

Adoption of FinTech: Evidence from Demonetization in India

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I. Objective of the Study

On the eve of November 8, 2016, the Indian Prime Minister announced in a sudden move that the two largest denomination notes, Rs 500 and Rs 1000, were “demonetized” with immediate effect and ceased to be legal tender. Overnight, 86 percent of the cash in circulation was thereby rendered invalid. Old notes were to be deposited in the banks by December 30, 2016, while restrictions were placed on cash withdrawals (Economic Survey 2015–2016 (2017)). While restrictions were initially placed on the convertibility of domestic money and bank deposits into cash, the government gradually started the remonetization process and continued to raise cash withdrawal limits, eventually lifting all cash withdrawal limits on March 13, 2017.

Due to the unprecedented nature of currency withdrawal, there was a strong incentive for consumers and merchants to adopt various electronic payment methods in the immediate period after the demonetization. On the other hand, the Government of India also engaged in a rapid currency printing program to alleviate the currency shortages, which finally resulted in removal of all restrictions in withdrawals on currency by March 13, 2017. At the same time, an important counteracting influence on this adoption was the actual barriers to adoption – technological, cultural and anonymity preferences. Thus, the Indian demonetization provides an ideal experiment to study the impact of a completely unanticipated shock on adoption on FinTech, in particular, focusing on short term as well as long term effects.

Another important benefit of this shock is that it provides a good setting to estimate network externalities in the adoption of FinTech. Post demonetization 500 and 1000 rupee notes could not immediately be converted to other denominations. This shortage of notes and the slow process of remonetization increased the cost of cash to customers as well as merchants above the notional value. In other words, it lowered the price of the network or digital transaction relative to a cash transaction. In industries or for individuals where this benefit exceeded the cost of digital transactions we should see a move to digital transactions.

We propose to carry out our analysis in several parts. In the first part, we will use differences in cash availability within-city - thus, a differences-in-differences identification strategy to estimate the take-up in digital payments in the period right after demonetization. As remonetization efforts progressed from November 8, 2016 to March 13, 2017 cash availability

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improved as time progressed. This will allow us to estimate relative costs of such adoption across different types of merchants as well as consumers.

Now, we turn to the longer term impact. Demonetization can be seen as a positive network externality shock. If the temporary cash shortage resulted in a critical mass of merchants and customers entering the network, then the convenience of using the digital transaction should persist even after cash becomes more easily available (post demonetization). Thus, as remonetization occurs, there will be positive adoption in long run if the price of digital payments is lower for consumers and/or merchants relative to cash transactions. This could occur if say the network externalities made it more convenient post-demonetization to transact digitally vis-à-vis cash. However, there could be a reversal from digital transactions to cash in the long run if the price of digital payments continues to be higher post demonetization as cash became more easily available.

One factor that complicates the adoption of FinTech in the Indian context is the prevalence of a large “unofficial” or grey economy. It is believed that this economy constitutes as much as 30% of the Indian GDP. Thus, both in the short term, as well as in the long term, merchants as well as consumers may be reluctant to engage in digital transactions due to the potential lack of anonymity.¹²

Our empirical setting contributes to this debate as well. In particular, some industries are more prone to tax avoidance relative to others. Using high density digital areas such as Mumbai, where the actual cost of engaging in digital transactions is quite low, we can also estimate the shadow cost of engaging in digital transactions that are not attributable to technological factors. This would provide novel evidence on the benefit of tax avoidance and thus one potential impediment to adoption of FinTech.

The rest of the proposal is organized as follows. Section II describes the demonetization event and institutional environment on cash disbursement. Section III describes the data used in the analysis. Section IV describes the empirical methodology. Section V describes the timeline of delivery.

II. Demonetization, FinTech and the Institutional Environment

Broadly the term FinTech is used to refer to all players in the larger FinTech ecosystem. FinTech could be large financial institutions such as Bank of America or State Bank of India (incumbents); big tech companies such as Apple, Google, Facebook, and Twitter; companies that provide infrastructure or technology that facilitate financial services transactions such as MasterCard, First Data; or could be market disruptors or startups that focus on particular innovative technology or processes (Garfinkel and Nicolacakis (2016)). In our analysis we wish to focus on all aspects of how demonetization propelled users to switch to digital transactions.

¹See Rogoff (2016) where the author makes a case for a less-cash economy. He looks at cash transactions in developed economies such as the US and finds that the convenience of cash is able to explain the small bills in circulation but cannot explain the huge amounts of higher denomination currencies in circulation. The evidence on cash use in legal transactions does not explain the huge amounts of large denomination cash in circulation. The author instead argues that there is a large currency demand in the underground economy which can account for the remaining cash in circulation.

²The Reserve Bank of India (RBI) Deputy Governor makes a case that FinTech product needs to both inspire confidence in the FinTech product as well as provide users anonymity (Gandhi (2017)).

As mentioned earlier, there was virtually no indication of the impending demonetization. This abrupt withdrawal of Rs 500 and Rs 1000 notes, often termed as a “surgical strike on black money”, was aimed to strengthen the fight against corruption, black money, counterfeit currency and terrorism, and its secrecy was justified for the same reasons

The PM stressed that in this entire exercise of demonetization, there would be no restriction of any kind on non-cash payments by checks, demand drafts, debit or credit cards and electronic fund transfer. Also, the notes will be replaced by new 500 and 2,000 rupee notes (remonetization), Mr. Modi said. Figure 1 shows that the total currency in circulation dropped drastically wiping nearly 86 percent of currency in circulation on the day demonetization was announced. While it has not reached pre-demonetization levels, the amount of cash in circulation has been steadily increasing since November 9, 2016. The data is up until March 3, 2017, a fortnight before all cash withdrawal limits were lifted.

Demonetization, which was initially aimed at countering black money hoarders and counterfeiters, was later publicized to be a big push to digital payments for the country.³ For a short period of time, digital payments applications and technologies such as the debit and credit card transactions, national electronic funds transfer (NEFT) and mobile banking applications saw a spike. However, as the new currency notes found their way back into the circulation, the picture started changing again - depicting just a temporary surge in the digital payments.

As the remonetization process progressed, the RBI strived to quickly distribute notes through currency chests. There are four currency note printing presses. The two government owned currency presses are in Nashik and Dewas whereas the other two are at Mysuru and Salboni and are run by an RBI subsidiary, Bharatiya Reserve Bank Note Mudran. Printed notes are despatched to vaults in over 31 offices of the RBI and to currency chests in to bank owned branches operate that operate like vaults.

Currency chests are branches (4075 nationally) of selected banks which have been authorised by the RBI to stock rupee notes and coins. The number and denomination of notes to be printed are decided by the RBI and the currency chests hold this cash for easy disbursement. The RBI has offices at 31 locations which receive notes from note presses and coins from the mints. These are then distributed to the currency chests (bank branches). The RBI has set up over 4,075 currency chests all over the country. 67 per cent are held in branches of the State Bank of India and its associate banks. Other Nationalised banks hold 1,173 chests, taking the share of the PSU banks to 95 per cent. Private sector banks (160), Co-operative banks (3) and foreign banks (4), regional rural banks (5) account for a relatively smaller share of currency chests.

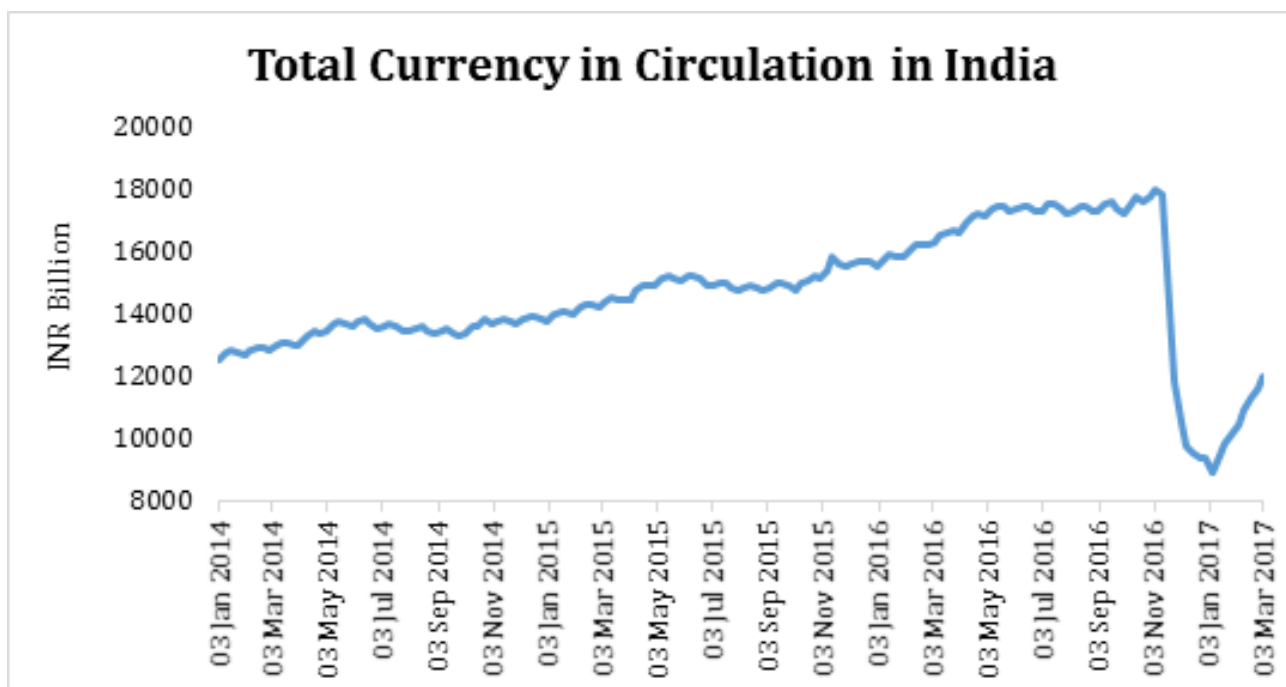
III. Data Description

We propose to collect three main sets of data. The volume and number of digital transactions will be collected from the Reserve Bank of India (RBI) and National Payments Corporation of India (NPCI). We will also collect publicly available data on location of currency chests across the nation provided by RBI. The third set of data on factors that affect take-up of digital transactions if from the 2011 Census Data, the National Survey Sample office (NSSO) 2013

³Anecdotally, this was done as there was an expectation that about 20% of the currency would not be deposited due to fear of prosecution by the government. However, as time progressed, it became clear that most of the currency in circulation would be deposited by the deadline of December 30, 2017. Hence, an alternate reason of increase in adoption of digital technological was emphasized in the government communications in the later period of the demonetization.

Figure 1. Currency In Circulation

The graph below plots the total currency in circulation since January 2014 up until March 2017. The sharp drop corresponds to demonetization announcement on 9th November, 2017. Data is from the reserve Bank of India (RBI) and is available at the fortnightly frequency.



Source: RBI

data, the Center for Monitoring Indian Economy (CMIE) consumer pyramids data. We also have access to data on location of mobile towers within India. We describe the data in further detail below.

A. Data on Digital Transactions

We aim to collect regulatory data on digital payments from 2 main sources. The first database is from the National Payments Corporation of India (NPCI). This is an umbrella organization for all retail payments system in India. It is a body promoted by the Reserve Bank of India (RBI) and ten core promoter banks (State Bank of India, Punjab National Bank, Canara Bank, Bank of Baroda, Union bank of India, Bank of India, ICICI Bank, HDFC Bank, Citibank and HSBC). It acts as a clearing house and provides data on online transactions for a number of key products.

One important financial product offered by the NPCI is the RuPay credit card, created to have a domestic multilateral system of payments in India. RuPay offers a lower transaction cost to customers as against other multinational financial services providers like Visa and Mastercard. The RuPay card was launched on 26 March 2012. RuPay cards have lower costs and are more affordable compared to Visa and Mastercard since the transactions are processed domestically leading to lower clearing and settlement costs. However, the uptake in RuPay was low pre-demonetization. This is despite the fact that the government provided strong incentives to encourage RuPay transactions. For example, RuPay debit cards were provided to Jan Dhan account holders — part of a widespread financial inclusion scheme launched by the government — to enable them to access ATM and internet banking services. Table I, Panel A shows the volume (number of transactions) and value (total amount of transaction in Rupees) for RuPay cards both the point of sale (POS) transactions and e-commerce transactions. We see that RuPay POS transactions increased by 160 percent (in terms of volume) just after demonetization. But monthly growth rates fell by 18 percent as cash availability increased. The overall number of transactions were still higher than pre-demonetization levels. Figure 2 graphically depicts the number and volume of transactions.

Our empirical methodology will rely on cross-sectional variation across and within cities. Hence, we focus on RuPay digital transactions for which we also have geographic location of transactions. It is also economically meaningful to focus on RuPay digital transactions since they had the largest increase post demonetization (800% increase in December 2016 relative to December 2015 as per NPCI estimates, not shown in the graphs).⁴

We will also use data available from the Reserve Bank of India (RBI) on National Electronic Funds Transfer (NEFT), Real Time Gross Settlement (RTGS) and mobile transactions for which we have the geo-coding of the data. National Electronic Funds Transfer (NEFT) is a payment system allowing one-to-one fund transfers nationally wherein individuals, firms and corporates can electronically transfer funds from any bank branch to any individual, firm or corporate at any other participating bank branch. RTGS is a real-time settlement of funds individually on an order by order basis. Mobile payments data also refer to transactions occurring via mobile from one customer branch account to another. Table I, Panel B shows the volume (number of transactions) and value (total amount of transaction in Rupees) for NEFT, RTGS and mobile

⁴For completeness (depending on data availability) we will also plan to look at the remaining digital transactions data provided by NPCI. However, since the main empirical methodology uses geographic location, this part of the analysis will only use time series variation. The remaining digital products on NPCI are described in Appendix A.

banking payments. Figure 2, Panel B shows the corresponding figures. For NEFT digital payments we see a sharp rise in both the volume and value of transactions. Similarly, mobile transactions also showed an increase in digital payments. RTGS payments on the other hand showed almost no difference in pattern after demonetization. This is because these payments are not affected by cash availability. Since they target a different segment of the market, demonetization did not have a direct impact on transaction volumes.

Thus, due to data availability, we focus on two kinds of FinTech mentioned above: the digital transactions on NEFT/RTGS/ mobile payments of the large financial institutions (incumbents); and the digital transactions on the RuPay infrastructure that facilitates financial services.

Table I. Digital Transactions: Volume and Value

The table below shows the volume and value of digital transactions used in our analysis. The top panel shows the RuPay transactions for point of sale purchases and e-commerce sites. For completeness we also show the data for Immediate Payment Service (IPMS) transactions (this data will not be eventually used in our cross-sectional analysis because the exact location of the transaction is not available). This data is from the National Payments Corporation of India (NPCI). The bottom panel shows the transactions for National Electronic Funds Transfer (NEFT), Real Time Gross Settlement (RTGS) and mobile transactions. This data is from the Reserve Bank of India (RBI). The alternate columns indicate the growth monthly rates.

Panel A: NPCI data

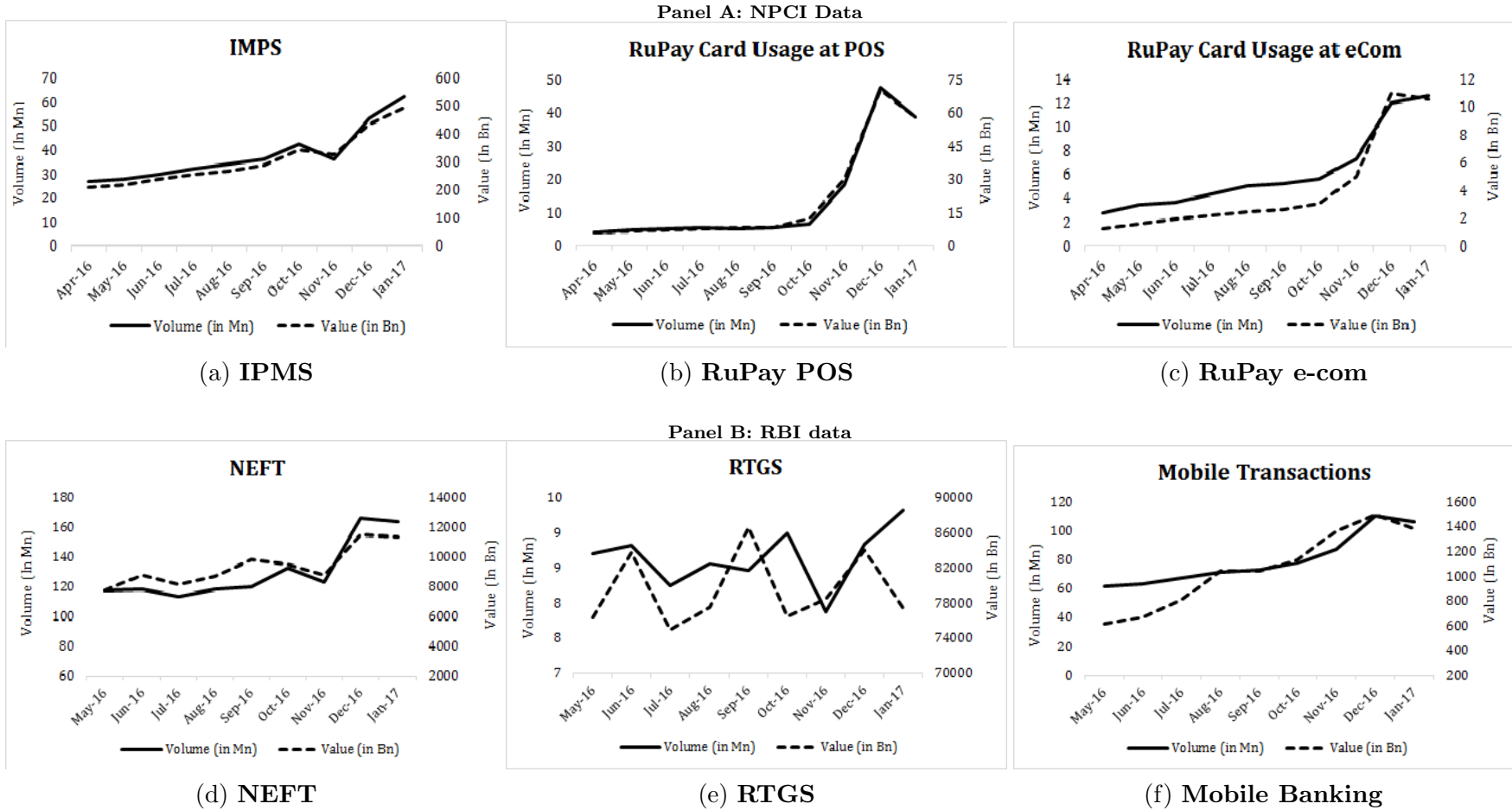
	IPMS				RuPay POS				RuPay e-com			
	Volume (in Mn)		Value (in Bn)		Volume (in Mn)		Value (in Bn)		Volume (in Mn)		Value (in Bn)	
May-16	27.66		216.18		4.47		6.48		3.43		1.54	
Jun-16	29.68	7%	237.17	10%	5.04	13%	6.74	4%	3.65	6%	1.88	22%
Jul-16	32.18	8%	256.17	8%	5.28	5%	7.6	13%	4.31	18%	2.18	16%
Aug-16	33.89	5%	268.49	5%	5.1	-3%	8.1	7%	5.02	16%	2.45	12%
Sep-16	35.93	6%	289.12	8%	5.16	1%	7.95	-2%	5.2	4%	2.57	5%
Oct-16	42.11	17%	343.71	19%	6.22	21%	11.97	51%	5.58	7%	3.06	19%
Nov-16	36.17	-14%	324.81	-5%	18.16	192%	30.06	151%	7.3	31%	4.97	62%
Dec-16	52.86	46%	432.01	33%	47.27	160%	70.05	133%	11.97	64%	10.95	120%
Jan-17	62.43	18%	491.26	14%	38.73	-18%	57.97	-17%	12.55	5%	10.53	-4%

Panel B: RBI data

	NEFT				RTGS				Mobile Banking			
	Volume (in Mn)		Value (in Bn)		Volume (in Mn)		Value (in Bn)		Volume (in Mn)		Value (in Bn)	
May-16	118		7733		9		76333		62		618	
Jun-16	118	1%	8815	14%	9	1%	83835	10%	63	2%	673	9%
Jul-16	113	-4%	8145	-8%	8	-7%	74920	-11%	67	7%	810	20%
Aug-16	119	4%	8764	8%	9	4%	77588	4%	72	6%	1039	28%
Sep-16	120	1%	9880	13%	8	-1%	86687	12%	73	1%	1043	0%
Oct-16	133	11%	9505	-4%	9	6%	76473	-12%	78	8%	1139	9%
Nov-16	123	-8%	8808	-7%	8	-13%	78479	3%	87	12%	1366	20%
Dec-16	166	35%	11538	31%	9	12%	84096	7%	111	26%	1498	10%
Jan-17	164	-1%	11355	-2%	9	6%	77486	-8%	106	-4%	1383	-8%

Figure 2. Digital Transactions

The graph below plots the total volume and value of transactions. The top panel shows the RuPay transactions for point of sale purchases and e-commerce sites. For completeness we also show the data for Immediate Payment Service (IPMS) transactions (this data will not be eventually used in our cross-sectional analysis because the exact location of the transaction is not available). This data is from the National Payments Corporation of India (NPCI). The bottom panel shows the transactions for National Electronic Funds Transfer (NEFT), Real Time Gross Settlement (RTGS) and mobile transactions. This data is from the Reserve Bank of India (RBI). In all graphs the primary axis shows the volume of transactions (solid line) in millions and value of transactions (dashed line) is in Rupees billion.



B. Location of Currency Chests

Location of currency chests is publicly available from the RBI website⁵. The exact address of each currency chest is available. The empirical methodology described in Section IV below directly measures the distance to each currency chest. To further refine our analysis, we can also potentially collect data on the amount of cash in the currency chests. While this makes the measurement of cash available more precise, our proxy for cash availability should also suffice.

C. Other Data

We will use hand-collected data on location of mobile towers across the country. For the across-city analysis we will use the digital readiness data defined as the number of mobile towers per capital in a city. Other measures include quality of mobile calls, availability of 3G networks in an area, number of subscribers, mobile coverage, mobile penetration data available from Indiastat. For credit card and bank account penetration data, we rely on CMIE consumer pyramids data. Demographics of the city, average education and percentage of salaried versus self-employed data is from the 2011 Census data. Data on formal versus informal employment is available from the 2013 National Survey Sample Office (NSSO).

IV. Methodological Approach

We will examine both sides of the two-sided market: consumers and merchants that is, C to B payments as well as B to B payments. We conduct the analysis in two stages. The first stage of the analysis shows the correlational relationship between uptake in digital transactions and factors that would affect digital take-up. The second stage of analysis is based on disaggregated geo-coded data and uses within-city variation in a difference-in-difference setting to estimate whether cash availability affected take-up in digital transactions post demonetization.

In the Section A below we first look at the correlational analysis using across-city variation. In the Section B below we look at the causal impact of cash shortage on digital transactions, both in the short term and the long term, using a within-city differences-in-differences identification strategy.

A. Correlational Estimates: Across-City Analysis

A.1. Structural Break Analysis

The first part of our analysis focuses on the immediate impact of demonetization across cities. We wish to estimate whether the number of digital transactions increased drastically following demonetization, that is, which areas witnessed a jump in the critical mass of merchants and consumers. We first estimate whether there was a structural break in the time-series data of number of digital transactions. The structural break analysis yields an indicator ($\mathbb{1}_{Break,c}$) for whether a city c witnessed a structural break in number of digital transactions post demonetization. We plan to use the tests in Chow (1960) and Bai and Perron (1998) to empirically test whether there was a structural break.

⁵See <https://www.rbi.org.in/Scripts/currencychestlink.aspx>

The cross-city empirical specification is as follows:

$$\mathbb{1}_{Break,c} = \alpha + \beta * Factor_c + \gamma * X_c + \epsilon \quad (1)$$

where $\mathbb{1}_{Break,c}$ is an indicator for whether a city experienced a structural break in the time-series of digital transactions. X_c are city-level controls. $Factor_c$ is a measure of factors that determine digital transactions uptake. One measure is cash availability. A proxy for cash availability is the number of currency chests per capita. Alternate measures could account for the size of the bank branch (currency chest) or directly use the cash in the currency chest (if the data is available). Other factors could include digital readiness. For example, digital payments have significant dependencies upon power and telecommunications infrastructure. It could be that cities that witnessed a sharp uptake in digital transactions were more digitally ready. We can replace *Cash Availability* with a measure of digital readiness such as the number of mobile towers per capital in a city. Other measures include quality of mobile calls, availability of 3G networks in an area, etc. Similarly, there are other variables which may be of interest such as demographics of the city, average education, percentage of salaried versus self-employed. We can also include merchant characteristics such as formalization of sectors and industries with higher tax evasion (such as real estate).

A.2. Growth Rate Differential

While the above analysis gives an estimate of whether the critical mass of merchants and consumers saw a sudden increase in digital payments, it does not tell us by how much. We are interested in the overall growth in digital transactions for the demonetization period relative to the pre-demonetization period.

The proposed empirical test is as follows:

$$\Delta Growth Digital Transactions_c = \alpha + \beta * Factor_c + \gamma * X_c + \epsilon \quad (2)$$

where $\Delta Growth Digital Transactions_c$ is growth in digital transactions in the period before demonetization relative to the period before⁶. X_c are city-level controls. $Factor_c$ as before is a measure of factors that affect digital payments described above.

B. Causal Estimates: Within-City Analysis

B.1. Distance to currency chests and Difference-in-Difference Specification

Now we causally estimate the short-term and long-term effect on adoption of financial technologies due to a temporary shortage of cash availability in India. We perform a more formal analysis using the rich geo-coding of data on digital transaction. Specifically, we are going to combine a difference-in-difference analysis before and after demonetization with exposure to areas that had easy availability of cash. The location of currency chests determine which areas

⁶What we are interested in is the change (kink) in the growth of digital transaction in the post-demonetization period relative to the growth rates in the pre-demonetization period. As a baseline we simply propose to use the difference in growth from the start of demonetization in November 9, 2016 to the end of demonetization (the period during which notes could be exchanged) in December 31st 2016. This measure could be refined by say for example using the local average response similar to the regression kink discontinuity estimate. That is, estimate the change (kink) in slopes (growth rates) very close to the demonetization dates.

had easier access to cash in the period immediately following demonetization. The underlying assumption is that areas close to currency chests had easier access to cash.

Section A looked at the factors that affected the take-up in digital transactions. While this descriptive analysis is helpful it does not *causally* estimate whether the temporary cash shortage resulted in as uptake in digital transactions. For example, anecdotal evidence suggests that rural areas were facing a cash crunch as currency chests were not supplying enough money to rural branches of banks, despite the RBI’s instructions to ensure at least 40 percent of new notes should be supplied to rural areas.⁷ However, many other factors vary across cities besides just cash availability and can affect digital take-up. For example, rural areas would have very different trends in digital readiness before the demonetization compared to urban areas. Instead we focus on within-city variation.

Instead of looking at across-city variation we look at the availability of cash in different regions within the city. Specifically, we have the exact location of each of currency chest which supplies cash. In normal times, that is pre-demonetization, when cash is readily available the distance to the currency chest should not matter. We use the distance of our most granular area of analysis, pincode (comparable to a zipcode in the US) to these currency chests as a measure of the difficulty in availability of cash post demonetization. This within-city variation of cash availability is more likely to satisfy the parallel trends assumption required for identification in a difference-in-difference strategy.

The empirical specification is:

$$y_{ict} = \alpha_i + \gamma_t + \eta \times \mathbb{1}_{Post} \times Distance\ to\ CC + \beta \times X_{ict} + \epsilon_{ict} \quad (3)$$

where i indexes pincodes, t indexes time, α_i and γ_t are pincode and year fixed effects. y_{ict} is the outcome of interest, that is number of digital transactions in a given pincode. For short-run impact we can look at the number of digital transactions restricted to one month after demonetization during which there was still a cash crunch. We also look at the long-term effect on digital transactions by including all transactions up until the current period in the analysis. $\mathbb{1}_{Post} = 1$ for the period after demonetization. *Distance to CC* refers to the distance of the nearest currency chest for a given pincode. The controls (X_{it}) include pincode level controls. Standard errors are clustered at the pincode level. The coefficient of interest is η , which measures the difference, conditional on controls, in outcome y number of digital transaction between pincodes that had low availability of cash (far away from currency chests) and pincodes that had high availability of cash after demonetization.

The amount of cash that could be withdrawn immediately after demonetization increased as RBI ramped up its remonetization efforts. Table A1 gives the cash limits across time. We can look at the dynamics of demonetization as we progress from November 9, 2016 to March 13, 2017 (when all cash withdrawal limits were lifted). To look at the dynamics across time we run the following event study study specification:

$$y_{ict} = \alpha_i + \gamma_t + \sum_{\tau} \eta_{\tau} \times \mathbb{1}_{\tau} \times Distance\ to\ CC + \beta \times X_{ict} + \epsilon_{ict} \quad (4)$$

where i indexes pincodes, t indexes time, α_i and γ_t are pincode and year fixed effects. y_{ict} is the outcome of interest, that is number of digital transactions in a given pincode. $\mathbb{1}_{\tau} = 1$ for the period τ . *Distance to CC* refers to the distance of the nearest currency chest for a given

⁷See <http://www.livemint.com/Money/dL9TNMWxtEUIrCFXCyKVoj/RBI-urges-currency-chests-to-ensure-40-of-da.html>

pincode. The controls (X_{it}) include pincode level controls. Standard errors are clustered at the pincode level. The coefficient of interest is η_τ , which measures the difference, conditional on controls, in outcome y number of digital transaction between pincodes that had low availability of cash (far away from currency chests) and pincodes that had high availability of cash in period τ . The estimates of η_τ for period τ periods will also allow for graphical analysis of the parallel trends assumption required for identification in the difference-in-difference strategy.

B.2. Factors affecting Digital Adoption

We now turn to the factors affecting digital adoption. We are interested in whether say treatment areas (far away from currency chests) with say higher digital readiness increased digital payments by more compared to control areas.

The empirical specification is:

$$\begin{aligned}
y_{ict} = & \alpha_i + \gamma_t + \eta \times \mathbb{1}_{Post} \times Distance\ to\ CC \\
& + \delta \times \mathbb{1}_{Post} \times Factor_{ic} + \phi \times \mathbb{1}_{Post} \times Distance\ to\ CC \times Factor_{ic} \\
& + \beta \times X_{ict} + \epsilon_{ict}
\end{aligned} \tag{5}$$

where i indexes pincodes, t indexes time, α_i and γ_t are pincode and year fixed effects. y_{ict} is the outcome of interest, that is number of digital transactions in a given pincode. $\mathbb{1}_{Post} = 1$ for the period after demonetization. *Distance to CC* refers to the distance of the nearest currency chest for a given pincode. The controls (X_{it}) include pincode level controls such as whether an area is rural, per capita income, etc. Standard errors are clustered at the pincode level. $Factor_{ic}$ could be the digital readiness of a pincode measured as the distance of the centroid of the pincode to the nearest mobile tower. We look at a variety of factors mentioned above. If data is available, we use the pincode measure. Where not available, we use a more aggregated measure such as at the district or city level.

The coefficient of interest is ϕ , which measures the difference, conditional on controls, in outcome y number of digital transaction between pincodes that had low availability of cash (far away from currency chests) and pincodes that had high availability of cash after demonetization differentially across areas which were say more digitally ready compared to others. Similarly we look at other factors such as demography, self-employed versus salaried, etc.

V. Timeline for completion

The specific project plans are as follows: first stage from March 20, 2017 to May 25, 2017 will focus on the correlational analysis using city-wide variation. Data collection of aggregate level measures to supplement correlational analyses will be undertaken during this period. Analysis for the second stage will focus on the causal estimates analysis using within-city variation.

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Appendix

Table A1. Cash Withdrawal

Date	Event	Main Specifications
8-Nov-16	Demonetization	<p>Withdrawal of Legal Tender Character of existing Rs. 500 and Rs. 1000 Bank Notes</p> <p>Bank notes of aggregate value of Rs. 4,000 or below may be exchanged</p> <p>No limit on deposits</p> <p>Cash withdrawal from a bank account over the counter restricted to Rs. 10,000 per day subject to an overall limit of Rs. 20,000 a week</p> <p>No restriction on the use of any non-cash method of operating the account (including cheques, demand drafts, credit or debit cards, mobile wallets and electronic fund transfer mechanisms)</p> <p>Withdrawal from ATMs restricted to Rs. 2,000 per day</p>
13-Nov-16	Revision in Limits for Cash	<p>Exchange of Specified Bank Notes, over the counter increased from the existing Rs. 4000 to Rs. 4500</p> <p>Daily limit on withdrawal from ATMs increased from the existing Rs. 2000 to Rs. 2500 per day</p> <p>Weekly limit of Rs. 20000 for withdrawal from bank accounts increased to Rs. 24000 and the daily limit of Rs. 10000 per day stands withdrawn</p>
17-Nov-16	Limit for Exchange Over the Counters Revised	Limit of exchange of SBNs in cash, across the counter of the banks shall be Rs. 2000
20-Nov-16	Withdrawal Limits from ATMs unchanged	Daily limit of withdrawal from recalibrated ATMs was increased from Rs. 2000 to Rs. 2500 per day while retaining the same at Rs. 2000 in case of other ATMs until they are re-calibrated
21-Nov-16	Cash Withdrawal Limit Facility for Overdraft/Cash Credit Accounts	Current account holders were allowed to withdraw up to Rs. 50000 in cash, in a week. This facility extended to Overdraft and Cash Credit accounts also.
21-Nov-16	Cash Withdrawal for Wedding	Maximum of Rs. 250000 allowed to be withdrawn from the bank deposit accounts till December 30, 2016 by either of the parents or the person getting married (Date of marriage has to be on or before December 30, 2016)
24-Nov-16	Discontinuation of over the Counters Exchange of SBN (Specified Bank Notes)	No over the counter exchange (in cash) of SBNs after midnight of November 24, 2016. Members of public who approach the banks for OTC exchange SBN may be encouraged to deposit SBNs into their bank accounts.

Table A1. Cash Withdrawal (contd.)

Date	Event	Main Specifications
25-Nov-16	Exchange facility to foreign citizens	Foreign citizens (i.e. foreign passport holders) can exchange foreign exchange for Indian currency notes up to a limit of Rs. 5000 per week till December 15, 2016
25-Nov-16	Withdrawal of cash - Weekly limit	Banks advised to continue to allow their existing customers to withdraw cash from their accounts (from ATMs) upto Rs. 24,000 per week,
26-Nov-16	Requirement for maintaining additional CRR	All Scheduled Commercial Banks / Regional Rural Banks / all Scheduled Primary (Urban) Co-operative Banks / all Scheduled State Co-operative Banks to maintain with the RBI, effective from the fortnight beginning November 26, 2016 an incremental CRR of 100 per cent on the increase in NDTL between September 16, 2016 and November 11, 2016 (Current CRR: 4% of NDTL)
2-Dec-16	Withdrawal of the Incremental CRR	RBI withdrew the requirement of incremental CRR, effective the fortnight beginning December 10, 2016
16-Dec-16	Rationalisation of customer charges for Immediate Payment Service (IMPS), Unified Payment Interface (UPI) & Unstructured Supplementary Service Data (USSD)	All participating banks and Prepaid Payment Instrument (PPI) issuers shall not levy any charges on customers for transactions upto Rs. 1000 settled on the Immediate Payment Service (IMPS), USSD-based *99# and Unified Payment Interface (UPI) systems. (with effect from January 1, 2017 till March 31, 2017).
16-Dec-16	Rationalisation of Merchant Discount Rate (MDR) for transactions upto Rs. 2000	In order to facilitate wider acceptance of card payments, the following special measures for debit card transactions (including for payments made to Government), are being introduced for a temporary period:(a) For transactions upto Rs. 1000, MDR shall be capped at 0.25% of the transaction value.(b) For transactions above Rs. 1000 and upto Rs. 2000, MDR shall be capped at 0.5% of the transaction value.
16-Dec-16	Exchange facility to foreign citizens	Foreign citizens to exchange foreign exchange for Indian currency notes up to a limit of Rs. 5000 per week till December 31, 2016 (earlier December 15, 2016).

Table A1. Cash Withdrawal (contd.)

Date	Event	Main Specifications
19-Dec-16	Deposit of Specified Bank Notes (SBNs) into bank accounts	(a) Tenders of SBNs in excess of Rs. 5000 into a bank account will be received for credit only once during the remaining period till December 30, 2016.(b) Tenders of SBNs up to Rs. 5000 in value received across the counter will allowed to be credited to bank accounts in the normal course until December 30, 2016.
30-Dec-16	Closure of the scheme of exchange of Specified Bank Notes (SBNs) at banks on December 30th 2016	The closure of the facility of exchange of SBNs as at the close of business on December 30, 2016
30-Dec-16	Cash withdrawal from ATMs - Enhancement of daily limits	Daily limit of withdrawal from ATMs increased (within the overall weekly limits specified) with effect from January 01, 2017, from the existing Rs. 2500 to Rs. 4500 per day per card. No change in weekly withdrawal limits.
31-Dec-16	Facility for exchange of Specified Bank Notes (SBNs) during Grace Period - Verification of KYC and Account details	Facility for exchange of SBNs is made available for the resident and non-resident citizens who could not avail the facility from November 10 to December 30, 2016 on account of their absence from India during the aforementioned period.
3-Jan-17	Allocation of cash for rural areas	On observing that bank notes, being supplied to rural areas, at present, are not commensurate with the requirements of rural population, some steps were taken. With a view to ensure that at least 40% bank notes are supplied to rural areas, the banks maintaining currency chests were advised to take various steps
3-Jan-17	Exchange facility to foreign citizens	Foreign citizens to exchange foreign exchange for Indian currency notes up to a limit of Rs. 5000 per week till January 31, 2017 (earlier December 31, 2016).

Table A1. Cash Withdrawal (contd.)

Date	Event	Main Specifications
16-Jan-17	Enhancement of withdrawal limits from ATMs and Current Accounts	(a) The limit on withdrawals from ATMs enhanced from the current limit of Rs. 4,500 to Rs. 10,000 per day per card (operative within the existing overall weekly limit).(b) The limit on withdrawal from current accounts enhanced from the current limit of Rs. 50,000 per week to Rs. 1,00,000 per week and it extends to overdraft and cash credit accounts also.
30-Jan-17	Limits on Cash withdrawals from Bank accounts and ATMs - Restoration of status quo ante	(a) Limits placed on cash withdrawals from Current accounts / Cash credit accounts / Overdraft accounts stand withdrawn with immediate effect.(b) The limits on Savings Bank accounts continue for the present and are under consideration for withdrawal in the near future.(c) Limits on cash withdrawals from ATMs stand withdrawn from February 01, 2017. However, banks may, at their discretion, have their own operating limits.
8-Feb-17	Removal of limits on withdrawal of cash from Saving Bank Accounts	(a) Effective February 20, 2017, the limits on cash withdrawals from the Savings Bank accounts will be enhanced to Rs. 50,000 per week (from the current limit of Rs. 24,000 per week); and(b) Effective March 13, 2017, there will be no limits on cash withdrawals from Savings Bank accounts.
14-Mar-17	Demonetisation's end	The Reserve Bank of India (RBI) lifted the withdrawal limit on savings account from Monday putting an end to withdrawal policies related to demonetisation

A. NPCI Data: Digital Transaction Products

This section describes all the data on digital transaction products available from NPCI.

- **Unified Payments Interface (UPI)**

UPI is a system which integrates transaction across multiple (participating) banks in one mobile application. The transaction is processed with a virtual ID, unique for every user, and a M-PIN generated for the bank account which is being used for transaction. UPI has helped overcome the barriers of transacting across different banks.

- **Bharat Interface for Money (BHIM)**

BHIM is a mobile application launched by government of India which uses Unified Payments Interface for banking transactions. Apart from English, BHIM is also launched in 8 regional languages to ensure maximum integration of Indian public with the virtual banking system.

- **Immediate Payment Service (IMPS)**

IMPS is an instant real time inter-bank electronic fund transfer service using internet banking portal. It requires the user to register the recipient bank on it's bank's net banking portal to be able to transfer funds to the recipient instantly.

- ***99#**

It is an automated tele-banking service launched by Government of India to enable people to do banking transactions without good internet connectivity. It allows users to transfer funds to other bank accounts, change M-PIN, get mini statement, etc. through an automated call. It also has an extension *99 * 99# specifically for checking the status of linking Aadhar number to one's bank account.

- **National Automated Clearing House (NACH)**

NACH has been launched to replace multiple Electronic Clearing Services (ECS) running across India into a centralized system. The government aims to promote it for repetitive bulk payments like those towards distribution of salaries, dividends, interest, pension, etc. This aims to eliminate locational barriers to banking services within India.

- **Check Truncation System**

The present MICR check clearing system requires to move the check physically from one place to another thus delaying its clearance. The Check Truncation System immediately generates an electronic image of the check presented thus substituting physical movement of the check.

- **Aadhar Enabled Payment System (AEPS)**

AEPS is an approach by the government of India to enable people to small banking transactions through Aadhar Card authentication. Presently, a user can do balance enquiry, cash withdrawal, cash deposit and Aadhar to Aadhar fund transfers through a Micro PoS and a micro ATM card with Aadhar number.

- **RuPay**

RuPay is an Indian card scheme launched by NIPC created to have a domestic multilateral system of payments in India. RuPay offers lower transaction cost to customers as against other multinational financial services providers like Visa and Mastercard. The government provided RuPay debit cards to Jan Dhan account holders to enable them to access ATM and internet banking services.

- **Bharat Bill Payment System (BBPS)**

The BBPS system aims to bring multiple bill payment systems in India under a single structure. Bharat Bill Payment Central Unit will not do any financial transactions by itself but rather guide users to different bill payment portals. It will also be responsible for setting standards, ensuring transaction security, quick redressal of grievances, etc. for the entire ecosystem.

The data for the above mentioned digital products is to be obtained from National Payments Corporation of India (NPCI). Apart for this, we also collect bank-wise data on NEFT/RTGS and other mobile transactions for the period of May 2016 to February 2017 from the RBI website.