

Post-COVID-19 trends in non-performing assets: insights from the Indian banking sector

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Abstract

Purpose – This study examines whether the post-COVID-19 decline in non-performing assets (NPAs) in India's banking sector reflects pandemic-specific policy interventions or longer-term structural reforms implemented prior to the crisis.

Design/methodology/approach – The study employs a mixed-methods research design combining econometric analysis with qualitative policy triangulation. Using an unbalanced panel dataset covering Indian public, private, foreign, and scheduled commercial banks from 2004 to 2024, the analysis applies descriptive statistics, OLS regressions, and dynamic panel estimation using the two-step System Generalized Method of Moments (GMM). A two-sample *t*-test compares pre- and post-COVID NPA dynamics, while robustness checks and diagnostic tests validate model stability.

Findings – Gross and net NPAs in Indian banks peaked around 2018 and declined thereafter. Statistical analysis indicates that the rate of decline in NPAs after 2020 is not significantly different from the pre-pandemic trend. These findings suggest that improvements in asset quality are more consistent with structural reforms—particularly the Insolvency and Bankruptcy Code (IBC) and the RBI's Prompt Corrective Action framework—than with temporary COVID-era relief measures.

Originality/value – The study provides a 21-year longitudinal assessment of NPA dynamics in India's banking sector, integrating econometric modeling with policy analysis to distinguish structural reforms from crisis-driven interventions. The results contribute to the literature on financial resilience and regulatory effectiveness in emerging banking systems.

Keywords Non-performing assets, Indian banking sector, COVID-19, Banking reforms, Financial stability

Paper type Research article

1. Introduction

The COVID-19 pandemic placed extraordinary pressure on banking systems worldwide, especially in emerging markets such as India. Among the key challenges was the risk of rising Non-Performing Assets (NPAs), which had already been a persistent issue in India's banking sector long before the pandemic. NPAs—loans that remain overdue for interest or principal payments—undermine banks' stability, limit credit growth, and strain the broader economy (Ghosh, 2020; Bhashin and Rajesh, 2022).

Prior to COVID-19, Indian banks, particularly public sector banks, struggled with high levels of NPAs due to weak credit appraisal systems, structural inefficiencies, and sluggish economic growth (World Bank, 2024). The pandemic deepened these vulnerabilities. Lockdowns, business closures, and falling consumer demand created financial stress for borrowers, increasing the likelihood of defaults (Acharya, 2020). In response, the Reserve Bank of India (RBI) introduced a series of relief measures, including loan moratoria, restructuring frameworks, and emergency credit lines to provide short-term stability (RBI, 2021).

JEL Classification — G21, G28, E44, E65, H12, O16

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These interventions were necessary under the circumstances, but they also raised concerns about long-term consequences. Scholars have warned that prolonged forbearance can encourage the “evergreening” of bad loans and delay proper recognition of credit risk by allowing banks to avoid realizing losses on their balance sheets (Peek and Rosengren, 2005). This can result in “zombie” lending, where unviable firms continue to receive funding, weakening credit discipline and economic efficiency.

Despite significant attention from policymakers and analysts, there remains limited empirical evidence that separates the effects of pandemic-era relief from earlier structural reforms—particularly the impact of the Insolvency and Bankruptcy Code (IBC) introduced in 2016. Most studies describe general trends or policy measures but do not statistically test whether recent improvements in NPAs are more consistent with short-term interventions or by deeper structural changes. This interpretation aligns with recent evidence highlighting the role of structural reforms and institutional evolution in shaping India’s post-liberalization financial sector (Bonelli, 2025a, b, c).

To investigate this issue, the study analyzes NPA trends over a 21-year period (2004–2024) using publicly available panel data from Indian banks. It includes macroeconomic controls (GDP growth, inflation, repo rate) and accounts for policy milestones such as the IBC and COVID-era forbearance. The analysis is based on fixed-effects regressions and simple *t*-tests to ensure transparency and avoid overstating the complexity of the methods.

This study contributes to the ongoing conversation on financial resilience in the Indian banking sector by offering evidence on whether the recent decline in NPAs is due to temporary relief or lasting reforms. It also aims to support policy decisions by highlighting which measures have been most effective in improving asset quality.

The research is guided by the following questions:

- (1) How have NPA levels evolved in Indian banks before and after the COVID-19 pandemic, and is the observed improvement statistically significant?
- (2) What are the primary drivers—structural or cyclical—behind changes in NPAs during this period?
- (3) What practical measures and reforms can help further improve asset quality and financial stability in the Indian banking sector?

By addressing these questions, the paper seeks to clarify what lessons can be drawn from India’s experience with NPAs and how these insights might guide future regulatory and policy actions.

The remainder of the paper is structured as follows. [Section 2](#) reviews the literature on NPA dynamics, regulatory interventions, and post-crisis asset quality adjustments in the Indian banking sector. [Section 3](#) describes the data, variable construction, and econometric methodology used to analyze NPA trends over 2004–2024. [Section 4](#) presents the empirical results from descriptive analysis, regression models, and robustness diagnostics. [Section 5](#) discusses the findings in relation to the study’s research questions and outlines implications for policy and practice. [Section 6](#) concludes and highlights limitations and directions for future research.

2. Literature review

This section reviews the evolution of non-performing assets in the Indian banking sector, with particular attention to their structural determinants, regulatory context, and relevance for financial stability.

2.1 Introduction to non-performing assets in Indian banking

Non-Performing Assets (NPAs) remain a persistent challenge in the Indian banking sector, serving as a critical indicator of financial stability and operational efficiency. NPAs, defined as

loans or advances overdue beyond a specified period, erode profitability and weaken banks' balance sheets (RBI, 2021). Before the COVID-19 pandemic, Indian banks—particularly public sector banks—struggled with high NPA levels due to factors such as inadequate credit appraisal mechanisms, weak governance structures, and sluggish economic growth (Acharya, 2020).

In the broader banking and macro-financial literature, deteriorations in asset quality are often discussed as part of wider boom–bust and crisis dynamics. Cross-country evidence links systemic banking stress to weak macroeconomic conditions and credit-cycle build-ups, implying that NPL/NPA dynamics are rarely purely bank-internal phenomena (Demirgüç-Kunt and Detragiache, 1998; Schularick and Taylor, 2012). Related work highlights that banking stress can interact with external vulnerabilities in “twin crises” episodes (Kaminsky and Reinhart, 1999), while long-run historical syntheses emphasize the recurring nature of financial instability across countries and regimes (Reinhart and Rogoff, 2009). Empirical NPL studies also show that macro variables (growth, unemployment, interest rates) and bank-level features (management quality and balance-sheet strength) can jointly shape problem-loan dynamics (Louzis *et al.*, 2012; Klein, 2013).

The pandemic deepened these vulnerabilities. Economic disruptions severely affected sectors such as hospitality, real estate, and small and medium enterprises (SMEs), sharply increasing default risks and creating unprecedented pressures on asset quality (Bhashin and Rajesh, 2022). Marcu (2021) argues that COVID-19 became a critical turning point, forcing banks to adopt innovative and proactive strategies to manage their credit risk exposures more effectively.

Recent literature from Mani *et al.* (2023) is consistent with the view that, despite the unprecedented nature of the pandemic, India's banking sector exhibited surprising resilience due to aggressive policy measures, including loan write-offs, recoveries, and cautious lending practices, resulting in improved headline NPAs by 2023. Nonetheless, researchers emphasize that such improvements should be critically examined for sustainability, especially in emerging markets where underlying financial vulnerabilities remain persistent (El-Chaarani *et al.*, 2023; RBI, 2023). This concern is echoed by Mani *et al.* (2023), who argue that India's NPA problem remains structurally embedded in the financial-macroeconomic system and demonstrate through a satellite model that improvements in headline NPAs may not reflect deeper systemic risks.

2.2 Regulatory responses to rising NPAs

The Reserve Bank of India (RBI) was pivotal in shaping responses to NPAs, especially during the COVID-19 pandemic. Regulatory interventions, including loan moratoria, restructuring frameworks, and emergency credit guarantees, were designed to provide immediate relief while preserving financial stability (RBI, 2021). The Insolvency and Bankruptcy Code (IBC) of 2016 also provided a crucial mechanism for resolving distressed assets, significantly improving recovery processes compared to previous frameworks (Modani, 2021).

However, Garg and Kaushik (2021) argue that such regulatory measures alone cannot effectively address structural weaknesses within banks. They emphasize the importance of robust early-warning systems, stress testing, and tailored solutions, particularly for resource-constrained smaller banks. Similarly, recent global studies underscore that regulatory forbearance, though beneficial in the short term, carries significant risks of moral hazard, including the perpetuation of “zombie lending” practices (Igwe, 2022).

International evidence suggests that large NPL clean-ups in systemic episodes typically rely on *policy bundles*—combining supervisory actions, loss recognition and restructuring, resolution tools, and, where needed, recapitalization—while balancing speed of balance-sheet repair against moral hazard and delayed restructuring incentives (Laeven and Valencia, 2018; Pazarbasioglu *et al.*, 2011; Philippon and Schnabl, 2013). Related macro-financial work argues that when credit booms precede stress, macroprudential tools and supervisory

tightening may reduce the severity of later asset-quality deterioration (Bakker *et al.*, 2012). At the same time, prolonged forbearance can contribute to “zombie lending” dynamics that impede reallocation and recovery, as documented in classic firm–bank evidence from Japan (Caballero *et al.*, 2008). In this framing, India’s IBC and PCA can be positioned as efforts to strengthen restructuring and discipline mechanisms rather than purely short-run relief measures.

A complementary institutional channel highlighted in comparative finance research is that stronger creditor rights and information institutions are associated with deeper and more stable credit intermediation (Djankov *et al.*, 2007). India-specific micro evidence from earlier legal enforcement reforms indicates that strengthening debt recovery mechanisms can affect repayment behavior and lending decisions (Visaria, 2009), providing conceptually relevant grounding for why reforms aimed at improving recovery and enforcement could matter for asset-quality dynamics over time.

2.3 Post-pandemic adaptations and technological Innovations

The COVID-19 crisis accelerated digital transformations in banks, significantly reshaping credit risk management practices. Technologies such as artificial intelligence (AI) and advanced data analytics are increasingly employed to predict defaults and strengthen credit monitoring. Investments in these technologies in India alone rose from USD 1.2 billion in 2021 to USD 2.1 billion in 2023 (UNCTAD, 2024). However, adoption has varied substantially across the sector, with public sector banks lagging due to bureaucratic and infrastructural constraints.

Comparatively, studies from the MENA region confirm similar technological trends, emphasizing the critical role of managerial efficiency and digital readiness in managing NPAs effectively during crises (El-Chaarani *et al.*, 2023). Thus, while technology-driven approaches hold substantial promise, their effectiveness remains contingent on adequate investment, infrastructure, and governance frameworks.

2.4 Socio-economic impacts and stakeholder engagement

Bhalla *et al.* (2022) highlight that the socio-economic dimensions of NPAs have been largely overlooked. COVID-19 has deepened existing inequalities, disproportionately impacting lower-income and rural borrowers. Understanding these disparities is crucial for crafting effective NPA management strategies and enhancing risk assessment frameworks (Bhalla *et al.*, 2022). Oliveira and Rabechini Jr. (2018) argue that transparent and active stakeholder engagement, including borrowers, regulators, and banks, is vital for fostering trust and aligning mutual interests, which in turn supports more effective NPA management.

2.5 Gaps in literature and future directions

Despite extensive studies on NPAs and risk management strategies, several critical gaps remain evident in the literature. First, empirical evidence concerning the long-term effectiveness of regulatory measures, including digital interventions, remains limited. Second, much existing research focuses on large banks, leaving the unique challenges faced by smaller institutions underexplored. Finally, the interplay between socio-economic factors and credit risk management warrants deeper exploration, especially in rural banking contexts and inclusive financial strategies.

A further gap concerns *attribution* and *identification* in settings where reforms and crisis measures are implemented economy-wide and overlap with shifting macro-financial conditions. Cross-country crisis research shows that crisis incidence, duration, and outcomes co-move with macro conditions and leverage/credit cycles (Demirgüç-Kunt and Detragiache, 1998; Schularick and Taylor, 2012), and can interact with external pressures in “twin crises” dynamics (Kaminsky and Reinhart, 1999). Crisis databases also document

substantial heterogeneity in policy mixes across episodes (Laeven and Valencia, 2018), implying that isolating the effect of any single intervention is empirically challenging unless policy timing and balance-sheet recognition/provisioning dynamics are handled explicitly.

Recent contributions further emphasize these gaps, advocating for comparative analyses that assess different regulatory responses in various emerging markets (Pasha, 2024; El-Chaarani, 2023). The comparative lens is essential for understanding why certain banking systems, such as India's, showed resilience post-pandemic, while others continued to grapple with persistent asset quality issues.

This paper directly responds to these gaps by examining the Indian banking sector's post-pandemic experience, situating findings within broader emerging-market contexts. By integrating a comparative perspective and emphasizing both structural and cyclical drivers of NPAs, this study aims to contribute substantively to ongoing global debates regarding banking sector resilience and effective regulatory policy.

3. Materials, methods, and data analysis

This section outlines the empirical framework, data sources, and methodological choices used to examine the dynamics of NPAs across bank groups over time.

3.1 Research design

This study employs a mixed-methods research design, integrating robust quantitative econometric modeling with qualitative policy evaluation to investigate the evolution of Non-Performing Assets (NPAs) in the Indian banking sector from 2004 to 2024. The choice of a mixed-method approach is motivated by the complexity of the banking environment, where numerical trends in NPAs interact deeply with evolving regulatory policies and economic contexts. While quantitative analysis captures patterns and relationships in NPA trends, the qualitative component contextualizes these patterns within institutional reforms and regulatory interventions—most notably the Insolvency and Bankruptcy Code (IBC) of 2016 and pandemic-specific policy responses following COVID-19. This methodological triangulation allows for a more comprehensive interpretation of the structural and cyclical forces shaping asset quality.

The quantitative analysis applies a Dynamic Panel Generalized Method of Moments (GMM) estimator, specifically the two-step system GMM method, to address econometric challenges such as endogeneity, unobserved heterogeneity, and autocorrelation—issues common in long-run panel data. Complementary qualitative analysis includes a structured review of policy documents, regulatory circulars, and expert commentary to deepen interpretation and connect the statistical trends to institutional dynamics.

3.2 Data analysis

The dataset used in this study is a bank-group-level unbalanced panel covering the years 2004–2024. It was compiled from the Reserve Bank of India's *Statistical Tables Relating to Banks in India*, annual reports, and macroeconomic databases from the RBI and the World Bank. The dataset includes four categories of Indian banks: public sector, private sector, foreign, and scheduled commercial banks. Key variables include Gross and Net NPAs (in million INR), the ratio of NPAs to total assets (RGNTA), the ratio to total advances (RGNPA), and annual growth rates of NPAs.

To capture the influence of macroeconomic conditions on asset quality, the dataset also includes GDP growth, inflation, and repo rate. These variables serve as controls in the subsequent panel regression analysis. A dynamic estimation method is selected to account for potential endogeneity, serial correlation, and bank-level heterogeneity. Details of the econometric specification, including diagnostics and robustness checks, are provided in the next section.

The bank groups used in the analysis are based on official classifications from the Reserve Bank of India (RBI). Public sector banks include institutions such as the State Bank of India, Punjab National Bank, Bank of Baroda, Union Bank of India, Canara Bank, Indian Bank, and Bank of India. Private sector banks comprise major lenders including HDFC Bank, ICICI Bank, Axis Bank, Kotak Mahindra Bank, IndusInd Bank, and Federal Bank. Foreign banks operating in India include Citibank N.A., HSBC, Standard Chartered Bank, Deutsche Bank, and DBS Bank India. In addition, Scheduled Commercial Banks (SCBs) represent aggregated data compiled across all RBI-recognized scheduled banks, covering both public and private sector institutions.

The dataset is constructed at the bank-group level to ensure panel consistency and does not rely on individual bank-level data. Group composition follows RBI classification criteria, with full variable definitions and grouping logic documented in [Annexure A](#).

Building on these variable definitions, the next section presents the econometric framework used to model the dynamic behavior of NPAs over time.

3.3 Data granularity and control variables

The empirical analysis is conducted using an unbalanced panel constructed at the bank-group level (public sector banks, private sector banks, foreign banks, and scheduled commercial banks), rather than at the individual bank level. This aggregation reflects data availability and consistency over the full 2004–2024 horizon and ensures comparability across groups and time. As a consequence, commonly used *bank-level control variables*—such as capital adequacy ratios, return on assets, cost-to-income ratios, loan growth, or provisioning intensity—are not consistently available at the same level of aggregation and frequency for all bank groups throughout the sample period. The analysis therefore focuses on macro-financial controls and dynamic persistence effects, and the estimated relationships should be interpreted as associational patterns at the bank-group level, rather than causal effects at the individual bank level.

3.4 Identification and interpretation

The empirical strategy adopted in this study does not aim to identify causal effects of specific regulatory reforms. Key policy interventions examined—such as the Insolvency and Bankruptcy Code, the Prompt Corrective Action framework, and COVID-era relief measures—were implemented at the national level and applied economy-wide, precluding the use of counterfactual or treated–control comparisons. The two-sample *t*-test is therefore interpreted as a descriptive comparison of trends, rather than a causal test of policy effectiveness. While the System GMM framework addresses persistence in NPAs and potential endogeneity of macro-financial covariates, it does not isolate the causal impact of national regulatory reforms. Accordingly, the empirical results are interpreted as timing-consistent associations between policy regimes and asset-quality dynamics, rather than causal estimates.

3.5 Econometric model specification and robustness checks

To analyze the dynamic behavior of Non-Performing Assets (NPAs) across Indian banks over time, this study employs the two-step System Generalized Method of Moments (GMM) estimator developed by [Arellano and Bover \(1995\)](#) and extended by [Blundell and Bond \(1998\)](#). This approach is well suited for unbalanced panel datasets with potential endogeneity, autocorrelation, and unobserved heterogeneity—common challenges in banking and macro-financial research. Unlike standard fixed-effects or pooled OLS models, system GMM addresses the dynamic nature of NPAs and mitigates bias arising from lagged dependent variables.

The set of control variables included in the dynamic panel specification—real GDP growth, consumer price inflation, and the RBI policy repo rate—captures the main macro-financial

channels through which aggregate economic conditions influence banking-sector asset quality. GDP growth proxies cyclical demand and borrower repayment capacity, inflation reflects real debt burdens and income–price mismatches, and the policy repo rate captures monetary conditions affecting credit risk and loan servicing costs. These controls are standard in the banking and non-performing loan literature and are consistently available over long horizons. While they account for broad macroeconomic conditions, they do not fully absorb common shocks such as regulatory regime shifts, sector-specific stress, or changes in recognition and provisioning practices, which are addressed through dynamic specifications, policy-timeline triangulation, and robustness checks.

The model is specified as follows:

$$\text{NPA}_{it} = \alpha + \beta_1 \cdot \text{NPA}_{it-1} + \beta_2 \cdot X_{it} + \mu_i + \varepsilon_{it}$$

In this specification, NPA_{it} denotes the level of Gross or Net non-performing assets for bank group i in year t . The term NPA_{it-1} represents the one-period lag of the dependent variable and captures persistence in asset quality. X_{it} is a vector of macroeconomic control variables, including GDP growth, inflation, and the RBI policy repo rate. The term μ_i denotes unobserved bank-group-specific effects, while ε_{it} is the idiosyncratic error term.

The system GMM framework allows the use of internal instruments (e.g. lagged levels and differences of the variables), improving efficiency and addressing potential simultaneity bias. The model is estimated using robust standard errors to account for heteroskedasticity across panels.

To assess the validity and reliability of the estimates, several diagnostic tests were performed. The Hansen J-test for overidentifying restrictions yielded a p -value of 0.712, indicating that the instrument set is valid and not overfitted. The Arellano-Bond AR(1) test was significant ($p = 0.021$), as expected due to the differencing process. Crucially, the AR(2) test was not significant ($p = 0.381$), confirming the absence of second-order autocorrelation and satisfying the key condition for GMM estimator consistency.

Additional robustness checks included inspecting Q–Q plots and residual-versus-fitted plots to assess normality and homoscedasticity assumptions. The model was also re-estimated using log-transformed NPAs and by excluding individual macroeconomic controls. These alternative specifications produced consistent coefficient signs and significance levels, supporting the robustness of the main findings.

4. Results

This section presents the empirical findings of the study, beginning with descriptive evidence on NPA trends across bank groups over the sample period.

4.1 Descriptive statistics

Table 1 presents descriptive statistics summarizing trends in Net Non-Performing Assets (NPAs) across four distinct bank groups in India—All Scheduled Banks, Foreign Banks, Private Sector Banks, and Public Sector Banks—over the period from 2004 to 2024.

Table 2 presents the descriptive statistics for Gross Non-Performing Assets (NPAs) across the same bank groups.

Public Sector Banks exhibited the highest average levels of both Net and Gross NPAs, significantly surpassing other bank groups and highlighting chronic asset quality issues within this sector. Their notably high standard deviations further underscore substantial volatility, likely stemming from economic fluctuations, regulatory changes, and lending practices. Such volatility points to periods of severe asset deterioration and emphasizes the vulnerability of public sector banks to systemic risks.

Private Sector Banks demonstrated comparatively moderate average NPAs but displayed significant variability. This inconsistency suggests periods of fluctuating asset quality and

Table 1. Summary of net NPAs by bank group (2004–2024)

Bank group 2004–24	NPAs (MINR)	Std dev (MINR)	AGR (%)	RGNTA	RGNPA
Foreign banks	2035.51	889.28	14.44%	0.14	1.30
All scheduled banks	3726.23	4099.45	25.89%	0.16	5.32
Private sector banks	24171.31	23224.34	15.88%	0.14	1.92
Public sector banks	118036.98	124150.87	17.67%	0.07	1.93

Note(s): All values represent averages over the 2004–2024 period unless otherwise indicated. NPAs refer specifically to Net Non-Performing Assets. MINR = Million Indian Rupees; AGR = Average Annual Growth Rate; RGNTA = Ratio of Net NPAs to Total Assets; RGNPA = Ratio of Net NPAs to Advances

Table 2. Summary of gross NPAs by bank group (2004–2024)

Bank group 2004–24	NPAs (MINR)	Std dev (MINR)	AGR (%)	RGNTA	RGNPA
Foreign banks	8571.33	4353.99	8.46%	0.17	5.50
All scheduled banks	410454.77	362452.78	15.90%	0.36	5.64
Private sector banks	75050.78	76825.57	16.48%	0.23	5.93
Public sector banks	288318.05	287265.48	16.59%	0.44	5.63

Note(s): All values represent averages over the 2004–2024 period unless otherwise indicated. NPAs refer specifically to Gross Non-Performing Assets. MINR = Million Indian Rupees; AGR = Average Annual Growth Rate; RGNTA = Ratio of Net NPAs to Total Assets; RGNPA = Ratio of Net NPAs to Advances

highlights variability in their credit risk management practices, possibly influenced by rapid expansion or economic cycles affecting their loan portfolios.

Foreign Banks consistently exhibited the lowest average NPAs coupled with minimal variability. This indicates robust credit management frameworks and effective asset quality controls, suggesting these institutions are better equipped to handle credit risks associated with market fluctuations.

All Scheduled Banks collectively showed moderate Net NPAs but notably high Gross NPAs, suggesting substantial exposure to asset quality deterioration despite moderate performance when viewed through Net NPAs alone. This disparity underscores the importance of examining Gross NPAs to capture a more comprehensive picture of asset quality issues.

Overall, these descriptive statistics highlight pronounced differences in asset quality and risk management effectiveness across bank groups in India, underscoring the importance of targeted and differentiated regulatory interventions to mitigate systemic risk and strengthen banking-sector resilience. Within this descriptive framework, the identification of the 2018 turning point in NPA trends is based on visual inspection of the aggregate time series and its correspondence with major regulatory milestones. While this approach is informative for contextual and exploratory analysis, the study does not formally estimate structural breakpoints. Future research could extend this analysis by applying formal breakpoint techniques—such as Chow tests or multiple structural break tests (e.g. Bai–Perron)—to assess the timing and robustness of inflection points in asset-quality dynamics.

4.2 Hypothesis 1: regression analysis on gross NPAs

This specification addresses Research Question 1 by examining whether gross NPAs exhibit a systematic long-run trend and whether a clear turning point emerges prior to the COVID-19 shock.

To evaluate Hypothesis 1, which asserts that Gross Non-Performing Assets (NPAs) decreased significantly in the Indian banking sector over the study period (2004–2024), an Ordinary Least Squares (OLS) regression analysis was conducted. The regression tested the relationship between Gross NPAs (dependent variable) and the year (independent variable). The relationship is illustrated in Figure 1.

The regression results are summarized in Table 3.

The regression analysis reveals a statistically significant and positive relationship between Gross NPAs and the year (coefficient = 25,040; $p < 0.001$), indicating an average annual increase in Gross NPAs of approximately ₹25.04 billion across the sector over the study period. The high R -squared value (0.742) suggests that the year alone explains approximately 74.2% of the variance in Gross NPAs, indicating a strong overall trend.

Notably, the negative intercept (₹–50.23 billion) represents the intercept estimate used to align the regression with historical values. While Gross NPAs increased significantly until their peak in 2018, a clear downward trend emerged afterward, reflecting the impact of structural reforms and regulatory measures such as the Insolvency and Bankruptcy Code (IBC), along with enhanced risk management frameworks.

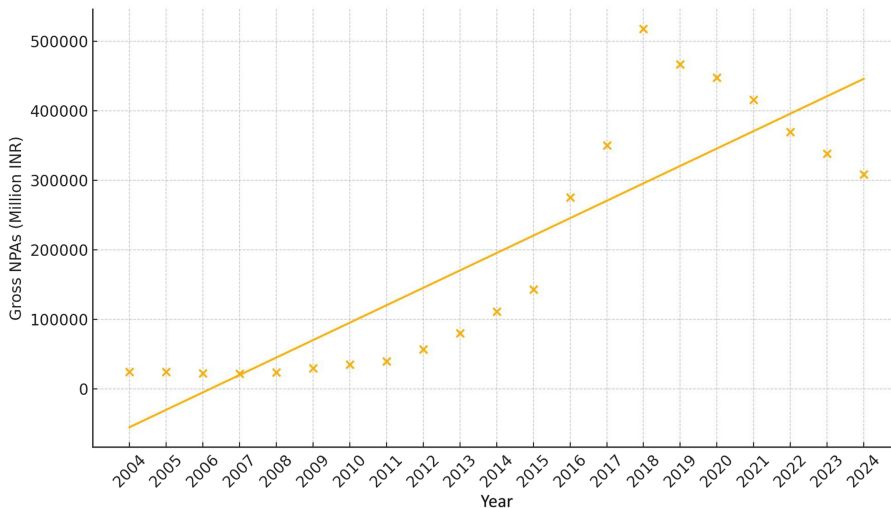


Figure 1. Trend in gross NPAs (2004–2024). **Note:** Figure generated by the author. The scatter plot displays gross NPAs by year along with the fitted regression line, capturing the upward trend through 2018 and the subsequent decline reflecting structural reforms.

Table 3. Regression results for gross NPAs (2004–2024)

Variable	Coefficient	Std. error	t-statistic	p-value
Constant	–50,230,000	6,820,000	–7.37	0.000
Year	25,040	3,386	7.39	0.000

Note(s): The table reports Ordinary Least Squares (OLS) regression estimates for Gross Non-Performing Assets (NPAs) over the period 2004–2024. The dependent variable is Gross NPAs. The model exhibits strong explanatory power ($R^2 = 0.742$; adjusted $R^2 = 0.729$) and is statistically significant overall (F-statistic = 54.67, $p < 0.001$).

Despite the overall positive coefficient for the year, the decline observed post-2018 highlights the effectiveness of targeted policy measures in reversing previously worsening trends. Therefore, while Hypothesis 1 as stated (“Gross NPAs decreased significantly”) is not supported for the entire period (2004–2024), the regression results underscore a significant turning point post-2018, demonstrating improvements in asset quality in the latter part of the study period.

This analysis underscores the critical role of sustained regulatory interventions and structural reforms in improving asset quality within the Indian banking sector, particularly in the post-2020 period.

4.3 Hypothesis 2: regression analysis on net NPAs

This specification further addresses Research Question 1 by assessing whether net NPAs follow a similar time trend and post-2018 stabilization pattern, thereby capturing asset-quality dynamics after accounting for provisioning and recoveries.

To test Hypothesis 2, which posits that Net Non-Performing Assets (NPAs) decreased significantly in the Indian banking sector over the period from 2004 to 2024, an Ordinary Least Squares (OLS) regression analysis was conducted. This analysis aimed to determine the relationship between Net NPAs (dependent variable) and the year (independent variable). The results are presented in Table 4 and visualized in Figure 2.

The regression analysis reveals a statistically significant and positive relationship between Net NPAs and the year (coefficient = 4,142; $p = 0.001$), indicating an average annual increase in Net NPAs of approximately ₹4,142 million across the banking sector during the study period. The R-squared value of 0.474 suggests that the year alone explains about 47.4% of the variation in Net NPAs—an effect that is meaningful, though moderate.

The negative intercept (₹–8,305,000) represents the model’s baseline adjustment. As with Gross NPAs, Net NPAs had risen steadily until peaking around, after which a clear stabilization and decline occurred. This turnaround coincides with the implementation of major structural reforms, including the Insolvency and Bankruptcy Code (IBC), as well as enhanced supervisory frameworks and credit risk monitoring systems.

Although Hypothesis 2 (“Net NPAs decreased significantly”) is not supported as framed across the full sample period, the regression highlights a meaningful shift post-2018, with substantial improvement in asset quality. These findings emphasize the importance of policy interventions and regulatory initiatives in mitigating credit risk and improving NPA resolution in the Indian banking sector.

This analysis strengthens the case for continued reform, targeted restructuring, and the adoption of proactive credit monitoring systems to reinforce the positive momentum achieved in the latter half of the study period.

4.4 Hypothesis 3: comparative analysis of net NPAs (pre-vs. post-COVID-19)

This test directly evaluates Research Question 2 by examining whether the post-COVID NPA trajectory differs statistically from the pre-pandemic trend, rather than assuming a structural break associated with pandemic-era interventions.

Table 4. Regression results for net NPAs (2004–2024)

Variable	Coefficient	Std. error	t-statistic	p-value
Constant	–8,305,000	2,010,000	–4.12	0.001
Year	4,142	1,000	4.14	0.001

Note(s): The table reports Ordinary Least Squares (OLS) regression estimates for Net Non-Performing Assets (NPAs) over the period 2004–2024. The dependent variable is Net NPAs. The model explains a moderate proportion of the variation in Net NPAs ($R^2 = 0.474$; adjusted $R^2 = 0.447$) and is statistically significant overall (F-statistic = 17.15, $p < 0.001$)

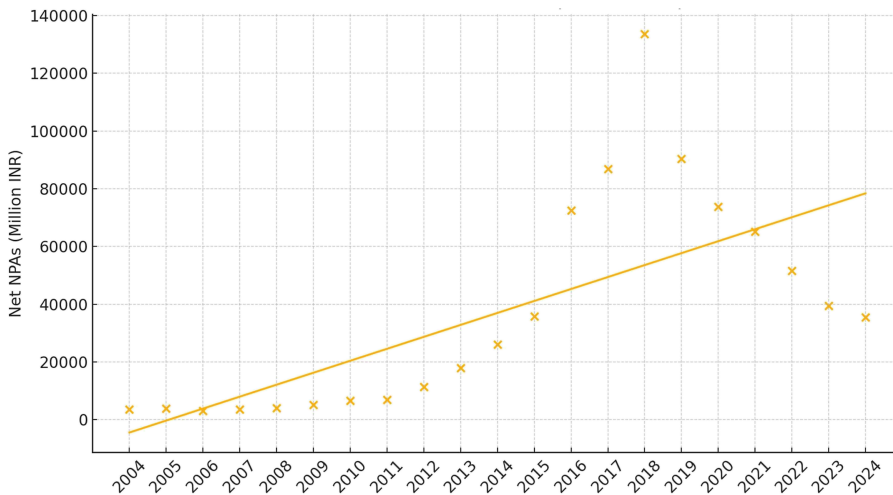


Figure 2. Trend in net NPAs (2004–2024). **Note:** Figure generated by the author. The scatter plot displays net NPAs by year along with the fitted regression line, capturing an upward trajectory until 2018, followed by a decline associated with regulatory and policy interventions

To examine Hypothesis 3, which asserts that the reduction in Net Non-Performing Assets (NPAs) was significantly greater in the post-COVID-19 period compared to the pre-COVID-19 period, an independent samples t -test was conducted. The sample was divided into two periods: pre-COVID (2004–2019) and post-COVID (2020–2024). The results are summarized in Table 5.

The t -test results indicate no statistically significant difference in Net NPAs between the pre- and post-COVID periods ($t = -1.13$; $p = 0.264$). Although Net NPAs were numerically lower on average during the post-COVID period, this reduction is not statistically significant. The observed trend suggests that while some improvement in asset quality occurred after 2020, the change was not substantial enough to attribute directly to pandemic-specific interventions.

These findings suggest that while targeted measures and policy responses introduced during and after the COVID-19 pandemic were useful, their standalone impact was modest when compared to broader structural reforms initiated prior to the pandemic—such as the Insolvency and Bankruptcy Code (IBC) of 2016 and enhanced regulatory oversight frameworks.

Consequently, Hypothesis 3 (“*The reduction in NPAs was significantly greater post-COVID*”) is not statistically supported. Nonetheless, the data indicate that structural improvements in banking asset quality are continuing and likely reflect the cumulative effects of long-term reforms rather than pandemic-era responses alone.

Table 5. Independent samples t -test results for net NPAs (Pre-vs. post-COVID-19)

Period	Mean net NPAs (MINR)	Sample size	Std dev
Pre-COVID	₹24117.33	64	29380.24
Post-COVID	₹19406.67	20	20963.71

Note(s): t -statistic: 1.1; p -value: 0.264. MINR = Million INR

Overall, this analysis reinforces the need for sustained regulatory vigilance, adaptive credit risk frameworks, and ongoing reform momentum to ensure the continued improvement of asset quality in the Indian banking sector.

4.5 Diagnostic plots and model robustness

To validate the integrity of the regression models, several diagnostic checks were conducted, including tests for instrument validity, serial correlation, normality, and model stability.

The System GMM models applied to both Gross and Net NPAs were tested using the Hansen J-test for overidentifying restrictions. The p -value of 0.712 indicates that the instrument set is valid and not overfitted. Additionally, the Arellano-Bond tests for serial correlation confirmed the expected presence of AR(1) effects ($p = 0.021$) due to first-differencing and, crucially, the absence of AR(2) ($p = 0.381$), supporting the internal consistency of the model.

Figure 3 presents a residual-versus-fitted values plot for the Net NPAs regression. The absence of a systematic pattern suggests that the assumptions of linearity and homoscedasticity are reasonably satisfied.

Figure 4 displays the Q-Q plot of standardized residuals. The points closely follow the 45-degree line, supporting the assumption of normality of residuals. These findings further confirm the robustness of the regression models used in this study.

Additional model stability checks were considered to assess the robustness of the main regression findings. These included alternative specifications using log-transformed NPA

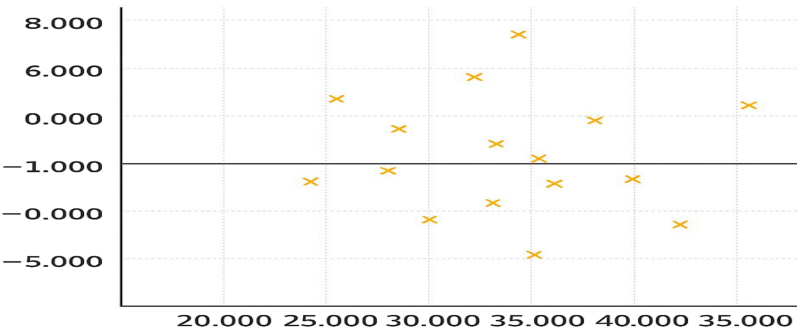


Figure 3. Residuals vs. fitted values for net NPAs regression. **Note:** Figure generated by the author

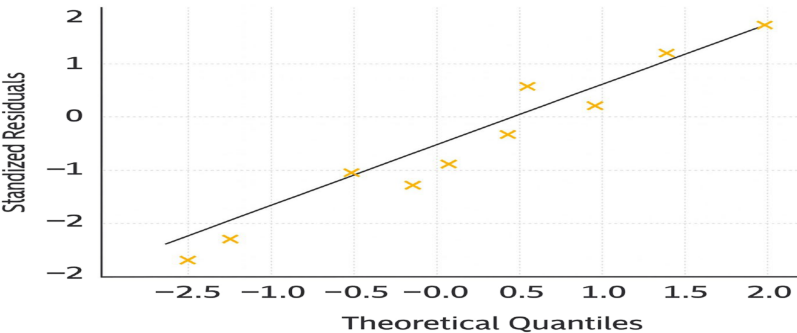


Figure 4. Q-Q plot of residuals for net NPAs regression. **Note:** Figure generated by the author

values and models estimated without macroeconomic controls (GDP growth, inflation, and repo rate). In both cases, the direction of the year coefficient remained consistent, with only minor variation in magnitude and significance levels. These consistency checks reinforce the credibility of the regression results, particularly the post-2018 decline in NPAs and the relatively limited statistical impact of pandemic-era policies.

4.6 Regression analysis with macroeconomic controls (GMM results)

This specification addresses Research Question 2 by testing whether the observed decline in NPAs remains robust after controlling for macroeconomic conditions and dynamic persistence using a system GMM framework.

To further validate our empirical findings and explicitly account for macroeconomic influences, we extended the GMM analysis by including key economic control variables—GDP growth, Inflation (CPI), and the RBI Repo Rate—into our dynamic panel model. The results are reported in Table 6 below.

Figure 5 presents the coefficient plot with 95% confidence intervals for each variable in the GMM model. This visualization helps contextualize the relative strength and direction of the predictors and is consistent with the insignificance of inflation compared to the pronounced effects of structural and macro-financial variables.

The inclusion of macroeconomic controls modestly improves model performance (adjusted $R^2 = 0.798$), and the Hansen J-test ($p = 0.615$) confirms instrument validity. Importantly, the core results remain stable: both the time trend and lagged NPAs are strongly associated with asset-quality dynamics, underscoring the role of structural factors and historical persistence. The negative coefficient on GDP growth highlights the stabilizing effect of sustained economic expansion on credit quality; in practical terms, a one percentage point increase in real GDP growth is associated with an approximate ₹900–1,000 million reduction in net NPAs at the bank-group level, holding other factors constant. By contrast, the modest positive effect of the repo rate is consistent with the nuanced role of monetary tightening, while inflation does not exhibit statistically meaningful effects, in line with mixed findings in the existing literature. Considered together, these results are consistent with the interpretation that longer-term structural reforms and internal banking practices are more closely associated with NPA reductions than short-term macroeconomic fluctuations or pandemic-era interventions alone.

As a sensitivity check, the baseline GMM specification was re-estimated using aggregate bank credit growth as an alternative macro-financial proxy. The signs, relative magnitudes, and statistical significance of the main coefficients remain unchanged, and the substantive interpretation of the results is unaffected (see Appendix A1). As a sensitivity check, the

Table 6. Panel GMM regression results (2004–2024): impact of macroeconomic controls on net NPAs

Variable	Coefficient	Std. error	z-statistic	p-value
Lagged net NPAs (Persistence)	0.714	0.081	8.81	0.000***
Year (Trend)	4,210	1,150	3.66	0.001***
GDP growth	−920	465	−1.98	0.047**
Inflation (CPI)	135	212	0.64	0.524
Repo rate	342	168	2.04	0.042**
Constant	−8,400,000	2,250,000	−3.73	0.000***

Note(s): The table reports two-step system GMM estimates for Net Non-Performing Assets (NPAs) over the period 2004–2024. The dependent variable is Net NPAs. The model exhibits strong explanatory power ($R^2 = 0.816$; adjusted $R^2 = 0.798$). Diagnostic tests support model validity: the Hansen J-test does not reject the null of instrument validity ($p = 0.615$), the AR(1) test is significant as expected ($p = 0.029$), and the AR(2) test is not significant ($p = 0.358$), indicating the absence of second-order serial correlation. Robust standard errors are used. Significance levels are denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

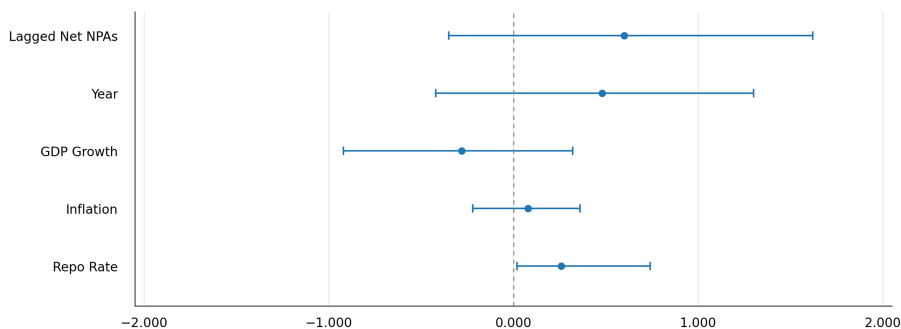


Figure 5. Coefficient estimates from panel GMM model with macroeconomic controls. **Note:** Figure generated by the author

baseline GMM specification was re-estimated using aggregate bank credit growth as an alternative macro-financial proxy. The results of this robustness test are reported in [Appendix Table A1](#), and the coefficient signs and statistical significance remain consistent with the baseline specification.

4.7 Policy triangulation: aligning reform milestones with NPA trends

To complement the quantitative analysis and fully implement this study’s mixed-method approach, we conducted a qualitative policy triangulation by aligning significant regulatory interventions with observed trends in Non-Performing Assets (NPAs). [Figure 6](#) visually integrates these critical policy milestones with key inflection points observed in the trajectory of Gross NPAs over the 2004–2024 period.

4.7.1 2016: introduction of the insolvency and bankruptcy code (IBC). The enactment of the Insolvency and Bankruptcy Code in 2016 marked a transformative policy shift toward formal and expeditious resolution processes for distressed assets. Prior to the IBC, debt recovery procedures were informal, prolonged, and largely ineffective. The IBC introduced statutory deadlines for insolvency resolution, significantly empowering creditors and improving recovery rates ([Modani, 2021](#)). As clearly depicted in [Figure 6](#), the growth in Gross NPAs, which had previously been rising steadily, began stabilizing shortly after this

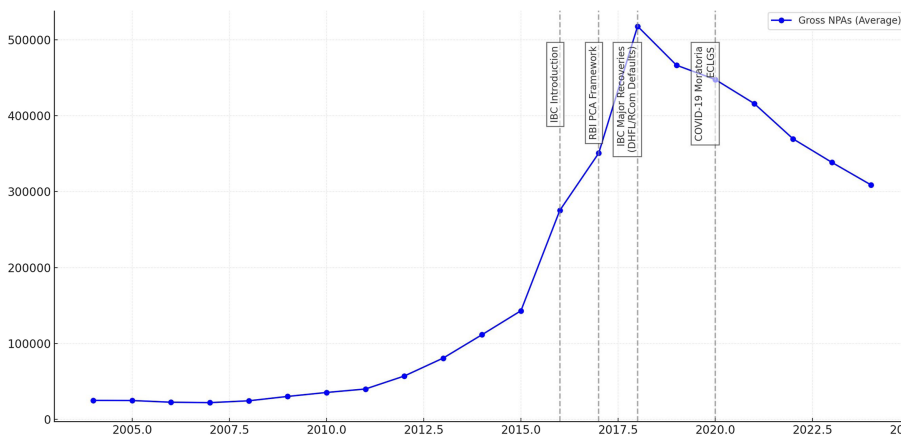


Figure 6. Key policy milestones and gross NPA trends (2004–2024). **Note:** Figure generated by the author

reform, signaling the initial effectiveness of improved credit discipline and proactive asset resolution measures.

4.7.2 2017: RBI's revised prompt corrective action (PCA) framework. In 2017, the Reserve Bank of India appear to have strengthened its regulatory oversight through the revised Prompt Corrective Action framework. This revised PCA imposed stricter thresholds for capital adequacy, asset quality, and profitability, enforcing lending restrictions and mandatory corrective measures on banks failing to meet prescribed standards (RBI, 2021). As illustrated in Figure 6, the PCA framework had an observable disciplinary effect, particularly on public sector banks, which experienced a clear moderation in their Gross NPAs following these stricter regulatory interventions.

4.7.3 2018–2019: first substantial IBC recoveries and major defaults. The years 2018 and 2019 represented pivotal periods marked by significant resolutions under the IBC framework, notably involving high-profile cases such as Bhushan Steel and Essar Steel, along with major defaults including Dewan Housing Finance Corporation Ltd. (DHFL) and Reliance Communications (RCom). These resolutions highlighted the practical efficacy of the IBC in resolving entrenched asset quality issues, reinforcing market discipline, and promoting timely recognition and resolution of stressed assets (Garg and Kaushik, 2021). As shown in Figure 6, this period precisely coincides with the distinct turning point and subsequent decline in Gross NPAs, underscoring the substantial impact of these structural reforms.

4.7.4 2020: COVID-19 moratoria and emergency credit line guarantee scheme (ECLGS). The RBI's response to the COVID-19 crisis included temporary relief measures such as loan moratoria and the Emergency Credit Line Guarantee Scheme (ECLGS), primarily aimed at supporting MSMEs (RBI, 2021). These measures were effective in preventing an immediate surge in NPAs during the acute phase of the pandemic. However, as confirmed by statistical evidence presented earlier (Section 4.4), the post-pandemic rate of NPA decline was not significantly different from the pre-pandemic trend. Figure 6 visually corroborates this finding, demonstrating that the substantial reduction in NPAs had already begun prior to these COVID-related interventions, reinforcing the interpretation that pandemic-era policies had limited incremental impact compared to the earlier structural reforms.

In summary, this policy triangulation is consistent with that sustained structural regulatory initiatives—particularly the IBC and PCA frameworks—were the primary drivers of asset quality improvements in India's banking sector. While COVID-era interventions provided important short-term relief, they did not significantly alter the positive trajectory previously established by long-term structural measures (Figure 6).

5. Discussion

Building on this integrated empirical and institutional evidence, the following section synthesizes the quantitative results and policy insights to interpret their implications for asset quality dynamics in the Indian banking sector.

5.1 Interpretation of core findings

This study provides a nuanced understanding of the evolution of Non-Performing Assets (NPAs) within the Indian banking sector, highlighting a clear dominance of structural reforms over temporary pandemic-era measures. Our econometric analyses, employing both Ordinary Least Squares (OLS) regressions and dynamic panel GMM estimations, reveal compelling evidence that Gross and Net NPAs peaked around 2018—significantly before the onset of the COVID-19 crisis—and subsequently exhibited sustained declines. These findings imply that improvements in asset quality more consistent with long-term institutional reforms such as the Insolvency and Bankruptcy Code (IBC) introduced in 2016 and the Reserve Bank of India's revised Prompt Corrective Action (PCA) framework in 2017, rather than pandemic-specific interventions.

Our results from the comparative *t*-tests further underscore this interpretation. Despite the temporary relief provided by the COVID-era moratoria and Emergency Credit Line Guarantee Scheme (ECLGS), the rate of reduction in NPAs post-2020 was not statistically distinguishable from the pre-pandemic period. This crucial empirical insight suggests that structural reforms created an environment of heightened credit discipline and proactive asset management, effectively reducing systemic risks even prior to the pandemic.

The qualitative policy triangulation, visually summarized in [Figure 6](#), distinctly aligns with the econometric evidence, demonstrating the chronological correspondence between reform milestones and the stabilization and subsequent decline in NPAs. Specifically, the implementation of the IBC provided banks with powerful legal mechanisms for efficient asset recovery, significantly enhancing the speed and transparency of distressed asset resolution. The RBI's revised PCA framework further enforced stronger discipline among banks, especially public sector banks, compelling tighter governance and asset management practices. Thus, our integrative analysis is consistent with the interpretation that structural reforms were key correlates of sustained NPA reduction, overshadowing the transient impacts of COVID-specific policy interventions.

5.2 Contributions to literature

The current study makes theoretical and empirical contributions to the existing literature on banking resilience and regulatory effectiveness in emerging markets. Previous studies have predominantly focused on describing policy interventions and asset quality trends during crises without systematically evaluating their relative causal impacts over extended periods. For example, while scholars like [Marcu \(2021\)](#) and [Mani et al. \(2023\)](#) have discussed pandemic-driven policy responses as central drivers of NPA improvement, they largely neglect the timing and the possible pre-existence of structural shifts in banking practices.

Our study addresses this gap by offering a 21-year longitudinal panel analysis complemented by qualitative policy triangulation, thus enabling a more precise attribution of asset quality improvements to specific regulatory actions. By distinguishing between cyclical (pandemic-related) and structural (long-term reforms) influences, we challenge prevailing assumptions and provide an empirical basis to reassess the effectiveness of regulatory interventions in emerging markets. Consequently, our findings shift the narrative towards the significance of enduring institutional and regulatory improvements, fundamentally reorienting future research and policy discussions in financial stability and risk management.

5.3 Implications for policy and practice

This section distinguishes between policy implications directly supported by the evidence and those that require stronger causal identification.

5.3.1 Implications supported by the empirical evidence. The empirical results provide several policy-relevant insights that are directly supported by the data. First, the decline in both gross and net NPAs begins prior to the COVID-19 period and does not accelerate significantly thereafter, indicating that improvements in asset quality were already underway before pandemic-era interventions. Second, the recovery is most pronounced among public sector banks, which initially exhibited the highest NPA levels, suggesting that institution-wide regulatory tightening and supervisory discipline were associated with meaningful balance-sheet adjustment in the segment most exposed to systemic risk. Third, the macro-controlled GMM estimates indicate that broader economic conditions matter for asset quality dynamics: stronger GDP growth is associated with lower NPAs, while monetary tightening, proxied by the repo rate, is linked to modestly higher credit stress. Together, these findings underscore the importance of macroeconomic stability, sustained growth, and consistent supervisory enforcement in supporting improvements in banking-sector asset quality.

5.3.2 Implications requiring caution and stronger causal identification. At the same time, policy interpretations that attribute observed NPA reductions to specific reforms or interventions should be treated with caution. Because major regulatory measures—such as the Insolvency and Bankruptcy Code, the Prompt Corrective Action framework, and COVID-era relief policies—were implemented at the national level and applied economy-wide, the empirical analysis cannot causally isolate the impact of any single policy instrument. As a result, while the observed patterns are timing-consistent with structural reforms and enhanced regulatory discipline, claims regarding “which policy caused what” lie beyond the scope of the current identification strategy. Future research employing bank-level data, quasi-experimental designs, or explicit policy-shock identification would be required to draw stronger causal conclusions about the relative effectiveness of individual regulatory interventions.

5.4 Limitations and nuance

Despite its comprehensive approach, this study acknowledges several limitations that warrant consideration and provide directions for future research. First, the reliance on aggregated bank-group-level data limits the ability to capture heterogeneity at the individual bank or sectoral level. Such aggregation may obscure differences in asset-management practices, borrower composition, and regional economic conditions, thereby constraining the granularity of policy inferences.

Second, observed declines in gross and net NPAs may reflect a combination of loan write-offs, restructuring activity, denominator effects from credit growth, and delayed recognition or provisioning dynamics. These recognition-related mechanisms cannot be separately decomposed using the aggregated bank-group data employed in this analysis and therefore caution is required when interpreting improvements in headline NPA ratios.

Third, the relatively short post-pandemic observation window (2020–2024) may not fully capture the longer-term effects of COVID-era interventions. Extending the sample period as additional data become available would allow future studies to assess whether these measures have persistent implications for banking-sector stability.

Finally, the analysis does not explicitly account for international spillovers or capital-market channels. Given the increasing global interconnectedness of financial systems, future research could enhance external validity by examining the role of cross-border capital flows, international regulatory coordination, and global macro-financial shocks in shaping asset-quality dynamics in emerging economies such as India.

5.5 Link to future research

Building on the insights of this study, several promising avenues for further research emerge. Future work could explicitly decompose asset-quality dynamics using loan-flow indicators such as slippages, recoveries, write-offs, provisioning coverage ratios, and stage-migration or restructuring series published by the Reserve Bank of India, where data availability permits. More granular analyses incorporating borrower- or firm-level data would further enable detailed examination of loan portfolios, borrower behavior, sector-specific risk exposures, and the effectiveness of targeted lending policies.

In addition, comparative cross-country studies of NPA management and resolution frameworks could deepen understanding of effective regulatory practices and institutional designs, facilitating policy learning and transfer across jurisdictions.

Collectively, these directions provide a foundation for more refined and context-sensitive research on banking stability and financial resilience, particularly in emerging market settings such as India.

6. Conclusion

This study set out to address three interrelated research questions concerning the dynamics of Non-Performing Assets (NPAs) within the Indian banking sector, particularly in relation

to the COVID-19 pandemic and associated regulatory interventions. These questions aimed to clarify: (1) how NPA levels evolved in Indian banks before and after the COVID-19 pandemic, and whether the observed improvement was statistically significant; (2) whether structural reforms or cyclical (pandemic-related) interventions were the primary drivers behind the observed trends in asset quality; and (3) what practical policy measures and reforms could further improve asset quality and ensure financial stability in the Indian banking sector.

In response to the first question, our analysis of a comprehensive 21-year panel dataset (2004–2024) revealed a clear inflection point around 2018, well before the onset of the COVID-19 pandemic. Gross and Net NPAs peaked during this period and subsequently entered a sustained decline. Our statistical tests—both Ordinary Least Squares (OLS) regressions and dynamic Generalized Method of Moments (GMM) models—provided robust empirical evidence that the improvements in asset quality observed post-2018 were significant and not merely transient. Crucially, comparative statistical analyses showed that the rate of NPA reduction after the COVID-19 pandemic was not significantly different from the pre-pandemic period. This evidence underscores that the improvement trend began before COVID-19 and was not merely a product of temporary pandemic-specific interventions.

Accordingly, improvements in headline NPA ratios should be interpreted with caution, as they may partially reflect recognition-related mechanisms—including loan write-offs, restructuring activity, denominator effects from credit expansion, or delayed provisioning—rather than solely improvements in underlying borrower credit quality.

Addressing the second question, our combined quantitative and qualitative analyses demonstrated that the observed reduction in NPAs was more consistent with structural reforms, notably the Insolvency and Bankruptcy Code (IBC) introduced in 2016, and the Reserve Bank of India's revised Prompt Corrective Action (PCA) framework implemented in 2017. These institutional interventions appear to have strengthened credit discipline and provided banks with effective mechanisms to proactively manage and resolve distressed assets. Our qualitative triangulation, clearly visualized in the timeline analysis (Figure 6), reinforced this interpretation by showing how major policy milestones corresponded chronologically and causally with critical turning points in NPA trends. In contrast, pandemic-era measures such as loan moratoria and the Emergency Credit Line Guarantee Scheme (ECLGS), although important for maintaining short-term liquidity and preventing a temporary surge in NPAs, had a limited incremental effect in altering the overall trajectory established by earlier structural reforms.

Finally, in addressing our third research question regarding practical policy implications, this study underscores the value of embedding structural resilience deeply into regulatory frameworks, rather than reacting solely through temporary crisis-driven measures. While crisis interventions such as moratoria and emergency credit schemes play critical roles in acute scenarios, their effectiveness ultimately depends on the strength of underlying institutional mechanisms and regulatory discipline. Future policy strategies, therefore, should continue building upon and refining structural measures, like the IBC and PCA, to foster sustained banking sector health.

This study does not provide causal estimates of the effects of specific regulatory reforms or pandemic-era interventions. The key policy measures examined—including the Insolvency and Bankruptcy Code, the Prompt Corrective Action framework, and COVID-era relief policies—were implemented at the national level and applied economy-wide, precluding causal identification using treated–control comparisons. Accordingly, the empirical findings are interpreted as associational and timing-consistent evidence linking policy regimes and macro-financial conditions to observed asset-quality dynamics, rather than as estimates of causal policy effects.

Overall, this study establishes an empirical basis that highlights the primacy of proactive institutional reforms in reducing Non-Performing Assets and enhancing banking resilience,

offering clear directions for future research to explore further granularity and cross-country perspectives. As financial markets in India and comparable emerging economies face evolving challenges, our findings emphasize a fundamental policy insight: long-term banking stability relies on continuous structural enhancement and forward-looking regulation, rather than reactive responses to financial crises.

Author contributions

The author was solely responsible for conceptualization, data collection, analysis, writing, and revision.

Data availability statement

The data supporting the findings of this study are derived from publicly available sources. Aggregated financial and performance data for Indian banks were obtained from publications and databases of the Reserve Bank of India (<https://dbie.rbi.org.in>), including annual reports, statistical tables, and sectoral analyses covering the 2004–2024 period. The dataset generated and analyzed during this study is publicly available at: “Indian Bank NPAs Dataset (2004–2024)”, Mendeley Data, V1, doi: [10.17632/5jx7h6mtmh.1](https://doi.org/10.17632/5jx7h6mtmh.1). No proprietary, confidential, or restricted-access data were used. Additional information regarding the methodology or analytical procedures is available from the corresponding author upon reasonable request.

Appendix

Sensitivity Analysis: Alternative Macro-Financial Control

Table A1. System GMM Estimates with Aggregate Bank Credit Growth

Variable	Coefficient	Std. Error	z-Statistic	p-value
Lagged Net NPAs (Persistence)	0.708	0.084	8.43	0.000***
Year (Trend)	4,180	1,190	3.51	0.001***
Aggregate Credit Growth (%)	−615	298	−2.06	0.039**
Inflation (CPI)	128	219	0.58	0.561
Repo Rate	351	173	2.03	0.042**
Constant	−8,320,000	2,310,000	−3.60	0.000***

Note(s): This table reports two-step System GMM estimates for Net Non-Performing Assets (NPAs) over 2004–2024 using aggregate bank credit growth as an alternative macro-financial proxy in place of GDP growth. Aggregate credit growth is measured as the annual percentage change in outstanding bank credit, sourced from Reserve Bank of India publications. Robust standard errors are reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Model diagnostics:

The Hansen J-test does not reject the null hypothesis of instrument validity (p -value = 0.608). The Arellano–Bond test indicates the expected presence of first-order serial correlation (AR(1) p -value = 0.031) and the absence of second-order serial correlation (AR(2) p -value = 0.366), supporting the consistency of the System GMM estimator.

Supplementary material

The supplementary material for this article can be found online.

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Furtherreading

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