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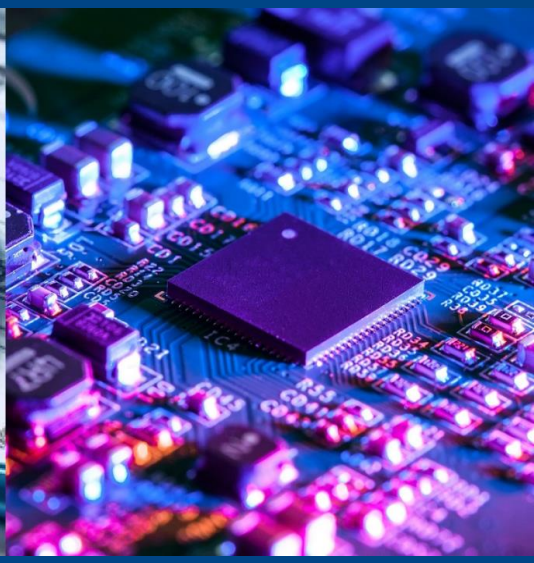

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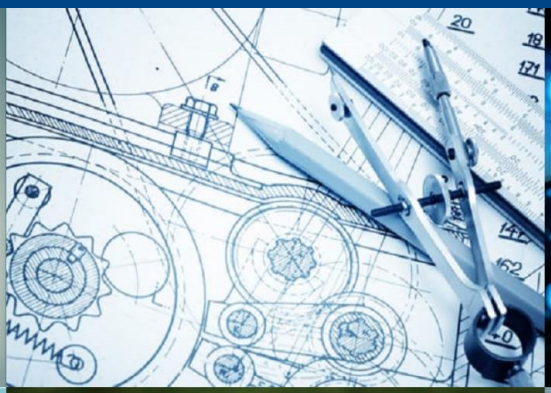

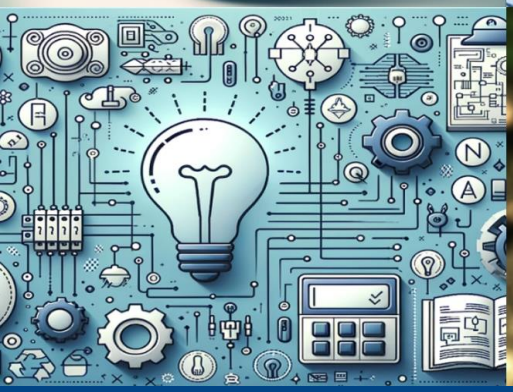

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UPI Led Digital Transformation and Its Impact on Traditional Banking Transaction Dynamics in India

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ABSTRACT: The rapid expansion of the Unified Payments Interface (UPI) has fundamentally transformed India's retail financial ecosystem. Launched in August 2016, UPI scaled from 0.18 crore to an estimated 185 crore annual transactions (CAGR ~138%) worth Rs. 246 lakh crore by FY 2024-25, reshaping consumer payment behaviour and reducing reliance on traditional banking channels. This study empirically examines UPI's impact on ATM withdrawals, debit card POS, credit card transactions, and electronic fund transfer systems (NEFT, RTGS, IMPS) using secondary time-series data spanning FY 2015-16 to FY 2024-25. Quantitative methods—trend analysis, CAGR computation, Pearson correlation, and growth index normalisation—are applied across five research hypotheses. Findings confirm strong substitution of ATM withdrawals ($r = -0.87$) and debit card POS ($r = -0.76$), complementary co-growth with credit cards ($r = +0.97$) and NEFT/RTGS, partial IMPS moderation, and a landmark financial inclusion impact with digital transaction penetration rising from 6.2% to 83.6% over the study period.

KEYWORDS: UPI, Digital Payments, Banking Transactions, Financial Technology, India, Payment Substitution, Financial Inclusion

I. INTRODUCTION

The Unified Payments Interface (UPI), launched in August 2016 by the National Payments Corporation of India (NPCI) under the oversight of the Reserve Bank of India (RBI), is a real-time payment system enabling instant, interoperable, and zero-cost fund transfers across all participating banks through mobile devices. Its frictionless design—eliminating the need for physical payment instruments, card details, or complex bank account information—proved transformative across demographic and geographic boundaries. Adoption accelerated sharply following the November 2016 demonetization of high-denomination currency notes, and expanded further with the entry of fintech platforms such as PhonePe, Google Pay, and Paytm, the proliferation of interoperable QR infrastructure enabling merchant acceptance at near-zero cost, and the Government of India's zero merchant discount rate (MDR) policy. By FY 2024-25, UPI accounted for an estimated 83.6% of all formal digital retail transactions in India by volume, placing India at the forefront of global real-time payment systems.

The implications for India's established banking sector are substantial. Banks had historically relied on ATM withdrawal fee income, debit and credit card interchange revenues, and electronic fund transfer service charges as meaningful contributors to non-interest income and customer touchpoints. The rise of UPI—routing payments through bank accounts but generating no direct fee revenue for those banks—has fundamentally altered this commercial and strategic landscape. Observed declines in low-value ATM withdrawals and debit card POS transactions signal a structural reorientation of consumer payment behaviour with significant consequences for banking infrastructure investment and revenue strategy.From a developmental perspective, UPI has served as a powerful enabler of financial inclusion, bringing previously unbanked or underbanked citizens into the formal digital economy for the first time. Rural and semi-urban populations who had limited access to physical banking infrastructure can now transact digitally through entry-level smartphones. This research rigorously examines, through longitudinal secondary data analysis over a decade, how UPI adoption has restructured India's traditional banking transaction patterns and what this transformation means for banks, regulators, and policymakers.

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II. REVIEW OF LITERATURE

A. Digital Payments and Banking Transformation

Humphrey, Pulley, and Vesala (2001) established that digital payments reduce transaction processing costs and drive systematic declines in traditional channel usage—the theoretical foundation of Payment Substitution Theory. Berger (2003) found that electronic banking systems substantially reduce institutional dependence on physical banking infrastructure. Claessens, Glaessner, and Klingebiel (2002) demonstrated that fintech innovations alter banking structures in developing economies by enabling secure, real-time, low-cost transactions. Hasan, Schmiedel, and Song (2013) confirmed a positive relationship between digital payment use and overall economic efficiency across a large cross-country panel. Mishra and Bisht (2013) documented growing Indian consumer gravitation toward digital channels for convenience advantages over physical banking, providing a pre-UPI baseline for the digital substitution dynamics examined in this study.

B. Mobile Payment Adoption and Consumer Behaviour

Davis (1989) proposed the Technology Acceptance Model (TAM), identifying perceived usefulness and ease of use as primary adoption drivers—both maximised in UPI's instrument-free, zero-cost, instant-settlement design. Venkatesh et al. (2003) extended this through UTAUT, with all four factors—performance expectancy, effort expectancy, social influence, and facilitating conditions—exceptionally favourable for UPI adoption. Dahlberg et al. (2008) confirmed trust, security, and usability as critical antecedents of mobile payment adoption; UPI's RBI-regulated, bank-account-linked architecture provided precisely the institutional trustworthiness needed to achieve consumer confidence across diverse demographic groups.

C. UPI Growth and Financial Inclusion

Sharma, Sharma, and Dwivedi (2019) identified ease of use and regulatory backing as key UPI adoption predictors. Gupta and Arora (2020) documented exponential UPI growth driven by zero-cost structure and QR ecosystem expansion. Kumar and Singh (2021) observed progressive consumer shifting from ATM and card payments to UPI. Raghavan and Sinha (2022) characterised UPI as a disruptive innovation redefining India's banking transaction flows. Donovan (2012) and Demirguc-Kunt et al. (2018) established that mobile payment systems significantly enhance financial inclusion in developing economies. Jack and Suri (2014) demonstrated transformative social impact of mobile money in Kenya—providing comparative context for India's UPI-driven financial inclusion outcomes.

D. Research Gaps

Five substantive research gaps inform this study: (1) absence of comprehensive empirical analysis of UPI's impact on disaggregated banking transaction channels using decade-long longitudinal data; (2) lack of channel-specific analysis distinguishing ATM, debit card POS, credit card, and EFT channels; (3) limited examination of financial sustainability implications for Indian commercial banks; (4) reliance on short-term datasets unable to distinguish permanent structural shifts from cyclical disruptions; and (5) no integrated empirical framework simultaneously examining UPI as both a channel disruptor and financial inclusion enabler.

III. RESEARCH METHODOLOGY

A. Scope, Data Sources, and Study Period

The study focuses on aggregate national-level banking and payment system data across FY 2015-16 to FY 2024-25. Secondary data are drawn exclusively from: NPCI Monthly Payment System Indicators (UPI and IMPS data); RBI Payment System Reports, Annual Reports, and Handbook of Statistics on Indian Economy (ATM, debit/credit card, NEFT, RTGS data); TRAI Annual Reports (smartphone and internet penetration); PMJDY Dashboard (Jan Dhan accounts, RuPay cards); and NABARD Annual Reports (rural financial inclusion). UPI transaction metrics serve as independent variables; ATM withdrawal, debit card POS, credit card, NEFT, RTGS, and IMPS metrics serve as dependent variables; smartphone penetration, internet subscribers, and UPI-enabled banks serve as control variables. The FY 2015-16 base year provides pre-UPI transaction benchmarks for all conventional channels.

B. Research Objectives and Hypotheses

Primary objective: To empirically analyse UPI's impact on traditional banking transaction patterns in India using quantitative longitudinal secondary time-series data across FY 2015-16 to FY 2024-25. Specific objectives include examining UPI growth trends, analysing traditional channel trends, comparing trajectories using CAGR and Pearson

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correlation, evaluating reduced physical banking infrastructure reliance, assessing strategic implications for banks, examining UPI's financial inclusion role, and providing evidence-based recommendations. Five hypotheses are tested: H1 (UPI negatively impacts ATM withdrawal volumes); H2 (UPI reduces debit card POS volumes); H3 (UPI negatively impacts credit card usage); H4 (UPI substitutes NEFT/RTGS/IMPS); H5 (UPI enhances financial inclusion).

C. Analytical Techniques

The following analytical techniques are employed: (1) Trend Analysis—examining direction and momentum of transaction volumes across the study period; (2) Compound Annual Growth Rate (CAGR)—formula: [(End Value / Begin Value)^(1/n) − 1] × 100, where n = number of years; (3) Year-on-Year Growth Rate Analysis—capturing annual fluctuations driven by discrete events such as demonetization (FY 2016-17), zero-MDR policy (FY 2019-20), and COVID-19 pandemic (FY 2020-21); (4) Pearson Correlation Coefficient—measuring linear association between UPI transaction volume and each traditional channel, with $|r| > 0.70$ adopted as the criterion for strong correlation; negative r indicates substitution, positive r indicates complementarity; and (5) Growth Index Normalisation—all channel transaction volumes normalised to base 100 in FY 2016-17 for comparative visualisation across channels with dramatically different absolute magnitudes.

IV. DATA ANALYSIS AND INTERPRETATION

A. UPI Transaction Growth: FY 2016-17 to FY 2024-25

UPI's growth over the study period is one of the most extraordinary expansions in global retail payment history. From 0.18 crore transactions valued at Rs. 0.07 lakh crore in FY 2016-17, UPI scaled to an estimated 185 crore transactions worth Rs. 246 lakh crore by FY 2024-25—a CAGR of approximately 138% in volume and 176% in value.

TABLE I: UPI Transaction Volume and Value: FY 2016-17 to FY 2024-25

Financial Year	UPI Volume (Cr Txns)	YoY Growth (%)	UPI Value (Rs. Lakh Cr)	YoY Growth (%)	Avg. Txn Value (Rs.)
FY 2016-17	0.18	—	0.07	—	3,889
FY 2017-18	0.92	411.1	1.00	1,328.6	1,087
FY 2018-19	5.35	481.5	8.77	777.0	1,640
FY 2019-20	12.52	134.0	21.32	143.1	1,703
FY 2020-21	22.33	78.4	41.04	92.5	1,838
FY 2021-22	46.03	106.1	84.17	105.1	1,829
FY 2022-23	83.75	81.9	139.20	65.4	1,663
FY 2023-24	131.00	56.4	199.90	43.6	1,526
FY 2024-25 (Est.)	185.00	41.2	246.00	23.1	1,330
CAGR (FY17–FY25)	~138% p.a.	—	~176% p.a.	—	—

Source: NPCI Monthly Payment System Indicators; RBI Annual Reports. FY 2024-25 estimated from first-half actuals and NPCI trend projections.

Three phases characterise UPI's trajectory: (1) Hyper-growth (FY 2016-17 to FY 2018-19, >400% p.a.) catalysed by demonetization and rapid QR ecosystem expansion; (2) Sustained triple-digit growth (FY 2019-20 to FY 2021-22)

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further accelerated by COVID-19 contactless payment adoption and zero-MDR policy; (3) Market maturation (FY 2022-23 to FY 2024-25, 40–82% p.a.) as UPI deepened penetration in semi-urban and rural segments. The consistent decline in average transaction value from Rs. 3,889 to Rs. 1,330 reflects UPI's progressive democratisation into everyday micro-transactions, displacing cash for small retail purchases across India's consumer economy.

B. Growth Index and Comparative Channel Analysis

TABLE II: Growth Index Analysis — All Payment Channels (Base FY 2016-17 = 100) and CAGR Comparison

Channel	Growth Index FY24-25	CAGR Volume	CAGR Value	Pearson r (vs UPI Vol)	Hypothesis Outcome
UPI	1,02,778	~138%	~176%	—	—
ATM Withdrawals	94	(0.7)%	2.7%	(0.87)	H1 Supported
Debit Card POS	103	(0.4)%	1.6%	(0.76)	H2 Supported
Credit Card	358	~17%	~27%	+0.97	H3 Not Supported
NEFT	291	~14%	~18%	+0.99	H4 Part. Supported
IMPS	445	~24%	~23%	+0.98	H4 Part. Supported
RTGS	—	~8%	~9%	+0.95	H4 Not Supported

Source: Computed from RBI Payment System Reports and NPCI data. Pearson r computed over 9 annual data points FY 2016-17 to FY 2024-25. Negative values in parentheses.

The growth index analysis provides compelling evidence of structural payment channel divergence. While UPI's index reaches 1,02,778 by FY 2024-25, the ATM withdrawal volume index settles at only 94—indicating actual absolute decline—and the debit card POS index reaches a modest 103, representing essentially negligible net growth across eight years of economic expansion. By contrast, credit cards reach an index of 358, NEFT reaches 291, and IMPS reaches 445, confirming their structural insulation from UPI substitution pressure. This contrast constitutes powerful evidence of UPI's selective, value-segmented restructuring of India's payment landscape.

C. Impact on ATM Cash Withdrawals and Debit Card POS (H1, H2)

ATM withdrawal volumes entered structural stagnation as UPI crossed 12 crore annual transactions in FY 2019-20. The sharpest decline occurred in FY 2020-21 at (13.0)%, driven jointly by pandemic-induced mobility restrictions and dramatically accelerating UPI adoption. Post-pandemic partial recovery proved temporary; volumes renewed decline in FY 2024-25 at (0.9)%. The Pearson correlation of (0.87) provides robust statistical support for H1. ATM CAGR of (0.7)% contrasts starkly with UPI's 138% CAGR, confirming systematic displacement of frequent low-denomination cash withdrawals for daily retail purchases.

Debit card POS volumes peaked at 4.63 crore in FY 2019-20 and contracted to 3.10 crore by FY 2024-25—a cumulative decline of approximately 33%. Year-on-year declines of (3.9)%, (8.6)%, and (9.4)% in FY 2022-23, FY 2023-24, and FY 2024-25 reflect secular structural displacement rather than cyclical weakness. The Pearson correlation of (0.76) confirms strong substitution (H2 Supported). UPI's interoperable QR code infrastructure eliminated the capital barrier of POS terminal installation, extending digital payment acceptance to the entire micro-merchant universe—vegetable vendors, autorickshaw drivers, and street traders previously beyond the reach of card payment networks.

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D. Impact on Credit Cards (H3) and EFT Systems (H4)

Credit card transactions exhibit a fundamentally different trajectory: volumes grew at a CAGR of approximately 17% and values at 27%, rising from Rs. 3.06 lakh crore to Rs. 21.50 lakh crore (Pearson r = +0.97). UPI dominates the small-value, high-frequency impulse-driven micro-transaction space previously served by cash and debit cards. Credit cards serve premium discretionary consumption, EMI-linked consumer durable financing, travel and hospitality spending, and reward-programme-driven purchasing—structurally distinct, higher-value domains where UPI's positioning is fundamentally incompatible. H3 is not supported; UPI and credit cards operate as complementary instruments in non-overlapping segments.

NEFT (CAGR +14%, r = +0.99) and RTGS (CAGR +8%, r = +0.95) demonstrate robust growth entirely insulated from UPI competition, serving institutional payroll, corporate treasury, and high-value settlement functions that UPI cannot address. IMPS, which occupies the small-value real-time transfer space most directly overlapping with UPI's retail use case, shows visible growth rate moderation and a declining share of total real-time retail payment volumes as UPI captured dominant consumer preference. H4 is therefore partially supported: UPI does not substitute NEFT or RTGS, but shows meaningful evidence of constraining IMPS growth in the small-value real-time payment segment.

E. UPI and Financial Inclusion Outcomes (H5)

TABLE III: Financial Inclusion Indicators vs. UPI Volume: FY 2016-17 to FY 2024-25

Financial Year	Jan Dhan A/Cs (Cr)	RuPay Cards (Cr)	UPI Volume (Cr Txns)	Internet Subscribers (Cr)	Digital Txn Penetration (%)
FY 2016-17	28.1	19.8	0.18	42.7	6.2
FY 2017-18	30.9	23.1	0.92	48.3	9.8
FY 2018-19	34.2	26.6	5.35	56.0	14.5
FY 2019-20	38.3	29.7	12.52	67.4	21.3
FY 2020-21	41.9	31.2	22.33	82.5	33.4
FY 2021-22	44.2	33.4	46.03	102.0	48.2
FY 2022-23	48.7	35.0	83.75	119.8	62.7
FY 2023-24	52.3	36.4	131.00	136.5	74.1
FY 2024-25 (Est.)	55.8	38.0	185.00	151.2	83.6

Source: PMJDY Official Dashboard; NPCI Ecosystem Reports; TRAI Annual Reports; RBI Annual Reports. Pearson r = +0.99 (Jan Dhan vs UPI volume); r = +0.98 (Digital Penetration vs UPI volume).

The data reveal a sustained and mutually reinforcing alignment between UPI's growth and deepening financial inclusion across all proxy indicators. Jan Dhan accounts grew from 28.1 crore to an estimated 55.8 crore—nearly doubling—with a Pearson correlation of +0.99 against UPI volume. RuPay card issuance doubled from 19.8 crore to 38 crore, progressively extending UPI access to populations with no prior formal digital payment experience. Internet subscribers expanded from 42.7 crore to 151.2 crore, creating the connectivity infrastructure for UPI access in geographically underserved areas. Most significantly, digital transaction penetration rose from 6.2% to an estimated 83.6%—a Pearson correlation of +0.98 against UPI volume—representing one of the most rapid large-scale financial digitalisation transitions documented anywhere globally. H5 is strongly and unambiguously supported.

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V. FINDINGS AND RECOMMENDATIONS

A. Consolidated Hypothesis Testing Results

TABLE IV: Consolidated Hypothesis Testing Results Summary

Hyp.	Research Statement	Key Statistical Evidence	Impact Direction	Decision
H1	UPI negatively impacts ATM volumes	ATM CAGR = (0.7)%; r = (0.87)	Strong Substitution	Supported
H2	UPI reduces debit card POS volumes	Debit POS CAGR = (0.4)%; r = (0.76); −33% from peak	Strong Substitution	Supported
H3	UPI negatively impacts credit card usage	Credit CAGR = 17%; r = +0.97; distinct segments	Complementary	Not Supported
H4	UPI substitutes NEFT/RTGS/IMPS	NEFT/RTGS insulated; IMPS share declining	Partial Substitution	Partially Supported
H5	UPI enhances financial inclusion	r = +0.99 (Jan Dhan); penetration 6.2% → 83.6%	Strong Positive	Strongly Supported

Source: Computed from RBI and NPCI data over 9 annual data points from FY 2016-17 to FY 2024-25.

B. Key Findings

UPI represents an unprecedented payment platform achievement—scaling from 0.18 crore to 185 crore annual transactions in under a decade, a CAGR of approximately 138% in volume and 176% in value, with no payment instrument in India's financial history achieving comparable adoption velocity across such a demographically diverse and geographically vast population base. ATM withdrawal volumes stagnated and declined (CAGR −0.7%), confirming systematic displacement of frequent low-denomination cash withdrawals for daily retail purchases, consistent with Payment Substitution Theory. Debit card POS entered a phase of structural and accelerating decline, contracting approximately 33% from its FY 2019-20 peak as UPI's interoperable QR code ecosystem extended digital payment acceptance across the micro-merchant universe at near-zero deployment cost. Credit cards demonstrated robust complementary co-growth (CAGR +17%), confirming non-overlapping structural segmentation between UPI's micro-transaction positioning and credit cards' premium discretionary spending domain. NEFT and RTGS remained fully insulated from UPI competition, while IMPS showed growth rate moderation and declining relative share of real-time retail payment volumes. Jan Dhan accounts nearly doubled, digital transaction penetration rose from 6.2% to 83.6%, and internet subscribers grew from 42.7 crore to 151.2 crore, collectively confirming UPI's transformative financial inclusion impact.

C. Theoretical and Managerial Implications

This study provides comprehensive empirical validation of Payment Substitution Theory within a large, demographically heterogeneous emerging economy, introducing a theoretically significant value segmentation boundary beyond which substitution effects reverse into complementarity. UPI's diffusion extends Rogers's (1962) Diffusion of Innovation Theory to account for institutional shocks and interoperable platform architectures as powerful adoption accelerators. The study also extends Financial Intermediation Theory to layered digital architectures in which partial consumer-layer disintermediation coexists with persistent settlement-layer bank intermediation.

For commercial banks, expanding ATM networks and POS terminal footprints in UPI-saturated markets is no longer economically rational. Capital must be redirected toward digital banking infrastructure, cloud-native core banking modernisation, and diversified revenue streams via UPI Credit Line products, data analytics monetisation, and digital

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cross-selling of insurance and wealth management products. For NPCI, maintaining UPI's zero-cost, fully interoperable architecture is non-negotiable given its documented financial inclusion impact. Priority expansion areas include credit-linked UPI, cross-border UPI interoperability, and offline NFC/USSD-based UPI for low-connectivity rural environments. For regulators, UPI's growing concentration risk as a single-platform dependency for the majority of India's retail payment transactions warrants dedicated business continuity planning, redundant infrastructure investment, and coordinated stress-testing protocols.

VI. CONCLUSION

This research delivers an unambiguous and historically significant verdict: UPI has fundamentally, structurally, and in all probability permanently reshaped India's retail payment landscape. The platform's growth from 0.18 crore to 185 crore annual transactions in under a decade has simultaneously and measurably displaced ATM cash withdrawal frequency (H1 Supported, $r = -0.87$) and debit card POS adoption (H2 Supported, $r = -0.76$)—the twin pillars of India's pre-digital consumer payment infrastructure—while coexisting with and facilitating the continued growth of premium credit card spending (H3 Not Supported, $r = +0.97$), institutional electronic fund transfers (H4 Partially Supported), and the broader digital banking ecosystem. Most significantly, UPI has generated substantial net-new financial activity by incorporating hundreds of millions of previously excluded individuals into the formal digital economy (H5 Strongly Supported; digital penetration 6.2% to 83.6%; Jan Dhan accounts nearly doubling).

For India's banking sector, UPI simultaneously disrupts legacy transaction revenue models and creates transformational opportunities to build next-generation digital financial service platforms on the foundation of the world's most sophisticated and inclusive real-time payment infrastructure. Future research should examine state-level disaggregated adoption patterns, CBDC-UPI interaction dynamics, credit-linked UPI products, and longitudinal profitability impact analysis of Indian commercial banks to extend the empirical framework established by this study.

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