Impact of UPI on Cash Demand – Evidence from National and Subnational Levels

by Sakshi Awasthy and Subrat Kumar Seet ^

While the broader shift to digital payments is well-established, regional adoption of the Unified Payments Interface (UPI) and its impact on cash demand remain underexplored. Using a dual empirical strategy - an autoregressive distributed lag model and panel quantile regression - this study finds that higher UPI adoption is associated with lower cash demand at both national and subnational levels, with state-level patterns suggesting non-linearity. Among other state-wise factors, income and ATM density are positively associated with cash demand, whereas workforce formalisation and educational attainment are linked to lower cash reliance.

Introduction

Payments underpin all economic activity. In a frictionless environment, the choice of payment mode may have less bearing on real outcomes; however, in practice, transaction costs and information asymmetries render certain payment methods more efficient than others in shaping economic growth (Dubey and Purnanandam, 2023). The shift from cash to digital payments, particularly fast payment systems, has been associated with increased welfare, financial inclusion, credit access, economic formalisation and financial resilience (Bachas *et al.,* 2018; Aguilar *et al.,* 2024; Aurazo and Franco, 2024; Cantú *et al.,* 2024). At the same time, existing literature is also strewn with instances of simultaneous rise in cash and digital payments (Bech *et al.,* 2018; Chen *et al.,* 2020; Caswell *et al.,* 2020), even as the transactional use of cash ebbs, or what is often described as the "paradox of banknotes" (Bailey, 2009). This trend has reinvigorated the debate on the impact of digital payments on cash, with significant implications for currency and liquidity management, underlying economic frictions, and broader macroeconomic policy.

India's fast payment system, Unified Payments Interface (UPI), launched in 2016, offers a unique empirical setting to study the evolving relationship between cash and digital payments for three key reasons. First, the scale of adoption has been unprecedented. UPI users have surged from around 30 million in 2017 to over 420 million by 2024 (RBI, 2024; Reddy *et al.,* 2024). Transaction volumes are nearing 200 billion a year, accounting for over 80 per cent of total digital payments (RBI, 2025). Second, the launch of UPI closely followed a large-scale financial inclusion drive *i.e., Pradhan Mantri Jan Dhan Yojana*, creating enabling conditions for widespread digital uptake across socio-economic groups. Finally, notwithstanding the growth in digital payments (especially UPI), currency in circulation has continued to rise, *albeit* at a slower pace in recent years, reflecting a dynamic interplay between cash and digital modes.

While the broader shift to digital payments is well-established (Nachane *et al.,* 2013; Chaudhari *et al.,* 2019; Raj *et al.,* 2020; Awasthy *et al.,* 2022; RBI, 2023), regional adoption of the UPI and its impact on cash demand at the state-level remain underexplored. Given India's geographical and income diversity, national aggregates may obscure regional disparities, as digital uptake may be concentrated in select

^ Authors are from the Department of Economic and Policy Research. Valuable insights provided by Dr. Rajiv Ranjan, former Executive Director, Shri M.M. Ramaiah, and Dr. Rakhe Balachandran are gratefully acknowledged. Authors are grateful to the team from Department of Currency Management, including Shri Sanjeev Prakash, CGM-in-Charge; Pradip Bhuyan, and Baswaraj Patil for making available the currency chest data. Authors are thankful to Shri Gunveer Singh, CGM-in-Charge, Department of Payment and Settlement Systems for facilitating access to region-wise UPI data. The views expressed in this paper are those of authors and do not represent the views of the Reserve Bank of India.

economic clusters, with cash being persistent in other regions. As per estimates, individuals in the top 20 per cent income group are twice as likely to use digital payments as those in the bottom 40 per cent (NPCI, 2020). More recent data show a steeper gradient, with the top 10 per cent by consumption expenditure twice as likely to report the *ability to use* UPI as the bottom 25 per cent, though the overall ability stands close to 50 per cent (NSO, 2025). As digital payments become central to economic activity, identifying regions that are excluded or lagging behind is crucial - not only to promote inclusive access but also to address infrastructure gaps and risks to consumer protection.

Against this backdrop, the paper examines the impact of UPI on cash usage by modelling cash demand at both national and subnational levels. Specifically, the study addresses four key research questions: (a) What is the impact of UPI on cash demand at the all-India aggregate level? (b) What regional patterns emerge in the adoption of UPI and cash? (c) How does UPI influence cash demand across states? and (d) Does this impact vary by state's income levels? Given the limited empirical focus on regional trends, this study provides one of the first state-level assessments of cash to UPI substitution in India.

The remainder of the paper is structured as follows: Section II reviews the literature, followed by descriptive analysis in Section III. Section IV outlines the data and methodology, while Section V presents the empirical results. Section VI concludes. Technical details and additional estimation outputs are presented in Annexures I–III.

II. Related Literature

There exists a substantial body of theoretical and empirical literature on the determinants of money demand (Friedman, 1999; Alvarez and Lippi, 2009). The demand for cash is traditionally attributed to three primary motives: the transaction motive linked to economic activity (Fisher, 1911); the precautionary motive, reflecting the need for liquidity in uncertain situations; and the speculative motive, driven by expectations about interest rate movements (Keynes, 1954). Building on this, money demand is reconceptualised as a stable function of wealth, incorporating expected returns on alternative assets such as bonds, equities, and durable goods (Friedman, 1956). The seminal inventory (Baumol, 1952) and portfolio (Tobin, 1956) theoretical models extend the money demand function by incorporating interest rates and transaction costs. More recent studies emphasise the negative impact of payment innovations on physical currency (Columba, 2009; Oyelami and Yinusa, 2013; Huynh *et al.,* 2014). Concurrently, a growing body of literature highlights the coexistence of cash and digital payments, attributing sustained cash usage to precautionary motives and economic uncertainties (Bech *et al.,* 2018; Caswell *et al.,* 2020; Chen *et al.,* 2020; Ardizzi *et al.,* 2020).

In the Indian context, studies have found a significant negative association between digital payments and currency demand, reflecting a growing substitution effect (Nachane *et al.,* 2013; Bhattacharya and Singh, 2016; Chaudhari *et al.,* 2019; Raj *et al.,* 2020; and Awasthy *et al.,* 2022; Udupa *et al.,* 2025). At the regional level, however, empirical research has largely focussed on digital payment adoption, instead of substitution dynamics. Using transaction level data from *PhonePe,* Dubey and Purnanandam (2023) find that districts with higher post-UPI cashless payment intensity experienced significantly greater household income growth. Drawing on the same dataset, a report by ICRIER finds that COVID-19 accelerated digital adoption and narrowed disparities in UPI's user penetration across

states and districts (Reddy *et al.* 2024). The report also identifies key drivers of digital adoption such as income levels, internet access, digital literacy, and financial infrastructure.

III. How does India Pay?

III.1. Aggregate-Level Insights into Payment Choice

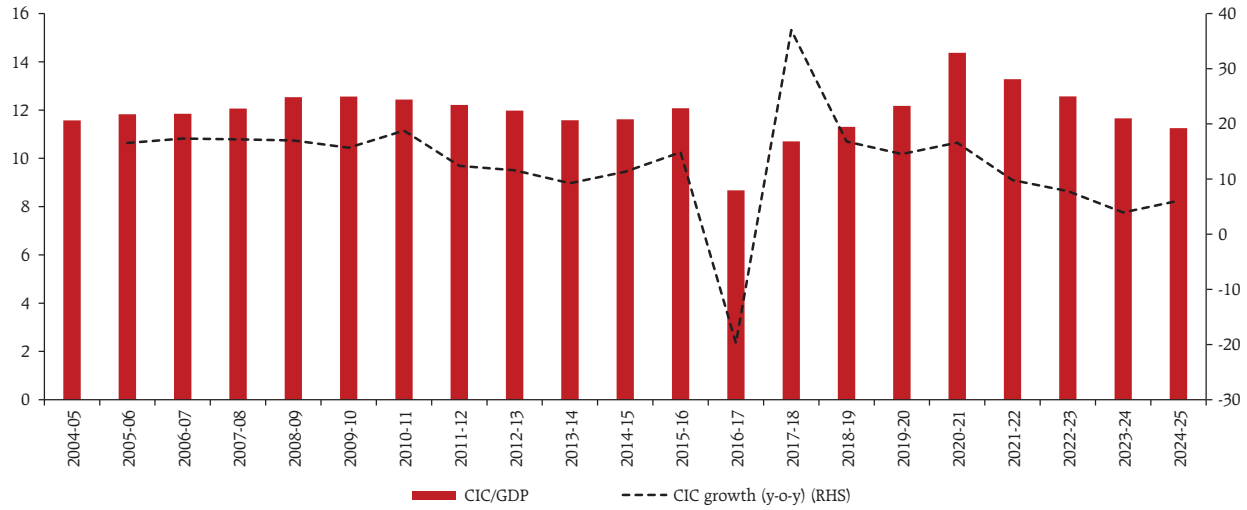
India has a diverse payment ecosystem, encompassing both cash and a broad suite of digital options. Currency in circulation (CIC)[1] has normalised from a peak of 14.4 per cent of Gross Domestic Product (GDP) in 2020–21 to 11.7 per cent in 2023–24 and further to 11.2 per cent in 2024–25. CIC growth slowed to 4–6 per cent in recent years, driven by structural shift towards digital payments, post-pandemic normalisation, phased withdrawal of ₹2000 notes, and greater formalisation (Chart 1). A marginal rise (y-o-y) in 2024-25 reflects higher rural demand and election-related spending. Real CIC growth turned negative in 2023-24 and remained modest in 2024-25, suggesting decline in inflation-adjusted cash demand.

In contrast, digital payments (value) as a share of GDP has risen sharply to over 800 per cent, with the pandemic acting as a catalyst for increased adoption in both volume and value terms (Chart 2a). Overall, total digital payments have exhibited robust growth over the last decade (2015-2025), recording a compound annual growth rate of 48 per cent by volume and 12.5 per cent by value. Monthly trends show a broadly sustained digital momentum amid tapering CIC growth (Chart 2b).

The shift away from cash is also evident in the decline in currency-to-demand deposits ratio to 1.31 in 2024-25 from 1.68 in 2015-16[2] and a steady fall in ATM cash withdrawals (as a share of GDP) since 2018-19 (Charts 3 a and b).

Chart 1: Trends in Currency in Circulation

(per cent of GDP, left axis; Per cent growth (y-o-y), right axis)

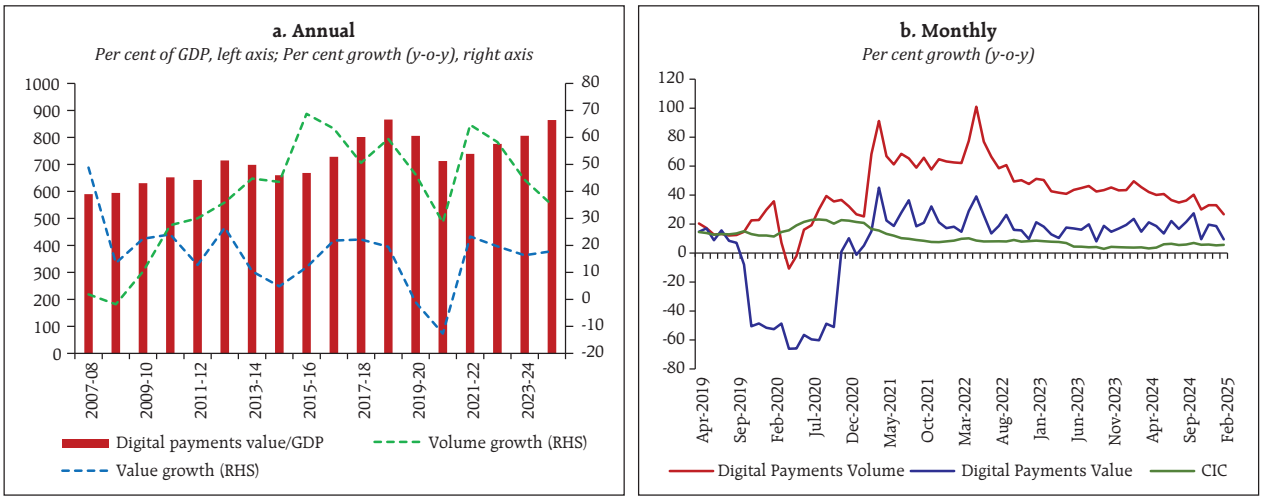


Sources: RBI; NSO.

[1] Given anonymity associated with cash-based economic transactions, CIC is taken as a proxy for cash demand, in line with previous RBI studies (Nachane *et al.*, 2013; Chaudhari *et al.*, 2019; Raj *et al.*, 2020)

[2] Since digital payments are backed by bank deposits, mainly demand deposits, a decline in the CIC-to-demand deposits ratio—holding other factors constant—indicates a shift towards digital modes of transaction, whereas an increase in the ratio reflects a rising preference for cash.

Chart 2: Trends in Digital Payments

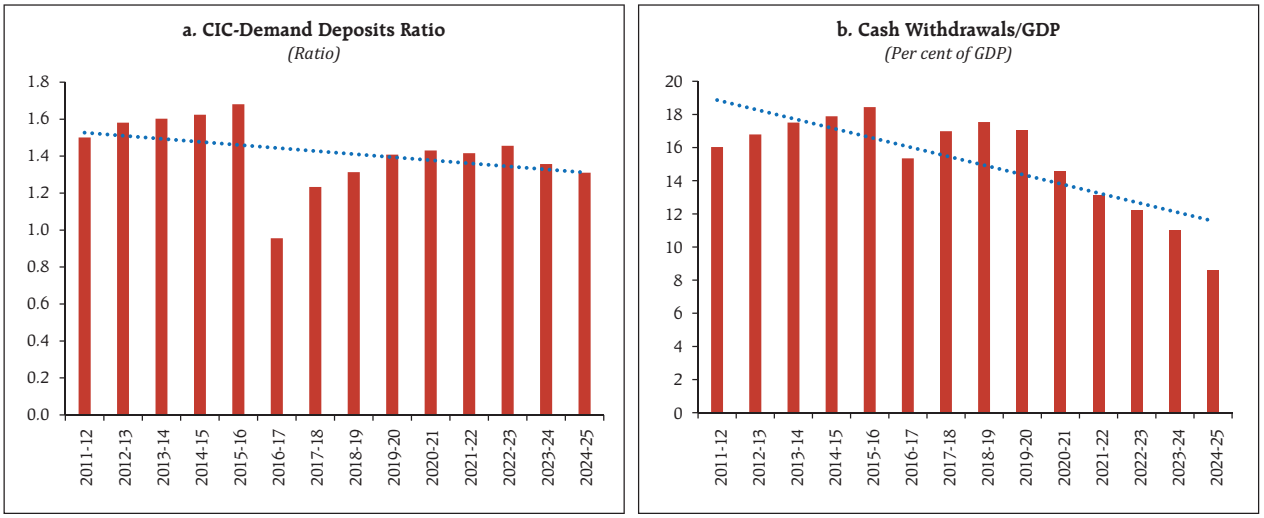


Note: Total Digital Payments include, *inter alia*, transactions under the Real Time Gross Settlement, National Electronic Funds Transfer, Immediate Payment Service, National Automated Clearing House, Unified Payments Interface, *Aadhaar* enabled Payment System, *Bharat* Bill Payment System, Cards and Prepaid Payment Instruments.
Sources: RBI; NSO.

A possible driver behind the decline in cash demand has been the rise of UPI. Transaction volumes logged under the fast payment mode surged to 18,586 crore in 2024-25 from 1,252 crore in 2019-20, with a marked acceleration post COVID-19. In less than a decade, UPI has become a leading payment system, processing more than 17 billion transactions a month and overall, accounting for 84 per cent and 9 per cent of total digital payment volumes and values, respectively, in 2024-25 (Table 1).

The strong UPI rally is underpinned by its open, technology-agnostic architecture that eases development of applications, user-friendly design, and increasing digital awareness (Aurazo *et al.* 2024). Growing use of UPI for daily low-value transactions is evident from the rising share of peer-

Chart 3: Trends in Demand for Cash



Note: Figures for 2024-25 are provisional. In chart b, data include cash withdrawals from debit and credit cards. Dotted line presents the linear trend in both charts.
Sources: RBI; NSO.

Table 1: Growth in UPI

Year	Volume (crore)	Value (₹ lakh crore)	Average Ticket Size (₹)	Share in Total Digital Payments Volume (per cent)	Share in Total Digital Payments Value (per cent)
2016-17	2	0.1	3867	0.2	0.0
2017-18	92	1.1	1200	6.3	0.1
2018-19	539	9	1627	23.2	0.5
2019-20	1,252	21	1703	36.8	1.3
2020-21	2,233	41	1838	51.1	2.9
2021-22	4,596	84	1831	63.8	4.8
2022-23	8,371	139	1662	73.5	6.7
2023-24	13,113	200	1525	79.7	8.2
2024-25	18,586	261	1404	84	9

Note: Average ticket size (₹) is computed as = ((Value/Volume)*1,00,000).
Sources: RBI; NPCI.

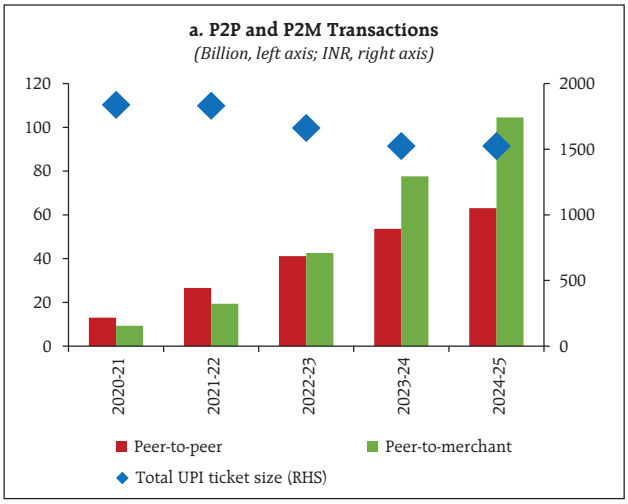
to-merchant (P2M) payments, narrowing ticket size of UPI payments (Chart 4a), and the bulk of the P2M volumes falling within the sub-₹500 value band (Chart 4b).

III.2. State-level Insights into Payment Choice

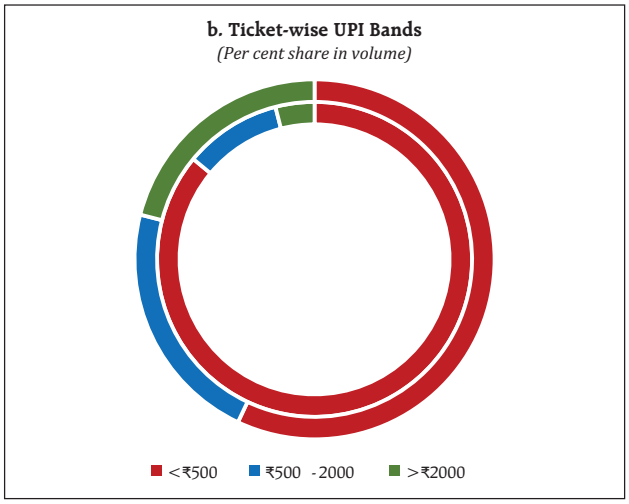
State-level analysis reveals regional variations shaped by income and structural factors. Due to unavailability of granular data on ATM withdrawals, cash usage is proxied by withdrawals from currency chests, which are regional repositories managed by commercial banks on behalf of the Reserve Bank of India. As all freshly issued notes pass through these chests, their withdrawal patterns are assumed to reflect public cash demand. On average, the share of annual cash withdrawals from ATMs (through debit and credit cards) to cash withdrawals at currency chests stands at 80 per cent in 2024-25.

In the absence of disaggregated UPI data, this study employs data from *PhonePe* (Pulse), a payment service provider accounting for 58 per cent of total UPI transaction volume and 53 per cent of value

Chart 4: Composition of UPI Transactions

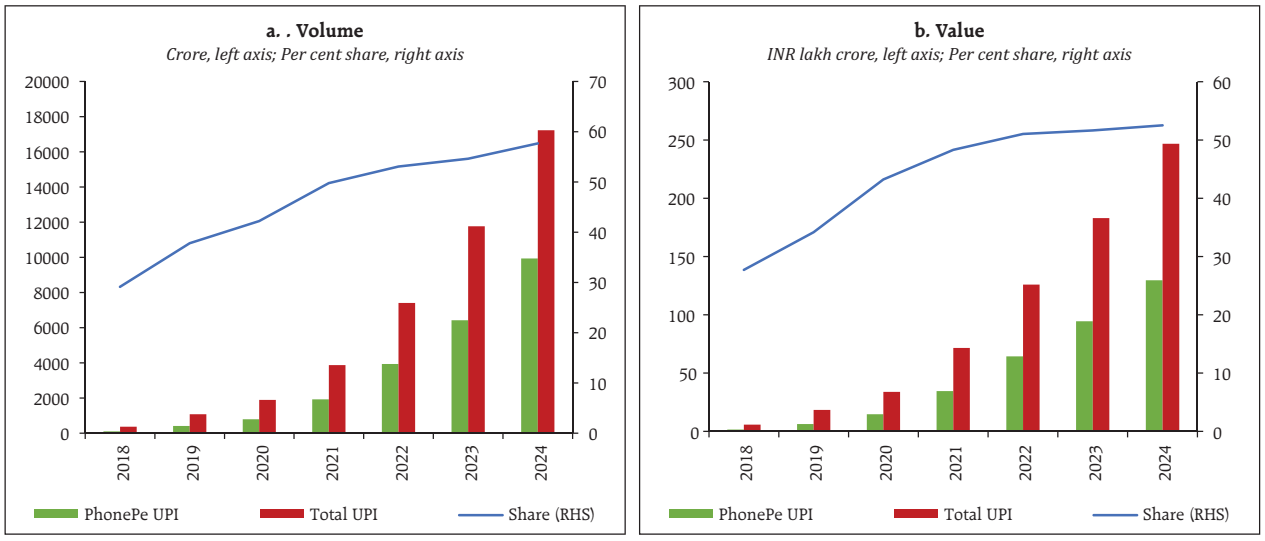


Source: NPCI.



Note: Inner and outer circles pertain to P2M and P2P transactions, respectively.
Source: NPCI.

Chart 5: Share of *PhonePe* in UPI over time



Sources: *PhonePe* Pulse, NPCI, Authors' calculations.

(Charts 5 a and b). This open-source dataset has been widely used in studies examining UPI diffusion across states and districts (Dubey and Purnanandam, 2023; Reddy *et al.*, 2024).

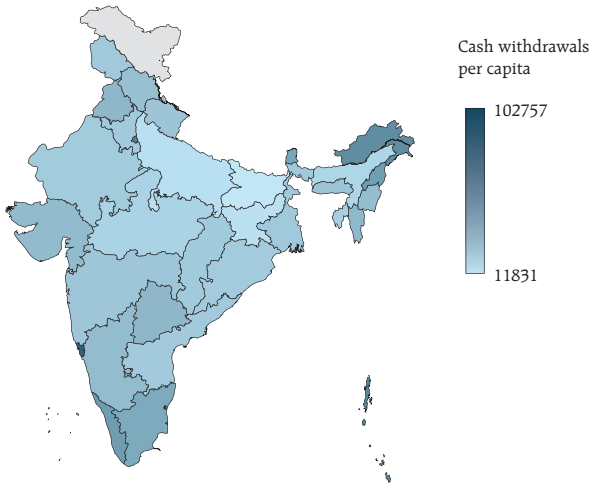
Two factors support the generalisability of this dataset as a proxy for overall UPI activity: First, *PhonePe*'s growth trajectory has closely mirrored overall UPI trends in recent years, with correlations between their growths being 0.99 for both volume and value. Second, *PhonePe*-based state-wise rankings exhibit a strong correlation with total state-wise UPI rankings in 2024, for which data was available ($r = 0.97$). To ensure comparability, both cash and UPI indicators are normalised by state population, yielding measures of cash and UPI intensities.

Cash intensity varies widely across states and Union Territories (UTs), with Goa, Delhi, Chandigarh, Arunachal Pradesh, Nagaland, Kerala, and Sikkim recording the highest per capita cash withdrawals (Chart 6), reflecting factors such as tourism and service-led cash usage, remittance inflows, rural areas' cash dependence, limited digital infrastructure, older demography, and security constraints. Recent trends indicate a broad-based and sustained decline in cash usage across most states over the past few years, suggesting a structural rather than transitory shift.

On the digital front, UPI intensity, proxied by *PhonePe* transactions, remains high in Telangana, Karnataka, Andhra Pradesh, Delhi and Maharashtra in per capita volume terms, aligning closely with the presence of urban centres, economic hubs and

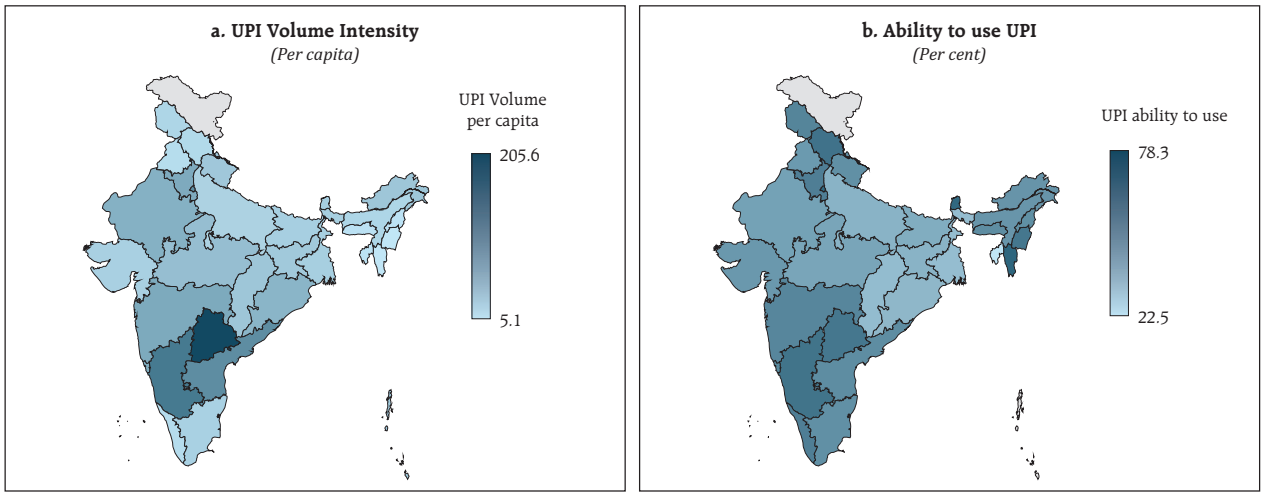
Chart 6: Cash Withdrawal Intensity in FY 2024-25

(Per capita)



Note: Cash intensity = Cash withdrawals$_i$ / population$_i$; where i = state.
Source: RBI.

Chart 7: State-wise Variation in UPI Adoption in FY 2024-25



Notes: (a) Chart a - UPI Volume intensity = UPI volume$_i$ / population$_i$; where i = state;
(b) Chart b - Ability of persons to perform online banking transactions using UPI as a share of total state population.
Sources: PhonePe Pulse; CAMS Survey, NSS 80th Round, NSO (2025).

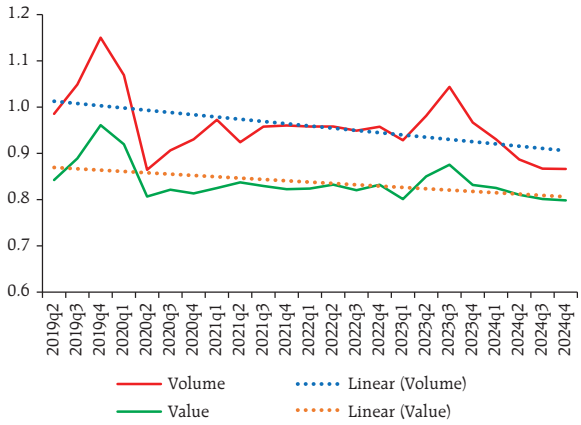
regions with high employment-driven migration (Chart 7a). In contrast, UPI uptake remains modest in several cash-dependent regions such as the North-Eastern states (Tripura, Manipur, Meghalaya, Nagaland). Data from a nationwide survey suggest relatively lower inter-state variation in the *ability* to use UPI for online banking transactions, with a modest skew towards the southern and northern states (NSO, 2025).[3] Notably, Chandigarh, Himachal Pradesh, Kerala, Manipur, and Mizoram exhibit high reported ability to use UPI (Chart 7b).

In terms of growth, most states have witnessed a surge in UPI adoption post pandemic (FY: 2022). Although the overall trajectory of UPI payments remains positive across states, the pace of growth has moderated due to high base effect from the pandemic year and a transition towards a more stable, self-propelling adoption curve.

UPI usage, however, continues to be concentrated, with the top 10 states accounting for nearly 80 per cent of total transaction volumes - a pattern that has remained relatively stable over time. Nevertheless, the trend decline in dispersion of UPI adoption across states is evident from the strengthening of sigma (σ) convergence since 2020, *albeit* at a gradual pace (Chart 8). This slower convergence may reflect

Chart 8: Sigma Convergence in UPI Payments Across States

(σ (log of UPI per capita))



Note: *Sigma (σ) convergence* refers to a reduction in the dispersion (standard deviation) of a variable such as UPI volume or value per capita across units (e.g., states) over time.
Source: Authors' calculations.

[3] These estimates are based on unit level data from National Statistical Survey's Comprehensive Modular Survey – Telcom, 80th Round released on May 29, 2025. The survey questionnaire includes a specific question posed to individual respondents: *"Whether able to perform online banking transactions via devices like computers, or mobile?"* The response options are: *(i) yes, through UPI only; (ii) yes, through net banking or other means (except UPI) only; (iii) yes, both UPI and other means; and (iv) no.*

heterogeneity in digital infrastructure, extent of formalisation, financial inclusion and literacy, and merchant acceptance across states.

IV. Data and Methodology

At the national level, an auto-regressive distributed lag (ARDL) model is estimated using quarterly data from Q2:2009 to Q4:2024 to assess UPI's impact on cash demand in nominal and real terms.[4] Key determinants include GDP, deposit rates (proxied by major banks' one year lower bounds), the share of high-denomination notes in circulation[5] (store-of-value proxy), and UPI transaction volumes (substitutive effect)[6], thereby accounting for transaction, precautionary, and speculative motives. Controlling for the high denomination notes' share also helps isolate UPI's impact on CIC, as high-value transactions may distort trends driven by predominantly small-value UPI payments. The sample period chosen reflects the structural shift following the Payment and Settlement Systems Act (2007) and minimises the global financial crisis's impact. Except for interest rates, all variables are seasonally adjusted and log-transformed. Stationarity checks using the Augmented Dickey-Fuller (ADF) test confirm that all series are I(0) or I(1), validating the ARDL framework. Key shocks, including withdrawal of specified bank notes in 2016 and COVID-19 lockdowns are captured through quarterly dummies.[7]

Building on the macro-level insights, cash determinants at the state level are analysed using fixed-effects[8] panel quantile regression for 31 Indian states and UTs over the period Q2:2019 to Q1:2025, at the 25th, 50th, and 75th percentiles of the cash distribution. The model accounts for unobserved state-specific heterogeneity and time effects. The sample period, beginning in 2019, captures the phase during which UPI gained traction. To examine heterogeneity across income groups, separate panel regressions are estimated for low, middle, and high-income states, stratified on the 25th, 50th, and 75th percentiles of net state domestic product (current prices).

As mentioned above, cash demand is measured by quarterly currency chest withdrawals and UPI adoption by *PhonePe* transaction data. In the absence of quarterly subnational GDP, economic activity is proxied using VIIRS VNP46A2 nighttime lights, which provides daily measurements of artificial (human-generated) illumination at \~500-meter spatial resolution. Quarterly state-level aggregates are computed as the sum of the "Gap Filled DNB BRDF Corrected Nighttime Lights" band, using zonal statistics over state boundaries, thereby eliminating any high-frequency volatility. This data has been widely used to estimate output and growth, especially in data-scarce granular geographical levels, and to better capture informal sector activity (Lahiri, 2020; Beyer *et al.,* 2022; Mathen *et al.,* 2024). Other control variables include ATM density (financial infrastructure), employee provident fund organisation (EPFO) net payroll additions (formalisation), Periodic Labour Force Survey (PLFS)'s educational attainment below higher-secondary level (literacy), and Telecom Regulatory Authority of India's internet subscriptions (digital infrastructure). All variables, except internet subscribers and education attainment levels, are

[4] The following long-run equation is estimated: $\ln(CiC_t) = \psi_0 + \psi_1 \ln(GDP_t) + \psi_2 INT_t + \psi_3 HDN_t + \psi_4 \ln(1 + UPI_t) + \mu_t$; where ψ_k are long-run coefficients.

[5] High denomination notes include ₹500, ₹1000 (before their withdrawal) and ₹2000 notes.

[6] Since UPI data is unavailable for the period before 2016, log (1 + actual UPI transactions) is used as the variable to ensure continuity. This variable remains constant for pre-2016 quarters, thereby not affecting the estimation.

[7] A dummy for the ₹2000 note withdrawal in May 2023 was initially included but found insignificant and thus, excluded from the final model. The effect may have been subsumed by the share of high-denomination notes variable, which likely accounts for its explanatory power in the main regression.

[8] Hausman Test validates the use of fixed effects model over random effects.

normalised by state population and log-transformed. Year fixed effects control for broad macroeconomic trends, while intra-year shocks like festivals, state elections, and COVID-19 are captured through quarterly dummies. While these regression estimates do not necessarily imply causality, they provide insights on the magnitude of these factors. Cross-state summary statistics and correlation heatmap are provided in Annex I.

V. Impact of UPI on Cash Demand: Empirical Evidence

V.1. National Level Insights

The UPI volumes are negatively associated with cash demand across models both in nominal and real terms, underscoring its role as a substitute for cash (Table 2). Income (GDP) emerges as the primary determinant of cash demand with elasticities ranging from 0.79 to 0.86, indicating a positive association between economic activity and cash usage. Deposit interest rates exhibit a negative and statistically significant effect, reflecting the opportunity cost of holding cash. Conversely, the higher denomination banknotes share shows a small but positive effect, consistent with its store-of-value role (Model 2). The post-estimation diagnostics confirm the absence of serial autocorrelation and heteroscedasticity at 5 per cent level. The error correction coefficient, which captures the speed at which short-run deviations adjust to the long-run equilibrium, shows that 24-30 per cent of deviations are corrected within a single quarter. Moreover, the Bounds test F-statistic exceeds the upper bound of the critical values, confirming the existence of a long-run relationship between these variables.

Owing to the specified bank note withdrawal, the dummy coefficient for Q4:2016 and Q1:2017 is negative and statistically significant (Annex II).

Table 2: Impact of Unified Payments Interface on Currency in Circulation

Dependent Variable: Log of Currency in Circulation

	Nominal		Real	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
Model Type	*ARDL (3,2,0)*	*ARDL (3,2,0,0,0)*	*ARDL (3,2,0)*	*ARDL (3,3,0,0,0)*
Income	0.86*** (0.03)	0.83*** (0.04)	0.84*** (0.06)	0.79*** (0.10)
Interest Rate	-0.05*** (0.01)	-0.05*** (0.01)	-0.04*** (0.01)	-0.03** (0.01)
UPI Volume		-0.016*** (0.01)		-0.013*** (0.01)
HDN Share		0.005*** (0.01)		0.005** (0.01)
Intercept	1.80*** (0.60)	1.96*** (0.60)	1.95* (1.03)	2.36 (1.50)
Cointegration Tests				
Bounds Test: F statistic #	89.6	134.7	283.37	318.3
Error Correction Coefficient	-0.26*** (0.01)	-0.24*** (0.01)	-0.30*** (0.01)	-0.28*** (0.01)
Model Tests				
Adjusted R squared	0.99	0.99	0.99	0.99
SIC and AIC	-4.73 and -5.13	-4.74 and -5.21	-4.52 and -4.91	-4.48 and -4.98
Post-estimation Tests				
LM Test of Autocorrelation: Probability	0.63	0.08	0.49	0.05
BPG Heteroscedasticity Test: Probability	0.91	0.85	0.73	0.79
CUSUM and CUSUM squared stability test	Stable	Stable	Stable	Stable

Notes: (a) The standard errors are in parentheses. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
(b) CIC, income and UPI are natural logarithm transformed. Real CIC refers to CIC deflated by the Consumer Price Index (CPI) to adjust for price levels and reflect the purchasing power of money.
(c) Model 1 is the baseline model without UPI and HDN share. Model 2 incorporate UPI volume and HDN share.
(d) All the models have relevant dummy variables for withdrawal of specified bank notes, COVID-19 first wave and second wave.
(e) As robustness check, the share of UPI in total digital transactions was also considered, which takes the value of zero for the pre-2016 period. The results confirm the negative association between UPI share and cash demand. Further, the inclusion of the COVID-19 Stringency Index revealed a positive and statistically significant impact.
(f) # Critical values for F statistic at 5 per cent level are around 3.0 and 6.0 for I(0) and I(1) assumptions, respectively.
(g) In post-estimation checks, null hypothesis is no serial correlation for LM test, and homoscedasticity for BPG test.

Source: Authors' calculations.

Further, dummy variables for both the first and second waves of the pandemic are positive and statistically significant, suggesting that the increase in currency demand during the lockdown was driven by precautionary and store-of-value motives, consistent with previous findings (Caswell *et al.,* 2020; Chen *et al.,* 2020; Awasthy *et al.,* 2022; RBI, 2023).

V.2. State Level Insights

V.2.1. By Cash Quantiles

Consistent with the aggregate regression, economic activity as proxied by nighttime lights exhibits a strong and statistically significant association with cash usage across all states (Table 3, Model 1). While its influence remains consistently positive across the conditional distribution of cash demand, it marginally attenuates from lower to upper quantiles of cash usage (Models 2 – 4).

UPI volumes per capita display a negative and non-linear association, given the negative linear term coupled with a positive squared term. This indicates that increases in UPI usage substitute for cash, however, beyond an estimated threshold (log UPI per capita = 2.18) and as digital adoption matures, the substitution effect moderates, possibly reflecting saturation or behavioural inertia. Plotting the UPI coefficient across different cash quantiles indicates a stronger substitution effect in upper quantiles, implying that in cash-intensive states, digital adoption exerts a stronger dampening impact on cash usage (Chart 9). This pattern may reflect a combination of higher initial cash dependence, policy and market efforts, and steeper early-stage learning curves in digital adoption. Similar non-linear dynamics are observed for UPI value per capita (Table 1:Annex III).

Internet subscriber base, as a proxy for digital infrastructure, exerts only a weak influence, with borderline significance at the median quantile. The degree of formalisation displays a concave

Table 3: State-wise Impact of UPI Volume on Cash Demand – By Cash Quantiles

Dependent Variable: Log of Currency Chest Withdrawals per Capita

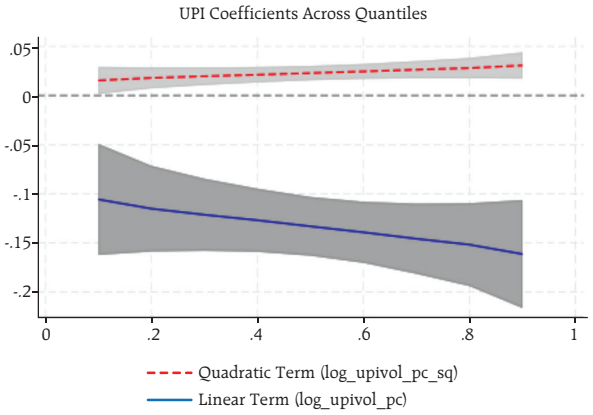
	(1)	(2)	(3)	(4)
Variables	**Full sample**	**25th Quantile (Low cash)**	**50th Quantile (Mid cash)**	**75th Quantile (High cash)**
Economic activity#	0.25*** (0.05)	0.29*** (0.06)	0.26*** (0.05)	0.21*** (0.06)
UPI Volume#	-0.13** (0.05)	-0.12*** (0.03)	-0.13*** (0.03)	-0.15*** (0.04)
UPI Volume squared#	0.03*** (0.01)	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.01)
ATM density#	0.77** (0.29)	0.52*** (0.19)	0.76*** (0.15)	1.04*** (0.21)
Degree of formalisation#	-0.11*** (0.03)	-0.12*** (0.03)	-0.11*** (0.03)	-0.10*** (0.04)
Degree of formalisation squared#	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Education attainment level	-0.01 (0.00)	-0.00 (0.00)	-0.01** (0.00)	-0.01** (0.00)
Internet Subscriber Base@	0.05 (0.04)	0.05 (0.04)	0.05 (0.03)	0.06 (0.05)
Covid Dummy	0.04*** (0.01)	0.05* (0.03)	0.04** (0.02)	0.04 (0.03)
State Election Dummy	0.05*** (0.01)	0.05** (0.02)	0.05*** (0.02)	0.04* (0.02)
Festival Dummy	0.05**	0.05***	0.05***	0.05**
Constant	17.27*** (2.40)			
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	688	688	688	688
R-squared	0.43			
F statistic	66.07			
Prob > F	0.00			
Number of States	31			

Notes: a) The standard errors in parentheses are clustered by state. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
b) # Variables are in per capita terms and log transformed.
c) @ Variable is in quarter-on-quarter growth terms.
d) Due to data unavailability for Ladakh, Lakshadweep, Dadra and Nagar Haveli, Sikkim and Puducherry, the sample size of the number of states and UTs is reduced to 31.
e) These results control for year fixed effects.
f) State-wise degree of formalisation is computed as the log of net payroll additions under EPFO adjusted for population.
g) While state-wise CPI was included as control, it was found to be statistically insignificant, possibly due to its effect being absorbed by economic activity and overall limited cross-state variation. Additionally, rural and urban population proxies were considered; however, as these are based on Census 2011 data, they were excluded from the fixed-effects panel regression.

Source: Authors' calculations.

Chart 9: UPI Volume Impact on Cash Demand by Quantiles

(Coefficient Estimate, Quantile of Cash Demand Distribution)



Note: The chart plots the coefficients of log(UPI volume per capita) [linear impact] and log (UPI volume per capita squared) [quadratic impact] in various quantile regressions.
Source: Authors' calculations.

relationship with cash demand. Initial formalisation is associated with lower cash reliance, possibly due to improved access to banking and digital wage payments, which wears off later (post log of degree of formalisation = 5.8). This pattern suggests that informal sector remains more cash-intensive, with lower willingness to adopt digital payments (Ligon *et al.*, 2019), possibly owing to limited integration with formal financial networks (Lahiri, 2020). Further, states with higher proportions of population with at least higher secondary education show lower cash demand at median and upper quantiles, reflecting the positive relationship between education and digital alternatives. Structural shocks, along with policy and seasonal dummies such as COVID-19, state elections, festivals and the marriage season are all positively and significantly associated with spikes in cash demand across the distribution, reaffirming its episodic and precautionary nature in line with Raj *et al.*, (2020).

V.2.2. By Income Groups

Although UPI adoption exhibits a non-linear relationship across income groups, mid-income states display the strongest substitution elasticity, indicating that they are at a critical inflection point in the ongoing digital transition (Table 4). Economic activity is positively associated with cash demand

Table 4: State-wise Impact of UPI Volume on Cash Demand – By Income Groups

Dependent Variable: Log of Currency Chest Withdrawals per Capita

	(1)	(2)	(3)
Variables	**Low Income States**	**Mid Income States**	**High Income States**
Economic activity#	0.26***	0.22**	0.41***
	(0.07)	(0.09)	(0.10)
UPI Volume#	-0.15*	-0.22***	-0.08*
	(0.08)	(0.06)	(0.05)
UPI Volume squared#	0.05**	0.04***	0.01*
	(0.02)	(0.01)	(0.01)
ATM density#	1.22**	0.45	0.58
	(0.54)	(0.31)	(0.43)
Degree of formalisation#	-0.06	-0.09***	-0.16
	(0.08)	(0.02)	(0.13)
Degree of formalisation squared#	0.01	0.01***	0.01
	(0.01)	(0.00)	(0.01)
Education attainment level	-0.01*	0.01	-0.01**
	(0.01)	(0.01)	(0.00)
Internet Subscriber Base@	0.07	0.01	0.05
	(0.06)	(0.02)	(0.21)
Covid dummy	0.04*	0.03	0.02
	(0.02)	(0.03)	(0.02)
State Election Dummy	0.03	0.06**	0.01
	(0.03)	(0.03)	(0.02)
Festival Dummy	0.03	0.08	0.08**
	(0.02)	(0.05)	(0.03)
Constant	21.50***	13.47***	16.52***
	(4.88)	(2.10)	(3.46)
Year Fixed Effects	Yes	Yes	Yes
Observations	244	235	209
R-squared	0.50	0.54	0.50
Number of States	14	15	11

Notes: (a) Low, mid and high-income states pertain to the 25th, 50th and 75th percentile, respectively, of the net state domestic product (current prices).
(b) The standard errors in parentheses are clustered by state. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
(c) # Variables are in per capita terms and log transformed.
(d) @ Variable is in quarter-on-quarter growth terms.
(e) Due to data unavailability for Ladakh, Lakshadweep, Dadra and Nagar Haveli, Sikkim and Puducherry, the sample size of states and UTs is reduced to 31.
(f) These results control for year fixed effects.
Source: Authors' calculations.

in all income groups, but its magnitude is higher in high-income states. ATM density is associated with higher cash usage only in low-income states than in more affluent ones, underscoring their continued dependence on traditional access points. Formalisation of the workforce is negatively associated with cash usage, though only in mid-income states and that too up to a threshold. Additionally, higher education levels are linked with lower cash demand in low and high income states. Similar results prevail for UPI values per capita (Annex III, Table 2).

VI. Conclusion

The study examines the impact of UPI on cash demand in India. Using a dual empirical strategy of autoregressive distributed lag model and panel quantile regression, the article finds that higher UPI adoption is associated with lower cash demand at both national and subnational levels. At the aggregate level, descriptive trends indicate a structural shift in India's payment landscape, evident from currency growth moderating from pandemic levels and sustained UPI expansion with narrowing ticket sizes. Empirically, income, proxied by GDP, is positively associated with cash demand, while UPI and interest rates exhibit a negative effect.

At the state-level, preferences between cash and UPI, as proxied by *PhonePe* transactions, display regional variation. Early UPI adopting states continue to retain a dominant share of total UPI payments, however, a broad-based decline in cash demand across states and narrowing inter-state disparities in UPI adoption since the pandemic point to early signs of convergence. Empirical analysis reveals a negative and non-linear association between UPI adoption and cash demand across cash quantiles. While UPI largely substitutes cash, the effect moderates as digital adoption matures, possibly due to saturation or behavioural inertia. Income, proxied by nighttime lights, and ATM density are positively associated with cash demand, whereas workforce formalisation and higher educational attainment are linked to lower cash reliance. Income-group-wise segregation shows that mid-income states exhibit the strongest substitution elasticity, while lower-income states may unlock untapped substitution potential through improved literacy and greater workforce formalisation.

These findings suggest that a one-size-fits-all approach may not be sufficient for adoption and sustained usage of UPI. Region-specific targeted interventions aligned with each state's demographic, infrastructural, and behavioural context are likely to be effective. Expanding digital infrastructure and financial literacy interventions, incentivising digital wage transfers, and building trust in digital modes may accelerate cash-to-UPI transition across the spectrum.

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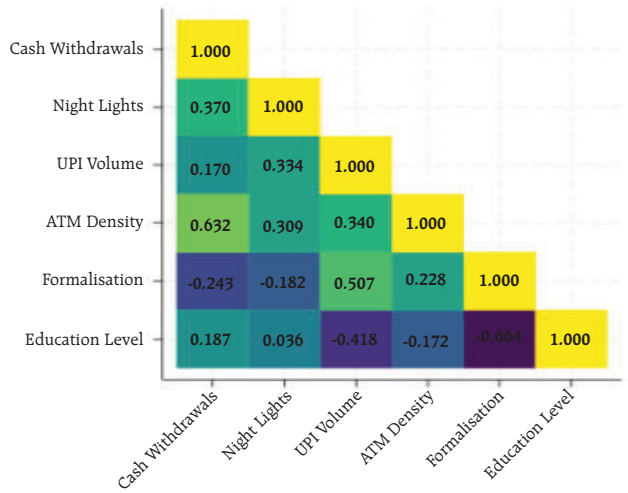
Annex I

Table 1: State-wise Summary Statistics of Select Variables

Variable	Type	Mean	Std. dev.	Min	Max	Observations
Cash Withdrawals	overall	9.06	0.66	5.34	10.56	792
	between		0.54	7.85	10.19	33
	within		0.38	6.56	10.31	24
Night Lights (Economic activity)	overall	-4.38	0.49	-5.68	-2.40	792
	between		0.44	-5.25	-2.98	33
	within		0.23	-5.13	-3.80	24
UPI	overall	1.04	1.48	-3.30	4.45	792
	between		0.92	-0.75	3.00	33
	within		1.17	-2.39	3.48	24
ATM	overall	-8.49	0.52	-9.64	-7.30	792
	between		0.52	-9.55	-7.33	33
	within		0.06	-8.72	-8.30	24
Formalisation	overall	9.85	2.52	1.39	13.78	718
	between		2.48	4.53	13.35	31
	within		0.62	3.66	12.41	24
Education Levels	overall	66.88	8.37	49.70	87.10	792
	between		8.24	53.70	85.34	33
	within		2.05	57.47	73.26	24
Internet Subscriber Base Growth	overall	0.02	0.12	-0.68	2.14	759
	between		0.01	-0.01	0.07	33
	within		0.12	-0.73	2.09	23

Note: All variables, except education and internet subscribers, are in per capita terms and log transformed.
Source: Authors' calculations.

Chart 1: Correlation Heat Map of Select Variables



Note: All these variables, except education, are normalised by population and log transformed.
Source: Authors' calculations.

Annex II

Table 1: Short-run Drivers of Currency Demand in India

Dependent Variable: LCIC (Log of Currency in Circulation)

	Nominal		Real	
	(1)	**(2)**	**(1)**	**(2)**
Model Type	*ARDL (3,2,0)*	*ARDL (3,2,0,0,0)*	*ARDL (3,2,0)*	*ARDL (3,2,0,0,0)*
	(a)	(b)	(a)	(b)
D(LCiC) (-1)	-0.23*** (0.02)	-0.26*** (0.02)	-0.20*** (0.03)	-0.25*** (0.02)
D(LCiC) (-2)	-0.15*** (0.02)	-0.14*** (0.02)	-0.13*** (0.03)	-0.12*** (0.03)
D(Income)	0.08* (0.04)	0.07* (0.04)	0.14*** (0.04)	0.18*** (0.03)
D(Income) (-1)	0.11*** (0.03)	0.12*** (0.03)	0.21*** (0.04)	0.26*** (0.04)
Dummy: SBN withdrawal	-0.31*** (0.01)	-0.33*** (0.01)		0.09*** (0.03)
Dummy: COVID first wave	0.10*** (0.01)	0.10*** (0.01)	-0.30*** (0.01)	-0.32*** (0.01)
Dummy: COVID second wave	0.03*** (0.01)	0.03*** (0.01)	0.12*** (0.01)	0.13*** (0.01)

Notes: (a) The standard errors are in parentheses. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
(b) CIC, income and UPI are natural logarithm transformed.
(c) Model 1 is the baseline model without UPI and HDN share. Model 2 incorporates UPI volume and HDN share.

Source: Authors' calculations.

Annex III

Table 1: State-wise Impact of UPI Value on Cash Demand – By Cash Quantiles

Dependent Variable: Log of Currency Chest Withdrawals per Capita

	(1)	(2)	(3)	(4)
Variables	**Full sample**	**25th Quantile (Low cash)**	**50th Quantile (Mid cash)**	**75th Quantile (High cash)**
Economic activity #	0.27*** (0.05)	0.31*** (0.06)	0.28*** (0.05)	0.23*** (0.07)
UPI Value #	-0.65*** (0.21)	-0.62*** (0.11)	-0.65*** (0.09)	-0.69*** (0.13)
UPI Value squared #	0.04*** (0.01)	0.03*** (0.01)	0.04*** (0.00)	0.04*** (0.01)
ATM density #	0.68** (0.29)	0.45** (0.19)	0.66*** (0.15)	0.93*** (0.22)
Degree of formalisation #	-0.12*** (0.03)	-0.13*** (0.04)	-0.12*** (0.03)	-0.12*** (0.04)
Degree of formalisation squared #	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Education attainment level	-0.01 (0.01)	-0.01 (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Internet Subscriber Growth @	0.06 (0.04)	0.04 (0.05)	0.06 (0.04)	0.07 (0.05)
Covid dummy	0.06*** (0.01)	0.06** (0.03)	0.06** (0.02)	0.05 (0.03)
State Election Dummy	0.04*** (0.01)	0.04** (0.02)	0.04** (0.02)	0.04 (0.02)
Festival Dummy	0.04* (0.02)	0.04** (0.02)	0.04*** (0.02)	0.03 (0.02)
Constant	19.59*** (3.12)			
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	688	688	688	688
R-squared	0.39			
F statistic	74.11			
Prob > F	0.00			
Number of States	31			

Notes: a) The standard errors in parentheses are clustered by state. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.

b) # Variables are in per capita terms and log transformed.

c) @ Variable is in quarter-on-quarter growth terms.

d) Due to data unavailability for Ladakh, Lakshadweep, Dadra and Nagar Haveli, Sikkim and Puducherry, the sample size of the number of states and UTs is reduced to 31.

e) These results control for year fixed effects.

Source: Authors' calculations.

Table 2: State-wise Impact of UPI Value on Cash Demand – By Income Groups

Dependent Variable: Log of Currency Chest Withdrawals per Capita

	(1)	(2)	(3)
Variables	**Low Income States**	**Mid Income States**	**High Income States**
Economic activity #	0.33*** (0.07)	0.21** (0.09)	0.41*** (0.10)
UPI Value #	-1.13** (0.52)	-0.90*** (0.08)	-0.35* (0.17)
UPI Value squared #	0.07** (0.03)	0.05*** (0.01)	0.02 (0.01)
ATM density #	1.13* (0.62)	0.33 (0.32)	0.55 (0.45)
Degree of formalisation #	-0.08 (0.08)	-0.10*** (0.02)	-0.17 (0.13)
Degree of formalisation squared #	0.01 (0.01)	0.01*** (0.00)	0.01* (0.01)
Education attainment level	-0.01* (0.01)	0.00 (0.02)	-0.01** (0.00)
Internet Subscriber Growth @	0.07 (0.06)	0.01 (0.02)	0.05 (0.21)
Covid dummy	0.07*** (0.02)	0.05 (0.03)	0.03 (0.02)
State Election Dummy	0.03 (0.03)	0.06** (0.02)	0.01 (0.02)
Festival Dummy	0.00 (0.02)	0.07 (0.06)	0.07** (0.03)
Constant	25.70*** (7.66)	16.84*** (2.34)	18.04*** (4.04)
Year Fixed Effects	Yes	Yes	Yes
Observations	244	235	209
R-squared	0.44	0.50	0.48
Number of States	14	15	11

Notes: (a) Low, mid and high-income states pertain to the 25th, 50th and 75th percentile, respectively, of the NSDP (current prices).
(b) The standard errors in parentheses are clustered by state. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
(c) # Variables are in per capita terms and log transformed.
(d) @ Variable is in quarter-on-quarter growth terms
(e) Due to data unavailability for Ladakh, Lakshadweep, Dadra and Nagar Haveli, Sikkim and Puducherry, the sample size of the number of states and UTs is reduced to 31.
(f) These results control for year fixed effects.

Source: Authors' calculations.