they would suffer from instrument proliferation and are reserved for an extended sample (Section 13). Further robustness checks cover alternative regulatory cut-offs, alternative index weights, and exclusion of banks affected by mergers. Estimation will be carried out in Stata or R, with SPSS used for descriptive statistics.

Table 3. Test plan and decision rules

Test	Statistic to report	Decision rule	Status
PSB vs PVB: GNPA, NNPA, ROA, ROE (H1)	t (or Welch t), df, p; U, p	Reject equality if $p < .05$ on both tests	Planned (follow-up study)
Governance, CRM → NPA (H2)	β , SE, p	Support if $\beta < 0$ and $p < .05$	Planned (follow-up study)
Digital adoption → NPA, ROA/ROE (H3)	β , SE, p	Support if $\beta < 0$ (NPA) and $\beta > 0$ (ROA/ROE)	Planned; exploratory
IBC vs AQR period (H4)	β on period dummies, p	Support if NPA lower and recovery higher in IBC period	Planned (follow-up study)

Test	Statistic to report	Decision rule	Status
Ownership moderation (H5)	Interaction β , SE, p	Support if at least one interaction is significant at $p < .05$	Planned (follow-up study)

9. Preliminary Evidence

This paper is a conceptual and research-design contribution. Bank-level estimation and interviews are reserved for a follow-up empirical study; accordingly no t-values, p-values, coefficients or R^2 are reported here. This section presents verified sector-level evidence that motivates the framework (Table 4) and a descriptive timeline of the reform cycle (Table 5).

9.1 Verified sector-level evidence

Table 4. Verified sector-level asset-quality indicators for scheduled commercial banks

Indicator	Value	Source
GNPA ratio, peak, March 2018	11.18%	PIB (2025), citing RBI data
GNPA ratio, March 2024	2.8%	RBI (2024)
GNPA ratio, March 2025	2.3%	RBI (2025)
GNPA ratio, March 2026 (multi-decadal low)	1.8%	RBI (2026)
Net NPA ratio, March 2024 → March 2026	0.6% → 0.4%	RBI (2024); Saha (2026)
Write-off to GNPA ratio, FY2024 → FY2025	29.5% → 31.8%	RBI (2025)
PSB GNPA ratio, March 2024 → March 2025	3.7% → 2.8%	All India Radio (2025), reporting RBI (2025)

Note. RBI (2025) states that write-offs by private and foreign banks led the rise in the write-off ratio, while write-offs by PSBs declined marginally; RBI (2026) states that write-offs relative to GNPA's remained elevated in 2025-26, particularly for PVBs and foreign banks. Figures are for SCBs unless stated; the peak value is on the basis reported by PIB (2025), which may differ slightly from the RBI Financial Stability Report basis (for example, PIB reports 2.2% for March 2025 against 2.3% in RBI, 2025).

9.2 Reform cycle (descriptive)

Table 5. Broad development of asset quality across the study period (interpretive)

Period	Broad banking-sector development	Interpretation to be tested
FY2015	Pre-AQR baseline	Reference level for the panel
FY2016-FY2018	AQR period; recognition of stressed loans	Recognition of previously unrecognised stress (tested via H4)
FY2019-FY2024	IBC resolution and provisioning; pandemic disruption in FY2020-FY2021	Resolution, write-offs and balance-sheet repair (tested via H4)

Period	Broad banking-sector development	Interpretation to be tested
FY2025-FY2026	GNPA 2.3% (March 2025) and 1.8% (March 2026) (RBI, 2025, 2026)	Multi-decadal lows; context only, outside the panel

9.3 Ownership comparison

Published studies indicate that ownership differences remain relevant despite aggregate improvement: performance and soundness vary by ownership type (Banerjee & Velamuri, 2015), efficiency trajectories differ between state-owned and private banks (Wanke et al., 2022), and governance determinants of asset quality are examined across public and private banks (Gupta & Sharma, 2022). Whether the ten selected banks differ significantly is a question for the tests in Table 3.

10. Findings and Discussion

The findings below are preliminary. Each is tied to an objective, research question and hypothesis, and each states what the evidence does and does not yet establish.

Finding 1 (O1, RQ1, H1). System-wide asset quality has improved markedly: the SCB GNPA ratio fell from a peak of 11.18% in March 2018 (PIB, 2025) to 2.8% in March 2024 (RBI, 2024), 2.3% in March 2025 (RBI, 2025) and 1.8% in March 2026 (RBI, 2026). Sector aggregates, however, cannot show whether the five PSBs and five PVBs selected here differ significantly; H1 is to be tested in the follow-up study.

Finding 2 (O3, RQ3, H4). NPA reduction cannot be judged from closing ratios alone. The write-off to GNPA ratio rose to 31.8% in FY2025, the RBI describes write-offs as a major component of NPA reduction over five years (RBI, 2025), and write-offs relative to GNPA remained elevated in 2025-26 (RBI, 2026). This supports measuring recoveries, upgrades and write-offs separately, as the framework does; the direction of the AQR-to-IBC change in recoveries (H4) awaits bank-level data.

Finding 3 (O2, RQ2, H2, H3). The literature indicates that governance and management quality matter for asset quality (Gupta & Sharma, 2022; Louzis et al., 2012; Tarchouna et al., 2017), which supports H2. Evidence linking digital adoption to NPAs is not available in the reviewed Indian studies, so H3 is exploratory and no finding on it can yet be claimed.

Finding 4 (O4, RQ4, H5). Published evidence on heterogeneity by ownership (Banerjee & Velamuri, 2015; Gupta & Sharma, 2022; Wanke et al., 2022) justifies modelling ownership as a moderator rather than a control, but the moderation itself (H5) has not yet been estimated.

Table 6. Alignment of findings with objectives and conclusions

Finding	Aligned with	Evidence status	Conclusion (Section 14)
F1: system asset quality improved; bank-level difference unknown	G1, O1, RQ1, H1	Sector data verified; H1 to be tested	C1
F2: write-offs are a major part of NPA reduction	G3, O3, RQ3, H4	Sector data verified; H4 to be tested	C2
F3: governance matters; digital evidence absent	G2, O2, RQ2, H2-H3	Literature-based; H2 supported in the literature, H3 exploratory	C3

Finding	Aligned with	Evidence status	Conclusion (Section 14)
F4: ownership heterogeneity supports moderation design	G4, O4, RQ4, H5	Literature-based; H5 to be tested	C4

Taken together, the evidence supports the framework's design but does not yet confirm its hypotheses. A technology-enabled credit process is expected to help only where governance and credit culture are sound, which is why the framework tests technology jointly with governance and ownership rather than in isolation.

11. Practical, Policy and Academic Implications

11.1 Implications for bank management

If the planned tests confirm H2, management should strengthen the whole credit-risk cycle (appraisal, monitoring, early-warning systems, concentration limits and recovery) rather than rely on post-default action. The management-quality evidence from the NPL literature points the same way (Louzis et al., 2012; Podpiera & Weill, 2008).

11.2 Implications for regulators and policymakers

Because write-offs were a major component of NPA reduction (RBI, 2025), supervisors should assess asset quality using recoveries, slippages, upgrades, write-offs and provisions together, not the GNPA ratio alone. If H5 is supported, supervisory focus should be differentiated by ownership. Evidence that the IBC improved credit conditions for distressed firms (Bose et al., 2021) supports continued attention to the speed and predictability of resolution.

11.3 Academic implications

The study moves the debate from which banks have higher NPAs to why outcomes differ, by combining governance, credit risk management, digital adoption, regulatory period and ownership in one design (G1-G4).

12. Limitations

First, the sample of ten large banks cannot represent cooperative banks, regional rural banks or smaller banks, and with ten banks statistical power is limited and dynamic GMM estimators are unsuitable. Second, disclosure practices differ across banks and years. Third, bank amalgamations and one parent-subsidiary merger in the period affect comparability and require pro-forma restatement. Fourth, the AQR and IBC overlap with macroeconomic events, including the pandemic, so period dummies cannot establish causality without a quasi-experimental design. Fifth, the governance, credit risk management and digital indices involve subjective coding choices that may introduce measurement error. Sixth, expert interviews are exposed to selection and social-desirability bias. Finally, this paper reports verified sector-level data only; bank-level estimation is left to the follow-up study.

13. Future Research Directions

Future work can (a) extend the sample to cooperative and regional rural banks to test whether the ownership-governance relationship differs across institution types; (b) use longer or larger panels so that dynamic estimators (Arellano & Bond, 1991; Blundell & Bond, 1998) become appropriate and so that persistence in asset quality can be examined; (c) assess the causal effect of the IBC with difference-in-

differences or survival analysis, building on firm-level designs such as Bose et al. (2021); and (d) compare countries with different public-ownership shares in banking.

14. Conclusion

C1 (from F1; O1, H1). Indian banks have moved from acute asset-quality stress to much stronger balance sheets: the SCB GNPA ratio was 1.8% and the net NPA ratio 0.4% in March 2026 (RBI, 2026; Saha, 2026), against a peak of 11.18% in March 2018 (PIB, 2025). Whether the largest PSBs and PVBs differ significantly in NPA outcomes and performance will be settled by the bank-level tests in Table 3.

C2 (from F2; O3, H4). NPA management should be evaluated through recoveries, write-offs and profitability, not closing ratios alone, because write-offs were a major component of NPA reduction (RBI, 2025). The proposed framework operationalises this through recovery rate and write-off intensity.

C3 (from F3; O2, H2-H3). Governance and management quality are credible drivers of asset quality in the literature (Gupta & Sharma, 2022; Louzis et al., 2012); the role of digital adoption remains an open, exploratory question.

C4 (from F4; O4, H5). Ownership is best treated as a moderating institutional variable, because published evidence shows heterogeneity in performance and in governance effects across bank types (Banerjee & Velamuri, 2015; Gupta & Sharma, 2022). The main contribution of the paper is therefore a performance-based framework that integrates governance, credit risk management, digital adoption and regulatory reform, with ownership as a moderator, together with a pre-specified testing plan. The paper does not claim empirical confirmation of H1-H5; those results will be reported once the bank-level dataset is analysed.

15. Recommendations

The recommendations below are conditional on the hypotheses being supported by the planned analysis.

15.1 Recommendations for PSBs

PSBs should strengthen board-level accountability for credit quality, improve the independence and effectiveness of risk and audit committees, and use data analytics in early-warning systems. Transparency in credit-decision and recovery processes can reduce agency problems of the kind described by Jensen and Meckling (1976).

15.2 Recommendations for PVBs

PVBs should use their operational and technology capacity to ensure that rapid credit growth does not weaken underwriting standards, and should support digital lending with sound borrower assessment, stress testing and continuous portfolio monitoring.

15.3 Recommendations for the RBI and policymakers

The RBI and policymakers should continue to assess NPAs through recoveries, slippages, upgrades, provisioning and write-offs rather than a single GNPA ratio, consider ownership-sensitive supervision if H5 is supported, and keep strengthening the speed, predictability and recovery outcomes of the IBC process.

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