Cash is King:
The Role of Financial Infrastructure in Digital Adoption

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Motivation

"Digitization of payments, transfers, and remittances contributes to the G20 goals of broad-based economic growth, financial inclusion, and women's economic empowerment"

— World Bank, the Better Than Cash Alliance, and the Bill & Melinda Gates Foundation Report, Aug. 28, 2014.

▶ Financial service innovations can increase financial inclusion, but traditional methods have had limited impact (Karlan et al., 2016).

▶ Digital payments show promise.
  ▶ Mobile payments (Suri and Jack, 2016) and debit cards (Higgins, 2019).
  ▶ Reduce risk of cash theft and cut travel costs (Rogoff, 2015).

▶ Our paper: Can digital adoption (by households) shift the informal economy into the organized/formal sector?

▶ Lessons from formalization on the firm-side.
  ▶ Decreasing costs of formal sector has had limited impact, but increasing costs of informality has been effective (De Andrade et al., 2014).

Can we force households in the informal sector to adopt digital transactions by making cash transactions costly?

This paper . . .

Exploits unanticipated <u>demonetization</u> episode in India of 86 percent of currency in circulation on November 8th 2016.

- ▶ Can a *temporary* cash supply shock force households to *permanently* switch to digital payments?

- ▶ What are the effects on households transacting in the informal sector?

  - ▶ Focus on areas with high-informality: cash-dependent areas.

  - ▶ Potential channels: financial infrastructure, tax evasion.

- ▶ Are there spillover effects in participation in financial instruments?

- ▶ What are the real effects on household consumption and aggregate economic activity?

Preview of Findings

- ▶ Demonetization made cash *temporarily* costly.

- ▶ Exploit unique regulatory data at granular pincode ($\approx$ zipcode) level to examine impact of cash shortage on digitization.

  - ▶ <u>Identification</u>: Use variation in distance to the nearest currency chests (intensity of treatment) to compare pincodes *within*-districts in a difference-in-difference specification.

- ▶ Cash shortage induces households to switch to digital transactions: Effects are large: 35% ↑ and persistent.

- ▶ Cash shortage disproportionately affected rural/cash dependent areas, but have a muted effect on digital adoption in these areas.

- ▶ Channel: lack of financial infrastructure.

- ▶ No spillovers on financial asset holdings, 32% ↓ in economic activity for worst hit districts.

Cash shortage can force households to switch to digital transactions *only* if accompanied (preceded) by investment in financial infrastructure.

Policy Background
The Demonetization Episode

- On November 8th 2016, Narendra Modi, the Prime Minister of India demonetized the two largest denomination of notes.

- 86 percent of the currency ceased to be a legal tender.

- Old notes were to be deposited in banks by December 30th, 2016 but significant limits were placed on withdrawal.

- The entire demonetization phase lasted up until March 13th 2017, after which all limits on withdrawal were withdrawn.

Demonetization made cash temporarily costly

Currency in circulation
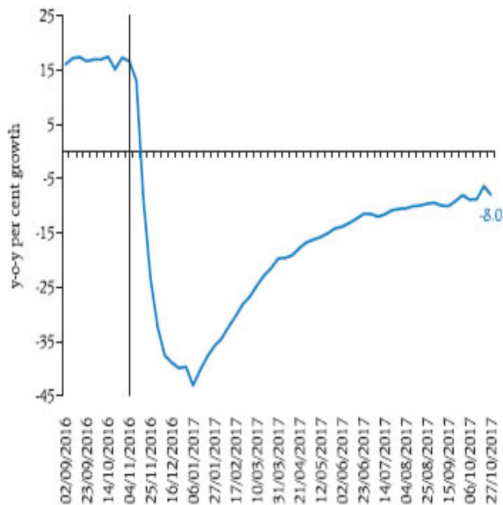
Source: RBI

Related Work

- ▶ Informality and development
  - ▶ Limited impact on firms of increasing the ease of formalization (De Mel et al., 2013; Jaramillo, 2009) but increasing the costs of informality has shown promise (De Andrade et al., 2014).

- ▶ Digital payment adoption (Higgins, 2020; Karlan et al., 2018).

- ▶ Role of financial infrastructure (Burgess and Pande, 2005).

- ▶ Impact of demonetization
  - ▶ Digital adoption: supermarket chain data in Agarwal et al. (2020); e-wallet data in Crouzet et al. (2020).
  - ▶ On the importance of cash (Chodorow-Reich et al., 2018); on firms (Subramaniam, 2019); on deposits (Chanda and Cook, 2020); on political outcomes (Khanna and Mukherjee, 2020).

This paper: Ideal pan-India POS data with high rural presence to explore digitization in areas with high informality.
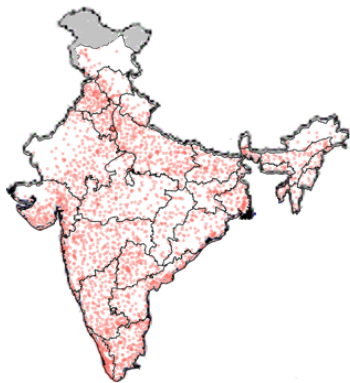
Data I: Cash and Digital transactions

- ▶ Monthly pincode ($\approx$ zipcode) data between January 2016 to April 2018: 11 months of pre-treatment and 17 months of post-treatment.

- ▶ Currency chest network.
  - ▶ Hub-and-spoke model: The currency chests serve as repositories of currency and are maintained by the commercial banks.
  - ▶ Currency is then distributed to 135,000 individual bank branches, which then supply cash to the 200,000 ATMs.
  - ▶ Geo-coded location of 4034 currency chests from the regulator Reserve Bank of India (RBI).

- ▶ Cash supply measures.
  - ▶ To measure cash available at pincode level, use ATM provided by the regulator National Payments Corporation of India (NPCI).

- ▶ Digital transactions data (main dependent variable) from the regulator NPCI.
  - ▶ Point of Sale (POS) transactions and volume from RuPay: Better pan-India coverage and ideal to study digitization penetration.

Data II: Heterogeneity and Consumption Data

▶ Identify rural pincodes as follows:
  ▶ <u>Pincode-level</u>: Use classification of rural and urban branches provided by RBI for all scheduled commercial banks in India.
  ▶ <u>District-level</u>: 2011–2012 National Sample Survey data on household demographic and employment characteristics.

▶ Consumption and financial holdings from Consumer Pyramids (CP) household survey
  ▶ Household-level panel across 170,000 households surveyed every 4 months since 2014.
  ▶ Oversamples urban households (upper bound of effects?)

▶ Night lights data from World Bank.

Good national coverage of pincode-level data
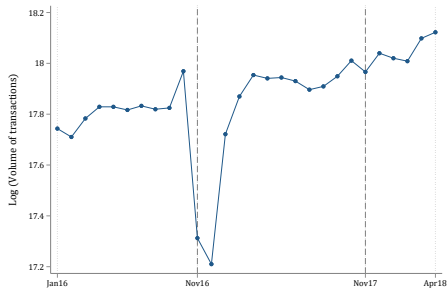
Location of Currency Chests
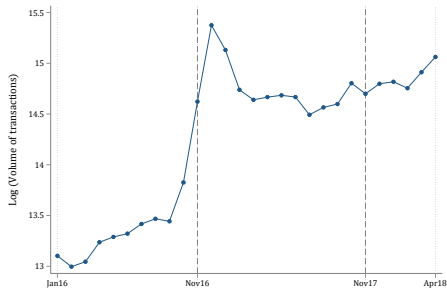
Pincode Data Availability
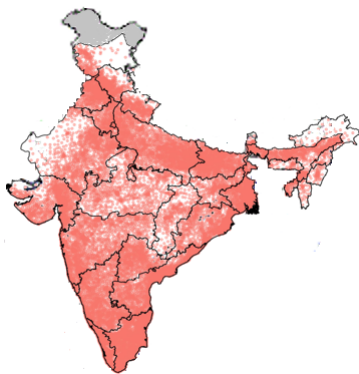
Currency chests spread across the country and pan-India coverage of pincode level data on cash proxy and digital transactions.

Aggregate time trends


Cash Supply Shock

Digital Transactions

Temporary ↓ in cash supply, but a persistent increase in digital transactions.

Empirical Identification

- <u>Challenge</u>: Treatment (demonetization) was nation-wide.

- <u>Exploit variation in distance to currency chest</u> as the variation in treatment intensity.

  - Transportation and logistical costs affected cash availability *during* demonetization.

- <u>Threats to identification</u>: Pincodes located farther away from the currency chests are very different from pincodes closer to the currency chests.

  - Exploit within-district variation with district-time fixed effects.
  - What matters for us is that the areas farther away from currency chests were not exhibiting *differential trends in digital payments* prior to demonetization (parallel trends assumption).
  - Endogeneity issue: Cash unavailability could be correlated with areas where demand for digital transactions is low.

Use a difference-in-differences design that compares pincodes at the same point in time (and in the same district) whose exposure to the demonetization shock differs.

Variation in Distance from Currency Chest
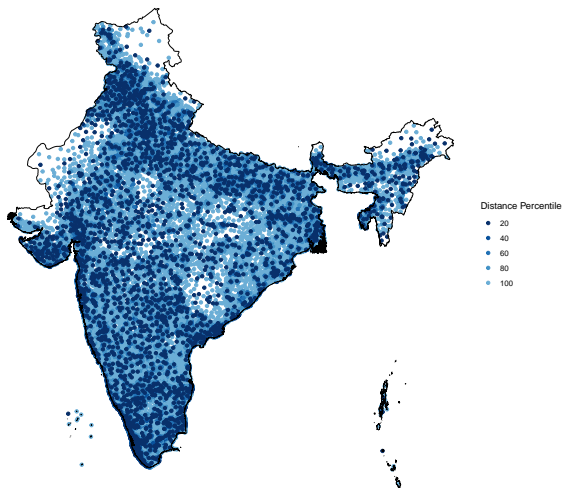
Significant variation in distance to currency chests of pincodes across the country.

Summary statistics

	Low Distance	High Distance
Share of Zipcodes in Tier I/Tier II Cities	0.17	0.05
Share of Zipcodes with At Least 1 Bank Branch	0.85	0.80
Number of POS Terminals	54.02	4.65
Number of ATM Terminals	19.90	4.72
ATM Transaction Counts (Rs. '000)	24.64	5.02
ATM Transaction Volumes (Rs. '000,000)	875.00	190.41
POS Transaction Counts (Rs. '000)	0.02	0.01
POS Transaction Volumes (Rs. '000,000)	9.61	0.73
Average ATM Transaction Value (Rs.)	3739.84	3566.35
Average POS Transaction Value (Rs.)	2026.23	1850.00

More hit pincodes are less likely to be in Tier I/Tier II cities and have lower infrastructure (branches, ATM, and POS terminals). Identification relies on similar trends absent treatment.

Differences across districts

	Low Distance	High Distance
Share of Rural Households	0.63	0.81
Share of Low Caste Households	0.67	0.68
Bank Branches Per Million	91.85	65.84
Avg. Household Age	33.50	32.14
Total Children	0.97	1.07
Average Yrs of Education	6.14	4.91
Head of Household Graduate	0.11	0.07
Head of Household Not in Labour Force	0.24	0.18
Head of Household in Agriculture	0.29	0.42
Head of Household White Collar	0.06	0.05
Head of Household in Business	0.07	0.05
Head of Household in Small Business	0.06	0.05
Head of Household in Industrial Labour	0.28	0.29
Household Invested in Financial Assets	0.21	0.18
Household Invested in Gold	0.07	0.06
Household Invested in Real Estate	0.07	0.06

Districts more hit by demonetization, were more rural, had higher unemployment, and had fewer branches.

Empirical specification
Difference-in-Difference

$$Y_{zdt} = \alpha_z + \delta_{dt} + \beta \times \text{Exposure}_{zd} \times \text{Near Term}_t$$
$$+\gamma \times \text{Exposure}_{zd} \times \text{Long Term}_t + \epsilon_{zdt}$$

▶ For outcome variable Y_{zdt} in pincode z in district d at time t.

▶ α_z and δ_{dt} are pincode and district-time fixed effects.

▶ Exposure_{zd} is a proxy for cash-shortage at the pincode level and is 1 for above median distances to the nearest currency chest.

▶ Post-demonetization dummies include Near Term$_t$ (November 2016 - October 2017) and Long Term$_t$ (November 2017 - April 2018).

▶ β (γ) captures the effect of the outcome variable for pincodes farther away from currency chests relative to pincodes closer to the currency chests in the near-term (long-term) *within* a district.

First Stage: Distance to currency chest and cash shortage
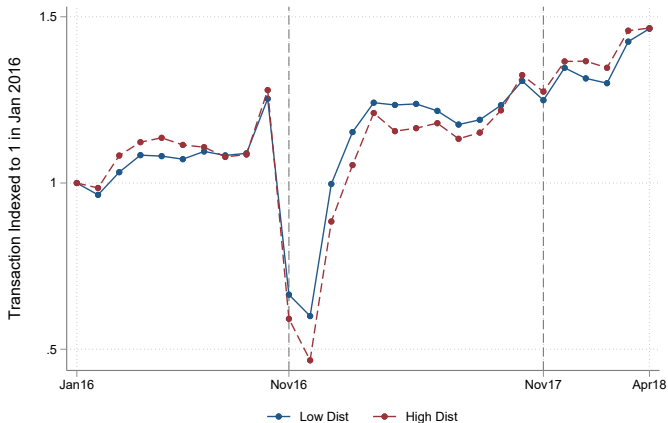
Pincodes farther away from currency chests witnessed a greater fall in cash availability, but effects were temporary and completely reverted by March 2017.

First stage: Distance to currency chest and cash shortage

	Cash Withdrawals	
Dependent Variable:	# ATM transactions	Vol. ATM transactions
	(1)	(2)
Near term $\times$ Exposure	-0.0989***	-0.148***
	(0.0356)	(0.0287)
Long term $\times$ Exposure	0.0345***	-0.0655***
	(0.0115)	(0.0172)
Observations	386835	386835
R sq.	0.939	0.914
Pincode FE	Y	Y
District $\times$ Month-year FE	Y	Y
Month-year FE	Y	Y

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Cash volume fell by 14.8 percent in the near-term in pincodes farther away from currency chests. But, effects reverted in the long-term.

Impact on Digital Transactions
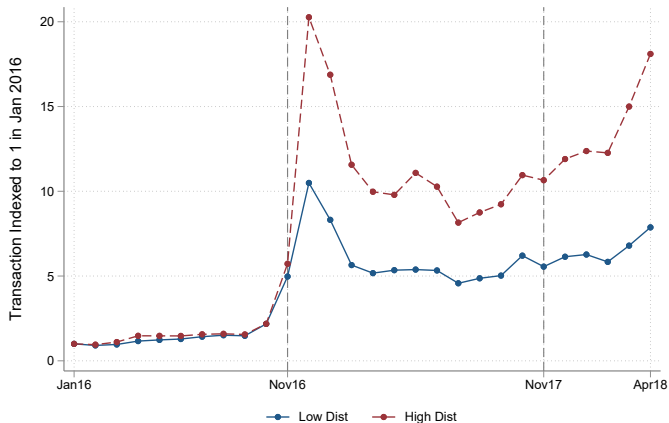
Pincodes farther away from currency chests are more severely hit by the cash supply shock $\implies$ ↑ switch to digital transactions.

Impact on Digital Transactions

Dependent Variable:	Digital Transactions	
	# PoS transactions	Vol. PoS transactions
	(1)	(2)
Near term × Exposure	0.149***	0.348***
	(0.0285)	(0.0346)
Long term × Exposure	0.245***	0.499***
	(0.0276)	(0.0343)
Observations	318162	318162
R sq.	0.912	0.875
Pincode FE	Y	Y
District × Month-year FE	Y	Y
Month-year FE	Y	Y

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

35 percent increase in volume of digital transactions in pincodes with high exposure to the *temporary* cash supply shock and effect persists in the long-term.

Event study plots

$$ln(Y_{zdt}) = \alpha_z + \delta_{dt} + \sum_{k=-11}^{17} \beta_k Exposure_z * Demo_{t+k}$$
$$+ f(ATM)_{zdt} + \epsilon_{zdt} \quad (1)$$

▶ Unit of observation: zip-code z in district d

▶ Y: number (volume) of ATM (POS) transactions

▶ $Exposure_z = 1$ if pincode's distance to nearest currency chest exceeds median pincode to nearest currency chest distance (11 kilometres)

▶ β: average monthly treatment effect for pincodes located at a distance greater than the median pincode to nearest currency chest distance

▶ Identify monthly average treatment effects for 11 periods before and 17 periods after the shock; $Demo = 0$ for November 2016

Event study plots
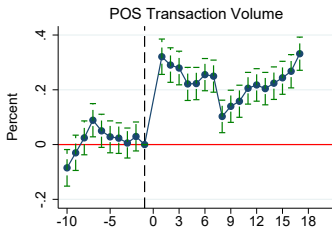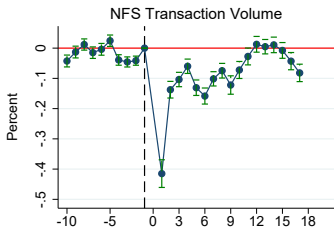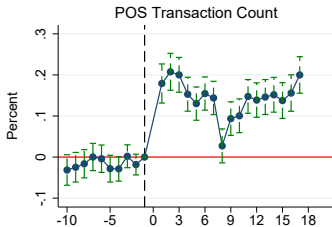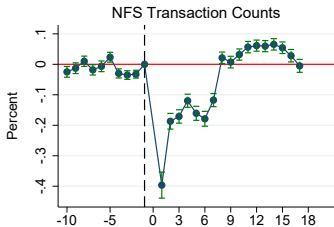
Parallel trends assumption cannot be rejected

Cash-dependency and digital adoption

Dependent Variable	# ATM trans.	Vol. ATM trans.	# PoS trans.	Vol. PoS trans.
	(1)	(2)	(3)	(4)
Near term × Exposure	-0.01	-0.04***	0.23***	0.28***
	(0.01)	(0.02)	(0.04)	(0.04)
Long term × Exposure	0.03*	-0.01	0.26***	0.33***
	(0.01)	(0.02)	(0.04)	(0.05)
Cash Dep. × Near term × Exposure	-0.01***	-0.01***	-0.01***	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
Cash Dep. × Long term × Exposure	0.00	-0.00***	-0.00	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	355800	355800	299675	299675
R sq.	0.939	0.915	0.909	0.872
Pincode FE	Y	Y	Y	Y
District × Month-year FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

But, much smaller effect on areas with high cash dependence.

Determinants of cash dependency

Rural Households — Share Rural Households vs. Cash as a Fraction of Consumption

Informal Workers — Share Informal Workers vs. Cash as a Fraction of Consumption
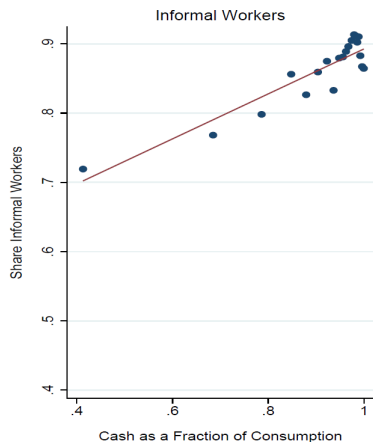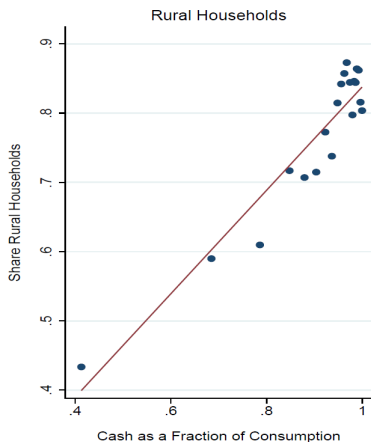
More cash-dependent areas have more rural households and more informal workers.

Effect on areas with varying informality

Measure of informality:	Rural	
Dependent Variable:	# trans.	Vol. trans.
	(1)	(2)
Near term × Exposure	0.207***	0.241***
	(0.0204)	(0.0254)
Long term × Exposure	0.218***	0.299***
	(0.0233)	(0.0284)
Near term × Exposure × Rural	-0.220***	-0.262***
	(0.0342)	(0.0394)
Long term × Exposure × Rural	-0.155***	-0.229***
	(0.0403)	(0.0442)
Observations	314845	314845
R sq.	0.938	0.902
Pincode FE	Y	Y
District × Month-year FE	Y	Y
Month-year FE	Y	Y

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Lower overall impact on digital transactions in rural areas.

Channel: Lack of Financial Infrastructure

Conditional on Pre-Treatment pincode Financial Infrastructure

Dependent Variable:	Zipcode Financial Infrastructure Index					
	< 25pc		25-75pc		> 75pc	
	# trans.	Vol. trans.	# trans.	Vol. trans.	# trans.	Vol. trans.
	(1)	(2)	(3)	(4)	(5)	(6)
Near term × Exposure × Rural	-0.0932	-0.182*	-0.199***	-0.236***	-0.00337	0.0326
	(0.0917)	(0.107)	(0.0551)	(0.0676)	(0.0701)	(0.0920)
Long term × Exposure × Rural	-0.134	-0.223*	-0.197***	-0.243***	0.0710	0.0545
	(0.108)	(0.122)	(0.0635)	(0.0764)	(0.0767)	(0.0987)
Observations	74714	74714	157224	157224	78388	78388
R sq.	0.902	0.871	0.946	0.913	0.965	0.931
Pincode FE	Y	Y	Y	Y	Y	Y
District × Month-year FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

No differential treatment effect across rural pincodes once the sample is restricted to the top quartile of pincode financial infrastructure.

Impact on consumption

	Monthly Per Capita Consumption Expenditure				
		All Households		Low Liquidity	High Liquidity
	(1)	(2)	(3)	(4)	(5)
Near Term × High Dist CC	.020***	.016***	.016***	.022**	.014***
	(.004)	(.004)	(.004)	(.010)	(.005)
Long Term × High Dist CC	-.049***	-.048***	-.051***	.005	-.062***
	(.006)	(.006)	(.006)	(.014)	(.007)
Near Term × Rural		.030***		.037***	.032***
		(.003)		(.008)	(.003)
Long Term × Rural		.033***		.028***	.038***
		(.004)		(.010)	(.004)
Near Term × Rural × High Dist CC		.001		-.019*	.003
		(.004)		(.011)	(.005)
Long Term × Rural × High Dist CC		-.008		-.034**	-.001
		(.006)		(.014)	(.006)
Observations	1237051	1237051	1237051	168235	1068816
R-sq.	.78	.78	.78	.71	.76
Dep Var Mean	2234.61	2234.61	2234.61	2234.61	2234.61
Pincode FE	Y	Y	Y	Y	Y
District × Month-year FE	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Decline in consumption driven by the rural households.

Impact on economic activity

Dependent variable: Ln(Night lights)

	(1)	(2)	(3)
	District Standardized Index - Night Lights		
	Full Sample	High Financial Infrastructure	Low Financial Infrastructure
Short Term * Treated	-.007	.000	.078
	(.006)	(.006)	(.098)
Long Term * Treated	-.028***	-.007	.105
	(.008)	(.009)	(.110)
Short Term * Treated* High Rural		-.005	-.197*
		(.011)	(.111)
Long Term * Treated* High Rural		.000	-.323**
		(.014)	(.135)
Observations	13257	6615	6642
R^2	.99	.99	.95

Reduction in economic activity as distance to currency chests increases. Effects driven by areas with limited financial infrastructure (cf. 2% ↓ in Chowdrow-Reich et. al).

Robustness: Accounting for the bank-branch network

Dependent Variable	No. of PoS trans.	Volume of PoS trans.
	(1)	(2)
Near term $\times$ Exposure	0.0944***	0.291***
	(0.0244)	(0.0279)
Long term $\times$ Exposure	0.193***	0.456***
	(0.0283)	(0.0311)
CC Deposits Share $\times$ Near term $\times$ Exposure	0.00773***	0.00859***
	(0.00154)	(0.00174)
CC Deposits Share $\times$ Long term $\times$ Exposure	0.00665***	0.00536***
	(0.00184)	(0.00198)
Observations	318810	318810
R sq.	0.910	0.872
Pincode FE	Y	Y
District $\times$ Month-year FE	Y	Y
Month-year FE	Y	Y

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conditional on similar areas, marginal impact of temporary cash shortage.

Conclusion

► Cash shortage during demonetization disproportionately affected rural districts.

► Although, shock to cash supply induced households to adopt digital payments (POS transactions), effects are limited in rural areas.

► Underline the vital role played by financial infrastructure.

► Limited spillovers on household participation in financial instruments.

► Cash supply shock hurt rural households without shock coping mechanism.

We highlight the large distributional consequences of massive cash supply shocks on districts with high informality.

Thank You!