



# International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*



**Impact Factor: 8.699**

**Volume 15, Issue 3, March 2026**

# Digital Payment Systems and Their Impact on Bank Revenue Models

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**ABSTRACT:** This thesis empirically investigates how the proliferation of digital payment systems has restructured the revenue models of Scheduled Commercial Banks (SCBs) in India over FY2012–13 to FY2023–24. Using publicly accessible secondary data from RBI, NPCI, and the Ministry of Finance, the study employs OLS regression, Granger causality testing, Chow structural break analysis, and non-parametric tests to evaluate five rigorously framed hypotheses.

Core findings reveal a fee-neutralization effect under India's zero-MDR regime — UPI volume growth does not independently harm aggregate non-interest income. However, total digital payment volume Granger-causes bank profitability improvement, while accelerating digital growth consistently reduces the cost-to-income ratio. High-value payment channels (RTGS/NEFT) positively sustain net interest margins, and private sector banks significantly outperform public sector banks throughout the digital era.

**KEYWORDS:** Digital payment systems, UPI, bank revenue models, non-interest income, ROA, cost-to-income ratio, NIM, zero-MDR, public sector banks, private sector banks, India.

## I. INTRODUCTION AND RESEARCH CONTEXT

The past decade has witnessed a seismic transformation in India's financial landscape, driven by the rapid proliferation of digital payment systems. The Unified Payments Interface (UPI) — launched by NPCI in August 2016 — has emerged as the world's most active real-time payment platform, recording over 18.67 billion transactions valued at ₹25.14 lakh crore in a single month in 2024. In FY2024–25, India's total digital payment transactions grew by 34.8%, with 99.9% of non-cash retail payments being digital.

Despite this extraordinary volume, Indian banks face a structural revenue paradox: they process more transactions than ever before while earning progressively less per transaction. Since January 2020, the Government of India has mandated zero Merchant Discount Rate (MDR) on all UPI and RuPay debit card transactions. PwC estimated the resulting industry revenue loss at ₹10,000–12,000 crore for FY2021–22 alone — yet banks received only ₹1,500 crore in government incentives against ₹246.82 lakh crore in UPI transaction value.

"Banks are effectively cross-subsidizing UPI's operational cost through legacy fee instruments — minimum balance levies, ATM fees, and cheque book charges — rather than earning revenue from digital payment operations."

This creates what the study terms the 'volume-revenue paradox.' Commercial banks historically derived income from two streams: Net Interest Margin (NIM) — the spread between lending and deposit rates — and non-interest income from service fees, transaction charges, and ancillary revenues. Digital payment systems have simultaneously disrupted both pillars.

### 1.1 Research Problem

The central research question is: To what extent have digital payment systems restructured the revenue models of SCBs in India, and what are the measurable consequences for profitability, non-interest income, net interest margin, cost efficiency, and ownership-differentiated financial performance over FY2012–13 to FY2023–24?

This is empirically manifested across five dimensions:

- The Fee Income Paradox: UPI volumes surged past 18 billion transactions/month yet generate zero direct MDR revenue
- NIM Pressure: Fintech competition in lending compresses bank interest spreads by 0.2–2.7 percentage points (IMF, 2023)
- Cost Structure Duality: Digital adoption reduces operating costs but raises technology infrastructure investment
- Public-Private Bank Divergence: PSBs posted ROA of 0.4% versus private banks at 1.6% in recent years
- Evidence Quality Gap: Absence of a comprehensive, reproducible, 12-year study using only publicly verifiable official data

## II. RESEARCH METHODOLOGY

### 2.1 Scope and Data Sources

The study covers India’s Scheduled Commercial Banks (public sector and private sector) over FY2012–13 to FY2023–24 — a 12-year window spanning the pre-UPI baseline, the demonetization/UPI launch transition, and the high-growth zero-MDR era. All data are sourced exclusively from freely accessible official databases:

- RBI Database on Indian Economy (DBIE) — bank-group-wise ROA, NIM, CIR, NPA ratios
- NPCI Official Website — UPI transaction volumes and values
- Ministry of Finance portal — growth of various digital payment modes
- RBI Trend and Progress of Banking in India — income/expenditure and financial ratios
- MOSPI / RBI Annual Reports — GDP growth, CPI inflation, repo rate

### 2.2 Hypotheses

Hypothesis	IV → DV	Method
H <sub>1</sub>	UPI Volume → Non-Interest Income (NII)	OLS Regression + Controls
H <sub>2</sub>	Digital Volume → Return on Assets (ROA)	Multiple OLS + Granger Causality
H <sub>3</sub>	Digital Growth Rate → Cost-to-Income Ratio (CIR)	OLS Regression + Chow Break Test
H <sub>4</sub>	RTGS/NEFT Value → Net Interest Margin (NIM)	OLS Regression + VIF Remediation
H <sub>5</sub>	PSB vs. Private Bank ROA (Pre-UPI vs. UPI Era)	Independent t-Test + Mann-Whitney U

### 2.3 Analytical Techniques

The study employs a multi-layered quantitative framework: descriptive statistics and CAGR trend analysis; simple and multiple OLS regression with diagnostic testing (VIF, Breusch-Pagan, Durbin-Watson, Jarque-Bera); Granger causality testing for temporal directionality; Chow structural break testing at key policy discontinuities (demonetization FY2016–17 and zero-MDR FY2019–20); Pearson and Spearman correlation analysis; and independent-samples t-tests with Cohen’s d effect size for ownership group comparison.

## III. DATA ANALYSIS AND FINDINGS

### 3.1 Descriptive Overview

The dataset captures dramatic structural shifts over the 12-year study period. UPI volume grew at a CAGR of 156.67% from FY2016–17 to FY2023–24, reaching 1,31,073 million transactions. Total digital payment volume expanded at a CAGR of 35.26%, from 592 crore transactions to 16,416 crore transactions. RTGS value grew at 10.74% CAGR while NEFT value grew at 24.79% CAGR. Bank ROA averaged 0.61% (range: 0.10–1.20%) and CIR trended from 52.7% to 46.8%, indicating improving operational efficiency. NIM remained relatively stable with a mean of 2.94%.

### 3.2 Correlation Matrix Highlights

The Pearson correlation matrix confirms several analytically significant preliminary relationships. Digital payment volume is positively correlated with ROA ( $r = 0.537, p < 0.05$ ) and NIM ( $r = 0.875, p < 0.01$ ), and negatively correlated with CIR ( $r = -0.684, p < 0.01$ ), consistent with the efficiency and margin hypotheses. NPA ratio emerges as the dominant control variable ( $r = -0.928$  with ROA), confirming that credit quality must be controlled across all models.

### 3.3 Hypothesis Testing Results

Hypothesis	Key Statistic	p-value	Decision	Interpretation
H <sub>1</sub> : UPI → NII	$\beta = +0.272, t = 1.17$ (controlled)	0.308	Fail to Reject H <sub>0</sub>	Fee neutralization: zero-MDR losses offset by cross-selling/CASA gains
H <sub>2</sub> : DIG_VOL → ROA	OLS $p = 0.067$ ; Granger $F = 21.61$	0.0016 (Granger)	Partially Supported	Unidirectional causal effect; digital adoption precedes profitability
H <sub>3</sub> : DIG_GR → CIR	$\beta = -0.042, t = -2.52$	0.045	Reject H <sub>0</sub> ✓	Each 1% rise in digital growth reduces CIR by 0.042 percentage points
H <sub>4</sub> : HVPV → NIM	$\beta = +0.000312, t = 3.675$ (remediated)	0.010	Reject H <sub>0</sub> ✓	RTGS/NEFT sustain NIM; high-value payments signal quality corporate credit
H <sub>5</sub> : PSB vs. PVT ROA	$t = -5.07, \text{Cohen's } d = 2.71$	0.0002	Reject H <sub>0</sub> ✓	Private banks outperform PSBs by 1.32 ppts ROA — very large effect

### 3.4 Key Finding Details

H<sub>1</sub> — Fee Neutralization Effect: In the bivariate model, UPI volume significantly predicts NII ( $\beta = 0.513, p = 0.002$ ). However, when NPA ratio and GDP growth are introduced as controls, the UPI coefficient becomes entirely non-significant ( $\beta = 0.272, p = 0.308$ ). This confirms that under zero-MDR, the direct fee income loss (~₹10,000–12,000 crore annually per PwC) is offset at the aggregate level by indirect benefits — CASA accretion, cross-selling of credit/insurance products, and merchant relationship income. NPA ratio dominates the model: each 1 percentage point increase reduces aggregate NII by ₹7,469 crore.

H<sub>2</sub> — Granger Causality Direction: The Granger causality test provides the study's most structurally important finding. Digital payment volume Granger-causes ROA improvement ( $F = 16.87, p = 0.0016$ ), while ROA does not Granger-cause digital payment volume ( $F = 0.264, p = 0.623$ ). This eliminates the reverse causality concern that profitable banks simply invest more in digital infrastructure. Effect size: a 1,000 crore transaction increase in digital volume predicts approximately 0.036 percentage point improvement in aggregate ROA.

H<sub>3</sub> — Continuous Efficiency Gains: Each 1 percentage point increase in the digital payment transaction growth rate reduces the aggregate CIR by 0.042 percentage points ( $p = 0.045$ ), with the model explaining 94.1% of CIR variance. Notably, Chow tests at both demonetization (FY2016–17) and zero-MDR (FY2019–20) breakpoints are non-significant, confirming that efficiency gains are continuous and structurally stable — not threshold-dependent — contrary to the non-linear J-curve predicted by some theoretical frameworks.

H<sub>4</sub> — High-Value Channel NIM Sustenance: RTGS and NEFT values are severely collinear ( $r = 0.937, \text{VIF} > 100$ ). After remediation using the HVPV composite variable, all three specifications yield consistent, statistically significant positive coefficients (HVPV:  $\beta = +0.000312, p = 0.010$ ; RTGS-only:  $p = 0.011$ ; NEFT-only:  $p = 0.008$ ). This contradicts the IMF's (2023) global prediction of NIM compression from digital disruption, finding instead that high-value payment processing reflects and reinforces quality corporate lending environments.

H<sub>5</sub> — Ownership Divergence: Private banks maintained a mean UPI-era ROA of 1.41% versus PSBs at 0.09% — a gap of 1.32 percentage points ( $t = -5.07$ ,  $p = 0.0002$ , Cohen's  $d = 2.71$ ). PSBs recorded three consecutive years of negative ROA (FY2016–17 to FY2018–19, trough: -0.90%), while private banks remained profitable throughout. The subsequent PSB recovery (ROA: -0.09% in FY2019–20 to +0.98% in FY2023–24) demonstrates that the gap is closeable but requires targeted digital capability investment.

#### IV. THEORETICAL AND MANAGERIAL IMPLICATIONS

##### 4.1 Theoretical Contributions

The study makes four theoretical contributions. First, it advances Diffusion of Innovation (DOI) theory by demonstrating continuous rather than threshold-dependent efficiency harvesting in banking — even marginal digital substitution of manual transactions delivers immediate CIR benefits, refining Rogers' (2003) S-curve model for financial infrastructure. Second, it enriches the Resource-Based View (RBV) by quantifying the VRIN capability gap between PSBs and private banks — Cohen's  $d = 2.71$  validates that superior digital capabilities generate sustainable, measurable competitive advantages. Third, H<sub>1</sub>'s fee neutralization finding challenges information asymmetry theories predicting systematic bank disadvantage under zero-MDR, proposing a data-as-compensation mechanism. Fourth, the unidirectional Granger causality (H<sub>2</sub>) provides the first time-series causal evidence in Indian banking literature that digital adoption precedes profitability, validating public infrastructure investment.

##### 4.2 Policy Implications

- Tiered MDR Framework: The fee neutralization holds currently, but H<sub>1</sub>'s non-significance may not persist as UPI transaction values cross ₹300 lakh crore annually. A 0.1–0.15% MDR for large merchants (turnover > ₹40 lakh), zero for P2P and small merchants, would distribute infrastructure costs fairly while preserving financial inclusion.
- PSB Digital Recapitalization: H<sub>5</sub> quantifies the cost of digital underinvestment at 1.32% ROA annually. Government capital infusions into PSBs should include ring-fenced digital technology budgets, not absorbed into credit provisioning alone.
- RTGS/NEFT Infrastructure Investment: H<sub>4</sub> confirms high-value payment channel importance for NIM. Policy should actively promote RTGS/NEFT adoption for corporate payments rather than allowing these channels to atrophy in favor of UPI.
- UPI Infrastructure Justification: H<sub>2</sub>'s Granger evidence provides empirical justification for continued public investment in NPCI/UIP infrastructure, establishing positive spillovers from digital payment adoption to banking sector profitability

##### 4.3 Managerial Implications

For PSB leadership, the 1.32 percentage point ROA gap demands digital capability building as a first-order strategic priority equal to NPA resolution. Specific imperatives include: establishing dedicated Digital Revenue Units to monetize UPI transaction data for credit cross-selling; accelerating API banking and fintech partnerships following the SBI YONO model; and embedding digital revenue KPIs in board accountability frameworks.

For private banks, H<sub>3</sub>'s CIR finding provides strategic justification for aggressive UPI volume acquisition even at zero MDR revenue — each transaction reduces operating costs and generates behavioral data. For RBI and the Ministry of Finance, the dominant role of NPA ratio across all models ( $r = -0.928$  with ROA) underscores that digital transformation ROI projections must scenario-test outcomes under elevated NPA assumptions above 7%.

#### V. LIMITATIONS AND FUTURE RESEARCH

##### 5.1 Key Limitations

- Aggregate-level data masks within-group heterogeneity; bank-level panel data with fixed effects would yield more precise estimates
- H<sub>1</sub> analysis uses only 8 annual observations (UPI launched 2016); quarterly data would improve statistical power
- Non-interest income is not disaggregated, conflating trading income, fee income, and recovery income
- OLS assumes linearity; given UPI's 156% CAGR, log-linear specifications may better capture diminishing marginal effects

- True structural causality requires IV methods using exogenous instruments (e.g., state-level demonetization shock intensity)

### 5.2 Future Research Directions

- Bank-level panel data studies with Arellano-Bond GMM estimation to control for endogeneity and dynamic adjustment
- Mediation analysis: Digital Adoption → CIR → ROA pathway to quantify the proportion of profitability effect mediated through cost efficiency
- International comparison: India's zero-MDR UPI versus Brazil's PIX, Mexico's CoDi, and China's Alipay ecosystem
- Microdata study tracing UPI onboarding to credit product conversion at the customer level
- ESG/sustainability dimension: carbon cost per digital transaction versus branch-based equivalent

## VI. CONCLUSION

This study empirically confirms that India's digital payment revolution is reshaping bank revenue models — but through efficiency and margin channels rather than direct fee income. The aggregate finding is clear: digital payment growth does not independently harm non-interest income under zero-MDR ( $H_1$ ), but it does Granger-cause profitability improvement ( $H_2$ ), consistently reduces the cost-to-income ratio ( $H_3$ ), and high-value payment channels sustain net interest margins ( $H_4$ ). The persistent private bank ROA advantage over PSBs ( $H_5$ ,  $d = 2.71$ ) is the most policy-actionable finding, establishing a structural digital capability gap that requires targeted government intervention.

*"Digital payments are reshaping bank revenue models primarily via efficiency and margin pathways rather than immediate fee income — with significant consequences for banking strategy and payment policy in India."*

The study's 12-year longitudinal scope, multi-source data triangulation, Granger causal evidence, and methodological transparency provide a robust empirical foundation for policy and management action. For the Reserve Bank of India, the Ministry of Finance, bank boards, and academic scholars, this research advances a unified framework for understanding how public digital infrastructure investment translates — with measurable efficiency and profitability spillovers — into the financial performance of India's banking sector.

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