Is Cash Still the Enemy? The Dampening of Demonetization's Ripple Effect on Mobile Payments

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Abstract. Technology diffusion has often been triggered unintendedly by crises and disasters, as witnessed in several cases including the demonetization cash-crisis surging mobile payment adoption in India. However, once the shock waves induced by the crisis event weakens over time, there exists a void that questions the sustenance of the technology whose diffusion was a ripple effect of the shock. This is seldom explored by the literature that focuses on the immediate aftermath of the crises. We address this limitation by examining the cash withdrawal patterns from ATMs in India post-demonetization for a continuous period of three years. The results provide strong empirical evidence to support our claims towards the dampening of demonetizations' ripple effect on mobile payments. The theoretical contributions of the study add further to the existing literature on technology diffusion and technology adoption post-crises with a focus on the digital payment systems. The findings have implications for policymakers and government concerned with the digital economy, with cash emerging as an enemy overshadowing the growth of digital payment methods.

Keywords: Mobile payments, Digital payments, Cash usage, ATM cash withdrawals, Technology diffusion

1 Introduction

November 2016 witnessed one of the biggest economic events in the history of the 21st century as the government of India introduced the demonetization of banknotes in circulation (Kumar, 2016). The policy invalidated 500 INR and 1000 INR banknotes in circulation and exchanging them for new banknotes issued by the government. The primary intent of the decision was taken to curtail the shadow economy and curb black money and unlawful transactions, but it led to both positive and negative unintended consequences (Dutta, 2018). One of the most welcome outcomes was the inevitable transformation of the economy from physical cash to digital cash amidst the unintended severe cash crisis that the policy introduced (Mehta, Patel, Mehta, & others, 2016). This natural experiment on the biggest democracy of the world has received widespread attention by various scholars around the world, adding to the existing literature on the digital economy, policymaking and ICT4D (e.g., Banerjee, Breza, Chandrasekhar, & Golub, 2019; Dash, 2017; Singh & Singh, 2016). Many of these studies argue that there

is an increase in the adoption of mobile payment technologies pan India post demonetization (eg., Pal, Herath, De', & Rao, 2020). This also has led to the launch of several digital wallets post demonetization like Google Tez, PhonePe, Airtel money, Amazon Pay, and other mobile payment technologies introduced by other banks (F. E. Bureau, 2019). These various wallets and banking apps that were supported by the common platform of UPI, resulted in the wider spread of UPI (Hetavkar, 2019). The flourishment of UPI was visible in the statistics reported by the National Payments Corporation of India (NPCI). See the graph in Figure-1 below for the steep rise in UPI adoption in the dimensions including the number of live banks, the volume of transactions, and the amount.

We can see from the graph that UPI transactions grew gradually and fast over the two years post demonetization, masquerading an effect of sustainable growth of digital payments. What went unnoticed in the growth curve is the return of the cash in circulation, specifically, the ATM withdrawals representing the cash for daily transactions. The steady decline of UPI payments two years post demonetization, as seen in the figure, is not the only evidence of the uncertain future of mobile payments, as we investigate empirically, but also the rising pattern of cash withdrawals from ATMs and posing huge threat to its sustenance.

2 Motivation

November 2016 witnessed one of the biggest economic events in the history of the 21st century as the government of India introduced the demonetization of banknotes in circulation (Kumar, 2016). The policy invalidated 500 INR and 1000 INR banknotes in circulation and exchanging them for new banknotes issued by the government. The primary intent of the decision was taken to curtail the shadow economy and curb black money and unlawful transactions, but it led to both positive and negative unintended consequences (Dutta, 2018). One of the most welcome outcomes was the inevitable transformation of the economy from physical cash to digital cash amidst the unintended severe cash crisis that the policy introduced (Mehta et al., 2016). This natural experiment on the biggest democracy of the world has received widespread attention by various scholars around the world, adding to the existing literature on the digital economy, policymaking and ICT4D (e.g., Banerjee, Breza, Chandrasekhar, & Golub, 2019; Dash, 2017; Singh & Singh, 2016). Many of these studies argue that there is an increase in the adoption of mobile payment technologies pan India post demonetization (eg., Pal, Herath, De', & Rao, 2020). This also has led to the launch of several digital wallets post demonetization like Google Tez, PhonePe, Airtel money, Amazon Pay, and other mobile payment technologies introduced by other banks (F. E. Bureau, 2019). These various wallets and banking apps that were supported by the common platform of UPI, resulted in the wider spread of UPI (Hetavkar, 2019). The flourishment of UPI was visible in the statistics reported by the National Payments Corporation of India (NPCI).

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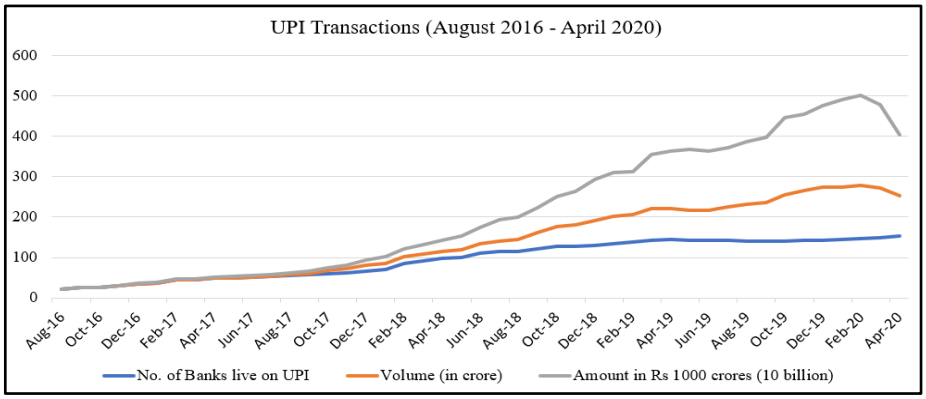

Source: National Payments Corporation of India (NPCI)

Figure-1: UPI Transaction Statistics

3 Literature

Before demonetization, mobile payment and banking research in India focused on why the adoption rates in India were insignificant although the technology had been accepted in many developing economies (Bamoriya & Singh, 2011; Srivastava & Thakur, 2013). Demonetization introduced mobile payments to the masses, as the cash crisis forced consumers and merchants to continue business through this seamless alternative mode of payment (Francisco, 2017). Several research studies have reported how this crisis turned out to be a boon for digital payments' growth (Agarwal, Basu, Ghosh, Pareek, & Zhang, 2018; Goriparthi & Tiwari, 2017; Pal, Herath, De', & Rao, 2018). Citizens reported the benefits of the new technology that went nearly unnoticed before the cash crunch (Pal et al., 2020). However, there is still a quest for knowledge to further examine the phenomenon of mobile payment spread in-depth, and specifically, answering why its growth curve keeps flattening and dropping post its rapid cross-country

diffusion. We answer this by observing the cash withdrawal patterns from ATMs through the year succeeding the phenomenal event.

Higher demand for physical cash forms a proxy for the reduction of transactions in digital payments, provided the external factors like inflation is accounted for (Arango-Arango & Suárez-Ariza, 2019). An individual's cash usage patterns changes with her or his digital payment usage (Stix, 2004), indicating a measurable drop in the amount of cash replaced with the growth in digital payment options (Humphrey, 2004). There remain various advantages of digital money including enabling convenient and seamless one-click transactions (de Kerviler, Demoulin, & Zidda, 2016; Mallat, 2007). However, studies have also identified issues with mobile payments in terms of the risks from thefts and failures, and difficult cross-platform transferability (Luo, Li, Zhang, & Shim, 2010; Wright, 2002). With other environmental and habitual effects, the demand for cash continues to rise globally (Arango-Arango & Suárez-Ariza, 2019), and particularly in India once the cash crisis started to gradually decline (Roy, 2017). This paper aims to verify this ongoing concern of the rise of cash usage and the threat of decline of digital payments.

4 Theoretical Foundation on Ripple Effect

Technology adoption has been often witnessed as unintended aftermaths like the ripple effect after crisis situations including technical, social, and financial crises and disasters (James Cater III & Beal, 2014). A ripple effect is defined as "a spreading, pervasive, and usually *unintentional* effect or influence" (Merriam-Webster Dictionary, 2020). Our first significant example includes the ERP systems' adoption as firms invested in the installation of ERPs to solve the sudden date format in their systems from 1900 to 2000, popularly called the Y2K problem (Chang, Yin, & Chou, 2008; Pliskin & Zarotski, 2000). As firms were threatened by their legacy system failures due to the sudden change in the historic date format, they chose the investment for new technology – the ERP systems (Themistocleous, Irani, & O'Keefe, 2001). This technical crisis of the Y2K problem resulted in the unanticipated diffusion of different technology. Next, we have the Arab Spring revolution creating a spark in social media usage (Bruns, Highfield, & Burgess, 2013). During the insurgency in several Arab Springs' countries between 2010 and 2012, the Twitter hashtag culture expanded, and motivated technology adoption researchers (Oh, Agrawal, & Rao, 2013; Rauniar, Rawski, Yang, & Johnson, 2014). Another example is the 1997 East Asian financial crisis triggered aggressive IT-business adoption in South Korea (Jeon, Han, & Lee, 2006; Lee, 2003). A campus shootout disaster in April 2007 on the Virginia Tech college campus led to a country-wide enhancement of the technologies for emergency procedures and response systems (Rasmussen & Johnson, 2008).

Although the crises events discussed here are disparate and of varied nature and impact, there is one common phenomenon among them – the ripple effect of crises on

technology adoption. In similar lines, we observe the ripple effect of demonetization on the adoption of digital payments. Research in technology adoption in the crisis domain has looked at the immediate rise in technology usage after the shock. However, we argue that the ripple effect would dampen over time, bringing the usage closer to pre-crisis levels as cash usage rises back to pre-demonetization normalcy.

5 Research Hypotheses

Demonetization created a severe cash crisis across India, with the shortage of acceptable new banknotes and long queues across banks and ATMs (Express, 2016). The only way to sustain transactions for daily livelihood was shifting to alternative payment options which included digital payments like debit/credit cards and mobile payment wallets (Goriparthi & Tiwari, 2017). As debit and credit card usage was limited to existing cardholders, mobile payments offered a quick installation and easy immediate payment option (Bhargava, 2017). Even local merchant and small-scale vendors started depending on mobile payments for continuing businesses in the absence of cash (M. T. Bureau, 2016). Therefore, we primarily hypothesize,

H1: *Demonetization has a ripple effect on the adoption of digital payment technologies, as seen through the sudden dip in cash withdrawals from ATM*

The adoption and diffusion of mobile payments post demonetization can, therefore, be attributed to the technology push by the crisis (Pal et al., 2018), as also seen in the crisis cases discussed above. However, as new banknotes reached the country's circulation system, citizens started reverting to the traditional cash system, often discontinuing the newly adopted mobile payments (Choudhury, 2018; Mint, 2017). The question remains if the ripple effect of the demonetization crisis on mobile payment technology continues to thrive or dampens over time. We posit,

H2: *People will gradually revert from alternative modes like mobile payments to cash as the dominant payment mode, and withdraw cash from ATMs as high as the pre-demonetization levels.*

In our study, the ripple and the dampening effect of demonetization on mobile payments are measured by dip and upsurge of ATM cash withdrawals, respectively, since cash usage can be used as a reverse proxy for digital payment diffusion (Arango-Arango & Suárez-Ariza, 2019). This analysis would throw light on technology adoption after crises or disasters, as it questions the sustenance of the technology once the shock in the environment disappears and original resources and conditions are restored. Certain technologies with greater switching costs, like the ERP system, are likely to flourish. However, individual-level IT artifacts like mobile payments or social media always have the threat of discontinuance in the absence of the shock condition that led to its adoption.

6 Research Methodology

The research methodology includes the data analysis of cash withdrawals from 100 ATMs, as discussed in this section.

6.1 Data Collection

The data for this study was provided by a very large cash management services provider in India that provides ATM management for most of the leading banks in India. The data reports daily ATM cash withdrawals in 100 ATMs spanning across 100 towns and 7 states of India for 4 years, from November 2015 to November 2019. Each ATM is a representative of the highest withdrawal outlet of a town. In order to mitigate the effect of out-of-money and technical issues impacting the daily withdrawal patterns, we aggregate the data to monthly resolution, thus having 48 observations for each ATM spanning 4 years (48 months). The data was then split into 4 different buckets-based representation 4 different years before after the day of demonetization (November 8, 2016). We have 1 year of data before demonetization as a bucket and 3 years post demonetization data as 3 different buckets, which will enable us to study the sensitivity analysis on the change in withdrawal patterns on a yearly basis. We filtered out the data from November 8, 2016, and Dec 30, 2016, because the Government of India banned the loading of ATMs with cash until the new currencies (500 INR and 2000 INR) were in circulation from Jan 2, 2017. (Refer to Table-1 for the descriptive statistics).

Table 1 . Descriptive statistics of the data

Total number of ATMs	100
Total number of Towns	100
Total number of States	7
Timeline of the data	Nov 2015 – Nov 2019
Average monthly withdrawal per ATM in INR (2015-2016)	4705741.69
Average monthly withdrawal per ATM in INR (2016-2017)	3456763.75
Average monthly withdrawal per ATM in INR (2017-2018)	4545057.87
Average monthly withdrawal per ATM in INR (2018-2019)	4410984.67

6.2 Data Analysis

Analysis of Variance (ANOVA) is a widely used statistical tool for the comparison of group means (Park, 2009). The classical one-way ANOVA is a highly influential method in confirmatory data analysis (Hesamian, 2016). For this study, ANOVA was conducted on the monthly ATM withdrawals to compare the means across 4 time periods. The analysis was further strengthened using ANCOVA, with controlling for the inflation rate and the state, to account for the external factors that could affect the cash usage measures.

7 Results

ANOVA was conducted with monthly ATM withdrawals as the dependent variable and the time-periods (4 buckets) as the independent variable. There was a significant difference in the monthly withdrawal patterns for the four time-periods [$F(3, 4896) = 47.031$, $p<0.001$], thus supporting hypothesis H1.

To strengthen the analysis further and to control for the effects of Inflation and location, a one-way ANCOVA was conducted with monthly ATM withdrawals as the dependent variable and the time-periods (4 buckets) as the independent variable, *controlling for Inflation rate and State.* We used the Inflation rates reported by the Indian Government for every year (source: data.gov.in) and the State was used to control for the locality. The ANCOVA was significant and there was a linear relationship between Inflation, State (covariates), and monthly withdrawals (dependent variable). There was a significant change in monthly withdrawals across different time-periods, controlling for Inflation and State [$F(3, 4894) = 43.551$, $p < 0.001$]. Both the covariates, Inflation and State, were significantly related to time-period [Inflation: $F(1,4894) = 30.397$, $p < 0.001$; State: $F(1,4894) = 189.406$, $p < 0.001$]. This implies that even after controlling for Inflation and State, there exists an influence of time-period (pre/post demonetization) on monthly ATM cash withdrawals, thus strengthening support for H1.

Although the ANOVA and ANCOVA results reported significant changes in monthly withdrawal patterns, it shows evidence that at least one of the time-periods differ from each other. We investigate further using post-hoc analyses to find pair-wise differences in monthly withdrawals across all the time-periods.

The sample size in each group is almost the same (12 months *100 ATM) and hence we did a Tukey HSD post-hoc analysis to estimate pair-wise comparisons of monthly withdrawals across the 4 time-periods. The results show that the mean monthly withdrawals for 2015-2016 (T1; M=4705741.69, SD=2990544.408) were significantly different from 2016-2017 (T2; M=3456763.75, SD=2665621.900, $p<0.001$). Also, the mean monthly withdrawals for 2016-2017 (T2; M=3456763.75, SD=2665621.900) was significantly different from 2017-2018 (T3; M=4545057.87, SD=3138506.664, $p<0.001$). (Please see Table-2).

However, the mean monthly withdrawals for 2017-2018 (T3; M=4545057.87, SD=3138506.664) was NOT significantly different from 2018-2019 (T4; M=4410984.67, SD=2595645.297, $p=0.659$). Also, mean monthly withdrawals for 2015-2016 (T1; M=4705741.69, SD=2990544.408) was NOT significantly different from 2018-2019 (T4; M=4410984.67, SD=2595645.297, $p=0.05$) at 95% confidence.

The results of the analyses indicate that the mean monthly cash withdrawal in T2 (the immediate year post demonetization; Nov 2016-Nov 2017) is significantly *lower* than the mean monthly cash withdrawal in T1 (pre demonetization; Nov 2015-Nov 2016); further, supporting hypothesis H1.

And, the mean monthly cash withdrawal in T3 (2 years post demonetization; Nov 2017-Nov 2018) is significantly *higher* than the mean monthly cash withdrawal in T2 (the immediate year post demonetization; Nov 2016-Nov 2017); thus, supporting hypothesis H3. And there is NO significant difference between periods T3 and T4; thus, together with supporting hypothesis H3.

To summarize, there was an immediate ripple effect reflecting *lesser* monthly withdrawals in the year post-demonetization (2016-17, M=3456763.75, SD=2665621.900) compared to the pre-demonetization time-period (2015-16, M=4705741.69, SD=2990544.408). As time progressed, gradually there is a damping effect reflecting higher monthly withdrawals from post-demonetization, raising to values closer to the pre-demonetization period (2015-16; M=4705741.69, SD=2990544.408 and 2018-19; M=4410984.67, SD=2595645.297).

Table 2. Tukey HSD Test with Monthly ATM withdrawals as Dependent Variable

				Tukey HSD Comparison of group mean differences		
Group	***N***	***Mean***	***SD***	***(1)***	***(2)***	***(3)***
2015-16(1)	*300*	*705741.69*	*2990544.41*			
2016-17(2)	200	*456763.75*	*2665621.90*	*-1248977.94****		
2017-18(3)	200	*545057.87*	*3138506.66*	*-160683.82*	*088294.12****	
2018-19(4)	*200*	*410984.67*	*2595645.29*	*-294757.03*	*54220.92****	*134073.21*
***Comments**: Hypothesis 2 supported, as (2,1); (3,2) and (4,2) are significant.*						

Note: Significance level, *p < 0.05, ** p<0.01, *** p<0.001

Table-3 presents the ANCOVA results. Refer to the figure-2 below for the plots of the ANCOVA results for the number of cash withdrawals versus the number of months post demonetization. The y-axis is monthly withdrawals in INR and the x-axis is the number of months starting 6 months prior demonetization. We could see a huge drop after 6 months (Nov 2016) when demonetization of banknotes was announced by the Government of India. Afterward, the daily monthly withdrawals decrease for a while and then slowly start to increase after 20 months, returning to old patterns. In the graph, the thick blue line represents the mean, and the shaded region represents the confidence interval of monthly withdrawals.

Table 3. ANCOVA Results with Inflation Rate and State as Covariates

Source	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	4	5.74×10^{14}	73.435	<0.001
Intercept	1	3.9×10^{14}	508.219	<0.001
Inflation Rate	1	2.37×10^{14}	30.397	<0001
State	1	1.48×10^{15}	189.406	<0001
Timeline (group: 4 years)	3	1.02×10^{15}	43.551	<0001
Error	4894	3.83×10^{15}		
Total	4900			

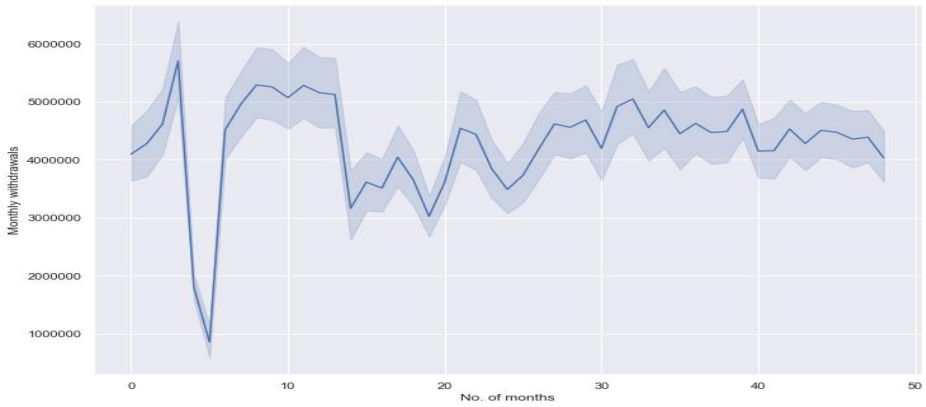

Figure 2: Plots

8 Implications

This study contributes to the two streams of literature – mobile payment diffusion, and technology adoption post-crisis. While the evidence of this study is not adequate to completely dismiss the claims of the rise in mobile payment usage in India post demonetization (Goriparthi & Tiwari, 2017; Mehta et al., 2016; Pal et al., 2020), it surely questions its future sustainability. Mobile payment and digital payment studies should once again focus on the factors beyond cash usage to understand the motivations promoting its future. On the other hand, studies on crises and technology adoption have observed and noted an upsurge in usage of certain technologies like ERP systems, social media, and security technologies, as an immediate consequence of the shock (Bruns et al., 2013; Rasmussen & Johnson, 2008; Themistocleous et al., 2001). By and large, there is a lack of focus on how these technologies sustained over time. This paper offers one of the primary studies on continued observation after an economic shock to observe if the behavioral changes were long-term or short-lived for the lingering duration of the crisis.

Policymakers and the government promoting the digital economy can gain practical lessons from this study. As many critiques have claimed a failure of the digital payment agenda through demonetization (Diplomat, 2017), we try to show with evidence why heavy cash dependence is the most dominant cause. However, like the nation, with a bulk of unorganized segment, continues to thrive on cash, it must be noted that developing nations with low digital penetration may find it difficult to depend on digital payments ecosystem requiring infrastructure like smartphone and Internet beyond the affordability of all (Ananth, 2016). It is then, that cash is the friend of the poor, not enemy.

9 Conclusion

This study aimed to analyze how well the ripple effect of demonetization cash crisis on mobile payment usage sustains, or whether it dampens over time. Cash withdrawal data across 100 ATMs used for the analysis, performed with ANCOVA statistical method. The results show the gradual restoration of cash withdrawals to the original pre-demonetization levels, questioning the strength of the ripple effect on mobile payments. Implications extend to mobile payments and technology in crisis literature, and for policymakers promoting the digital economy.

One limitation of this study is the lack of actual mobile payment usage data to verify the patterns in the cash withdrawals. However, since digital payment usage has been established as a cause for reduced demand for cash (Arango-Arango & Suárez-Ariza, 2019; Humphrey, 2004), our core assumption has theoretical support. Future research could analyze the cash withdrawal patterns with other critical transaction behaviors like mobile payment transactions, card-based POS payment statistics, and other modes of cash and digital transactions to draw a thorough picture of the payment landscape post a serious economic crisis.

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