Fintech For The Poor: Do Technological Failures Deter Financial Inclusion ? *

Padmanabhan Balasubramanian S V Ravi Chandra
Aditya Murlidharan Prasanna Tantri

April 4, 2019

*Padmanabhan Balasubramanian is from Goldman Sachs Group Inc. and can be reached at padmanabhan.balasubramanian@gmail.com. Ravi Chandra is from Indian School of Business and can be reached at ravi_chandra@isb.edu. Aditya Murlidharan (corresponding author) is from Indian School of Business and can be reached at aditya_m@isb.edu. Prasanna Tantri is also from Indian School of Business and can be reached at prasanna_tantri@isb.edu. We thank an anonymous banking correspondent aggregator for providing the data. We also thank Digital India Research Initiative (DIRI) at Indian School of Business for financial support. We thank Mohan Ramanath for help in Data collection. Any remaining errors are ours.

Fintech For The Poor: Do Technological Failures Deter Financial Inclusion ?

Abstract

We examine the impact of transaction failures on the working of a biometric enabled payment system introduced in India to facilitate banking by the poor. On an average, nearly one third of transactions fail. However, the proportion of failures decline steeply with user experience. The usage of the system, especially on the intensive margin front, increases significantly with experience. Finally, using the revealed preference framework, we find that transaction failures do not deter the users from using the biometric platform. Further tests reveal that convenience offered by technology seems to score over other conventional banking channels, despite high failure rate.

1 Introduction

The use of technology in finance, especially in high-end finance, is becoming ubiquitous. An emerging literature on fintech discusses the implications of technology on different segments of financial markets. The topics covered range from the design of block chain architecture (Cong and He (2018), Malinova and Park (2017)) to the role of fintech in P2P lending markets (de Roure, Pelizzon, and Thakor (2018)).[1] However, the impact of technology on the financial lives of the poor remains understudied. Parallely, a large and growing literature examines different ways of achieving financial literacy and financial inclusion, and their consequences (Cole, Sampson, and Zia (2011), Miller, Reichelstein, Salas, and Zia (2015), Fernandes, Lynch Jr, and Netemeyer (2014), Lusardi and Mitchell (2014), Cole, Giné, Tobacman, Topalova, Townsend, and Vickery (2013), Agarwal, Alok, Ghosh, Ghosh, Piskorski, and Seru (2017)). The use of modern technology is one such way (Bachas, Gertler, Higgins, and Seira (2018, 2017), Higgins (2018)). The use of technology brings with it the possibility of technological failure, especially when the users are not sophisticated. We study the possible impact of transaction failures caused by technological issues on the willingness of the poor to learn and continue with the formal financial system. To the best of our knowledge, the topic has not received much scholarly attention.

The plausible impact of fintech on the formal financial dealings of the poor is not clear ex-ante. It is possible that fintech improves access to banking by reducing costs through disintermediation and reduction in wastage of resources (Bachas, Gertler, Higgins, and Seira (2018)). Biometric authentication requirement may reduce frauds as well. On the other hand, most poor people live in developing countries, which do not have robust infrastructure to support fintech transactions. As well, the poor may also suffer from technophobia (Kenny (2002)). Given the above, a large portion of financial transactions carried out on fintech

[1]See Saloner and Shepard (1995), Rogoff (2015), Slemrod, Collins, Hoopes, Reck, and Sebastiani (2017), Einav, Klenow, Klopack, Levin, Levin, and Best (2017), Suri and Jack (2016), Gomber, Koch, and Siering (2017), Fuster, Plosser, Schnabl, and Vickery (2018), Riley (2018), Blumenstock, Callen, and Ghani (2018), Philippon (2016), D'Acunto, Prabhala, and Rossi (2017), Buchak, Matvos, Piskorski, and Seru (2018), Agarwal, Qian, Yeung, and Zou (2018), De Mel, McIntosh, Sheth, and Woodruff (2018) for more instances of fintech adoption and its impact.

platforms may fail. This may have the effect of driving the poor away from formal finance. Whether convenience overpowers technological and infrastructural challenges is, therefore, an empirical question.

We use the introduction of a biometric enabled payment system in banking transactions of the poor and first time bank account users in India as an economic setting. The system, known as Aadhaar Enabled Payment System (AEPS, henceforth), is based on a unique identifier provided to every citizen of India.[2] The identifier carries a number as well as biometrics (fingerprints, iris scan, and facial recognition) of an individual and hence can be used for authentication of transactions. A large number of India's poor hitherto did not have credible identification documents, which was a major roadblock for their formal financial inclusion (Mukherjee, Subramanian, and Tantri (2018)). In the year 2014, the government of India launched a massive bank account opening drive through which close to 300 million formerly unbanked citizens were provided with bank accounts.[3] However, realizing that the traditional ways of banking using cheque books and cards does not work for the first time bank account users owing to lack of familiarity, the government introduced AEPS for authenticating banking transactions.

The way the new system works is as follows. An agent of the bank, usually the local shopkeeper, known as the banking correspondent (BC), acts as a bank intermediary to the poor in villages. A person with a bank account needs to first authenticate his identity by providing his Aadhaar number and biometrics.Transactions can be performed after successful authentication. It is crucial to note that the user does not need to carry any card, document, or cheque book. Only Aadhaar number and finger prints are required. The user does not have to pay any fee for AEPS based transactions.

Using the functioning of AEPS as an economic setting, we ask the following questions. First, what proportion of transactions fail ? Second, do failures reduce as the user gains

[2]In total 1241 million Aadhaar cards have been issued so far. This is close to 96% of India's population.

[3]The bank account opening scheme was named "Pradhan Mantri Jan Dhan Yojna"(PMJDY). See Chopra, Prabhala, and Tantri (2017) and Agarwal, Alok, Ghosh, Ghosh, Piskorski, and Seru (2017) for more details about the program.

experience ? Finally, do technological failures reduce the probability of a user engaging in a voluntary transaction using the AEPS platform ?

We obtain data from a firm that acts as an aggregator of BCs. The firm recruits and manages BCs for banks. The BC network of the aggregator is spread throughout the country, although the majority of the BCs are located in the southern part of India. Our data set is at a transaction level. We have information about the nature of the transaction, the amount of the transaction, user identification using a masked id, the BC for the transaction, the mode of the transaction, the time stamp of the transaction, and most importantly, whether a transaction was successful or not. Using the information about the reasons for failure, we classify failures as biometric failures, other technical failures, and non-technical failures. Our data set spans a period of close to four years starting December 2014 and ending in December, 2018. Note that AEPS was introduced during December, 2014. We also collect information about transactions done through a newly introduced indigenous debit card named "RUPAY"card.

We start our analysis by noting that, on average, 34.03% of the transactions fail. 17.03% of failures are a result of biometric mismatch, 3.71% are due to other technical reasons and the remaining 13.3% are because of non-technical reasons. Note that non biometric technical failures include failures such as bank system failures, internet connectivity issues, among others. Non technical failures include typical banking failures such as lack of sufficient balance, invalid amount entered, etc. When we modify the definition of failure to count repeated attempts of a single transaction as one failure, the overall failure rate drops to 31.29%, biometric failure rate to 15.28%, technical failure rate to 3.47% and other non-technical failure rate to 12.55%. To answer the first question: the failure rate is indeed high.

We next ask whether failure rate goes down with users' experience. To this end, we divide the sample into quarterly user-ages. Univariate analysis reveals that the overall failure rate declines from **36%** during the first age-quarter of the user to**19%** during the tenth. Both biometric and non-technical failures decline with age. However, expectedly and reassuringly,

other technical failures, which are exogenous to the user, do not change much with experience.

We then test the association between user experience and failure using a regression framework. Following Chopra, Prabhala, and Tantri (2017), we organize the data at a user-quarter-age level and test whether the failure rate in any age quarter t is lower than the failure rate in all previous age quarters starting from age-quarter 1 to age-quarter $t-1$. With a view to induce sufficient variation within calender time, following Chopra, Prabhala, and Tantri (2017), we limit the analysis to ten age quarters.[4] We estimate nine separate regressions. While the first regression compares the failure rate between age-quarter two and age-quarter one, the last one compares the failure rate between age-quarter ten and the average failure rate in the first nine quarters. We include user fixed effects and hence account for time invariant user level factors. It is crucial to note that at any time, different users will be assigned to different age-quarters based on their respective starting points, inducing within calender time variation. Therefore, an age-quarter does not represent a particular season or a month for all cases.

We find that failure rate declines significantly with users' experience. Note that with every passing age-quarter, the failure rate declines. For example, the failure rate in age-quarter three is 3.7% lower than the failure rate in the first two quarters. Similarly, the failure rate in the tenth quarter-age is 5.6% lower than the failure rate in the first nine quarters. Even when we look at deposit and withdrawal failures separately, we find a clear learning effect. We then calculate the failure rate using the Rupee value of transactions (intensive margin) instead of number of transactions (extensive margin). We find similar results as before.

To account for survivorship bias, we perform two additional tests. First, we test whether drop out rate increases with age. Although there is a slight increase in drop out rates in age-quarter 2 and age-quarter 3, it stabilizes afterwards. The failure rate, on the other hand, continues to decline until the end. Second, for quarter-ages when a user is inactive, we use the failure rate of the immediately preceding quarter-age when the user was active. In other

[4]beyond 10 quarters, data gets limited only to initial entrants into the system.

words, we assume zero learning. Our results go through even after this modification. Given these results, survivorship bias is unlikely to explain our results.

What explains the reduction of technical and biometric failures with user experience ? The extant meta analysis on financial inclusion has shown that just in time learning by doing is probably the best way to achieve sustainable financial inclusion (Fernandes, Lynch Jr, and Netemeyer (2014), Miller, Reichelstein, Salas, and Zia (2015)). Our field visits and discussions with BCs and users reveal that with experience users figure out the way of keying in numbers and swiping the fingers. They also learn that some fingers work better than the others and the fact that keeping the fingers dry and clean helps. In addition, there could be exact locations and times of the day during which the connectivity is better. Finally, they also start first inquiring with the BC and other users about the state of bank systems on the day when they plan to transact. As far as non-technical failures such as lack of sufficient funds etc., it is easy to see learning playing out with time.

In the second part of the paper, we use the revealed preference approach to test whether high level of transactions failures lead to users opting out of AEPS. To this end, we compare a user's probability of engaging in a subsequent transaction, within a short time span, after a failed transaction and the same after a successful transaction. To avoid the possibility of repeated attempts after a failed transaction mechanically influencing our results, we leave out all subsequent transactions in a day after a particular transaction fails. In other words, we count the future activity window from the next day of a transaction, ignoring all transactions done on the same day after the transaction under consideration. Further, in different specifications, we consider only those transactions as subsequent transactions, which are not of the same type as the transaction under consideration. For instance, if the current transaction is say a deposit transaction, then we consider only the next withdrawal transaction as a subsequent transaction. We do this to avoid the mechanical impact stemming from users attempting to redo a failed transaction during their next visit to the BC. Finally, we consider only a cash deposit transaction as a subsequent transaction. This is because a cash deposit using the BC channel is completely voluntary.

As alluded to above, if transaction failures deter users, then we expect to find a lower tendency to engage in subsequent transactions, as measured by the three measures described above, after a failed transaction than after a successful transaction. We do not expect to find any difference in case, by revealed preference, if users still prefer the AEPS channel even after a failure. We find the later result. Our results hold up to a number robustness checks such as varying the length of subsequent period within which the future transaction is measured, weighting transactions by their Rupee value, and considering more than one failures. The results largely remain unchanged. The results are similar even we examine RUPAY card transactions.

Our results need to be interpreted with some caution. We do not claim that the users are not at all impacted by transaction failures. It is reasonable to assume that transaction failures, especially when the transaction is crucial or attempted during busy seasons, impose considerable hardships on the poor. However, our revealed preference results show that the difficulties faced by the poor because of transaction failures in AEPS must be lower than the difficulties faced while using the alternative means such as visiting the bank branch or dealing with the informal banking economy prevalent in villages (Hoff and Stiglitz (1998)). Note that a visit to a bank branch may possibly consume the entire working day of a poor person and also that transactions may fail there too, albeit at a lower rate. In fact, Bachas, Gertler, Higgins, and Seira (2018) show that the use of debit cards in Mexico led to significant savings in terms of time and resources for the poor. Note also that dealing with the informal economy and keeping cash have their own well known problems (Ashraf, Karlan, and Yin (2006), Banerjee and Duflo (2007), Rogoff (2015)).

We perform two more tests to examine the convenience argument. First, we find that close to 60% of AEPS transactions and close to two thirds of RUPAY transactions are executed during either non banking hours of a working day or during banking holidays. It is clear that users would have had to make difficult choice between working and going to the bank if they had to rely on traditional banking for these transactions. Second, we also find that activity levels of the users is positively related to the distance between the location

of BC and nearest bank branch. In other words, users dealing with BCs located in remote locations not having banking facilities are the most active. Both the above results help us explain the revealed preference results using the convenience argument.

We contribute to the growing literature that examines the impact of modern technology on finance (Biais, Bisiere, Bouvard, and Casamatta (2018), Foley, Karlsen, and Putniņš (2018), Tang (2018), Buchak, Matvos, Piskorski, and Seru (2018), Philippon (2016), Higgins (2018)). Our paper differs from the existing papers with respect to the technology being studied, the constituents studied, and also in its emphasis on the impact of transaction failures. We also contribute to the large literature on formal financial inclusion and financial literacy (Miller, Reichelstein, Salas, and Zia (2015), Behrman, Mitchell, Soo, and Bravo (2012), Lusardi, Michaud, and Mitchell (2017), Cole (2009), Drexler, Fischer, and Schoar (2014), Brown, Grigsby, Van Der Klaauw, Wen, and Zafar (2016), Skimmyhorn (2016)). The intervention, we study is close to "just in time"financial literacy suggested by (Fernandes, Lynch Jr, and Netemeyer (2014)). We find that such an approach leads to increased usage and reduced failure over time. Finally, we also contribute to the growing literature that studies the impact of technology on the economic lives of the poor (Bachas, Gertler, Higgins, and Seira (2018, 2017), Muralidharan, Niehaus, and Sukhtankar (2016), Banerjee, Duflo, Imbert, Mathew, and Pande (2014)).

2 Institutional Background

2.1

Aadhaar is the largest digital identity initiative in the world. Aadhaar number is a 12-digit random number issued by the government of India to all residents of India. The Unique Identification Authority of India (UIDAI), which is a statutory authority established under the provisions of the Aadhaar (Targeted Delivery of Financial and Other Subsidies, Benefits

and Services) Act, 2016, is entrusted with the task of issuing and managing Aadhaar.[5]

Any resident of India may voluntarily obtain a unique identification number. A person willing to enrol has to provide minimal demographic and biometric information during the enrolment process. Demographic information required include name, date of birth, gender, and address. Details such as phone number and email id are optional. Biometric information includes ten fingerprints, two iris scans, and facial photograph. Enrollment camps are regularly held in towns and villages. There is no charge for enrollment.

Aadhaar number is verifiable online. Since the number is unique and has biometric identification, it has the potential to eliminate duplicates and fake identities. The government has started using Aadhaar as a primary identifier to roll out several welfare schemes and programs. Lack of credible identification documents is one of the biggest hurdles the poor face while dealing with formal financial institutions (**?**). Aadhaar has the potential to solve this problem. The government has launched a major drive to seed all bank accounts in the country with Aadhaar. It is crucial to note that Aadhaar number is devoid of any intelligence and does not profile people based on caste, religion, income, health, and geography. Neither does it confer any citizenship rights. It is only a proof of identity.

2.2 Financial Inclusion

Despite a wave of nationalization of banks (See Cole (2009) for details about nationalization of banks), close to 50% of Indians did not have a bank account until the year 2014 (Chopra, Prabhala, and Tantri (2017)). With the goal of 100% financial inclusion, the government of India launched the Prime Minister Jan Dhan Yojna (PMJDY) program in the year 2014. Close to 350 million bank accounts have been opened under the initiative (Agarwal, Alok, Ghosh, Ghosh, Piskorski, and Seru (2017)).[6] The government soon realized that the active

[5]The Aadhaar Act 2016, makes UIDAI responsible for Aadhaar enrollment and authentication. UIDAI is also responsible for (i) operation and management of all stages of Aadhaar life cycle; (ii) developing the policy, procedure and system for issuing Aadhaar numbers to individuals; (iii) performing authentication; and (iv) requiring to ensure the security of identity information and authentication records of individuals.

[6]Source: https://pmjdy.gov.in/

use of these accounts faced two hurdles. First, traveling all the way to a bank branch located in the nearby town or in village headquarters was not feasible to the poor who survive on daily wages. Second, most poor people did not possess credible identification documents for authenticating transactions and were also not comfortable with traditional banking technology involving cheque books and debit/credit cards. In response, the government established the business correspondent network and also promoted the use of Aadhaar for financial inclusion.

2.2.1 Business Correspondent

Business Correspondents (BC) are retail agents appointed by banks for the purpose of providing basic banking services at locations that are not serviced by bank branches or ATMs. BCs are typically individuals having a permanent base in a village. Most common profiles of BCs include local shopkeepers, retired bankers, ex-servicemen, agents of government small saving schemes, among others. The intention of the government is to address the last mile delivery problem. BCs are allowed to perform basic banking functions such as opening bank accounts, collecting deposits, transfer of funds using network, facilitation of withdrawals, collection of small value loans, and selling third party products. The bank provides necessary technological infrastructure for BCs to operate. BC's are paid fee on number and value of successful transactions.

Banks found it difficult to deal with large number of atomistic BCs. This lead to the creation of intermediaries, such as our data provider, between banks and BCs. We call such intermediaries as BC aggregators. BC aggregators are mid sized firms that appoint and manage BCs for banks. They also maintain data relating to transactions done by the BCs.

2.2.2 AEPS

Before the advent of Aadhaar, BCs used to operate using traditional banking tools such as cheques and pay in slips. Some banks developed their own smart cards to be used for

customer identification and authentication. Need for a universal biometric enabled identifier was felt as the first time users of banking services found the existing instruments cumbersome to use.

The government of India introduced the AEPS starting from December, 2015. As a first step, the UIDAI, working with banks, developed the Aadhaar Payments Bridge (APB). APB is a repository of Aadhaar number of residents and their primary bank account number used. Next, all BCs were provided with AEPS equipments (called the micro ATM devices) that allowed the matching of user biometrics and the number. Photographs of micro ATM devices used by the BCs are depicted in figure A.1 to A.4 of the online appendix.

Under the AEPS, a typical transaction is executed as follows. First, the user provides his Aadhaar number, details of financial transaction sought and biometrics to the micro ATM device maintained by the BC. Second, digitally signed and encrypted data packets are transferred via bank switch[7] to UIDAI. This process is intermediated by National Payments Corporation of India (NPCI).[8] Third, UIDAI processes the authentication request and communicates the outcome in the form of Yes/No. In other words, UIDAI checks whether the Aadhaar number and biometrics match. They do not provide or seek any other information. Finally, if the authentication response is positive, the concerned bank executes the requested transaction. If not, the transaction is recorded as a failure.

Figure 6 depicts data about the number and the value of transactions done using AEPS platform nationally in Panel A and in our sample in Panel B. It is clear that there has been an exponential rise in the usage of AEPS with time.

[7]A networking device which connects computers in a network and helps in receiving forwarding and sending data to a destination device

[8]National Payments Corporation of India (NPCI), an umbrella organisation for operating retail payments and settlement systems in India. It is an initiative of Reserve Bank of India (RBI) and Indian Banks' Association (IBA). NPCI aims to create a robust payment and settlement infrastructure in India.

2.2.3 Rupay Card

The micro ATMs allow the use of debit cards as well. The government launched a low cost indigenous card known as the Rupay card. Rupay cards are managed by the NPCI. They work like any other normal debit card. PMJDY account holders are given Rupay cards at the time of account opening. The card gives the users the option of switching to traditional way of banking in case AEPS does not work. However, the users will have to carry the card physically and also remember the secret code (PIN). Sharing of PIN may lead to misuse and fraud. Such a possibility is lower in AEPS as both Aadhaar number and biometrics should match for a successful AEPS transaction.

3 Data And Summary Statistics

We obtain the transaction level data used in this study from one of the largest banking correspondent aggregators in the country. As explained in Section 2.2.1, the data provider acts as an intermediary between the bank and BCs. They engage with 3 banks and have BCs in 14 states of India. In figure 1, we highlight the regions where the BCs affiliated to the data provider are located. Most of the BCs are located in the southern part of the country. In our data set, we have data relating to transactions executed through BCs located in other parts of the country as well. We have data relating to all transactions done by all BCs working with the data provider. The data spans a period between December, 2014 to December, 2018. We start the sample period from December, 2014 as AEPS was introduced then. In total, we have data from 2,416 BCs located in 779 distinct villages as identified by their unique PIN codes.

The data are organized at a transaction level. Each line of data contains information about the transaction type, the transaction amount, a masked identity number of the person transacting, the type of instrument used for the transaction, identity of the BC executing the transaction, whether the transaction is successful or not and, if not, the error message

displayed. The transaction type column tells us the nature of the transaction. The most common transaction types are deposits and withdrawals, which account for more than two thirds of total transactions. Other types include balance enquiry, request for mini statements, request for ATM PIN, etc. The instrument here refers to the channel used for transaction. It can be either AEPS or Rupay Card. The data provider has given us masked identity instrument wise and not person wise. Therefore, we are not able to identify separately persons using multiple cards. We treat each masked identity number as a person. Finally, the error message clearly describes the reason for failure. The error messages range from "biometric failure" to "insufficient funds". We present the type of error messages in Table A.1 presented in the online appendix.

We present the sample construction details in Table 1. In total, our data set contains 9,049,389 transactions executed by 1,012,735 users. Out of this 9,17,696 are AEPS users. More than two thirds of the transactions are either deposits or withdrawals. The number of deposit transactions (1,149,842) is lower than the number of withdrawal transactions (4,753,319). The transaction data are drawn from 3 banks. Out of this, bank C is a government owned bank and accounts for slightly more than 98% of all transactions. The other two banks are old private sector banks.

Out of a total of 9,049,389 transactions 7,191,068 are executed using AEPS. The introduction of AEPS coincided with proliferation of direct benefit transfer. Not surprisingly, therefore, the number of withdrawal transactions (3,711,140) is close to three times the number of deposit transactions (792,237). A substantial number (2,570,656) are balance enquiry transactions. The distribution of transactions using the Rupay card is almost the same as the distribution of AEPS transactions. The total number of Rupay card transactions is 1,858,321 out of which 357,605 are deposit transactions, 1,042,179 are withdrawal transactions and the rest are other types of transactions.

3.1 Transaction Amount

We present summary statistics relating to transaction amount in Panels A and B of Table 2. In Panel A(B), we present the summary for successful (failed) transactions. In the first row of both the panels, we present summary for all transactions and in row 2 (3), we present the details regarding withdrawals (deposits). The average value of successful (failed) transactions is Rupees. 1523.66 (1395.67) whereas the standard deviation of successful (failed) transactions is Rupees.2538.51(3022.56). Within Rupay transactions, failed and successful transactions do not differ much in terms of transaction value.

3.2 Summary of Failures

We present summary statistics relating to failures in Table 3. We cover all types of failures, namely biometric failures, technical failures and non-technical failures. In row one, notice that the overall failure rate (34.03%) of AEPS transactions which is large. There is not much difference between the failure rate of withdrawals (33.93%) and that of deposits (32.17%). In row two, the overall failure rate of RUPAY (18.81%) is substantially lower than the the sample average. As in the case of AEPS, the difference between failure rate of withdrawals (19.68%) and deposits (14.87%) is relatively small.

We examine the three types of failures, namely biometric, technical and non-technical failures, separately. We notice that 17.03% of AEPS transactions fail due to biometric mismatch. The failure rate is 17.31% for withdrawals and 15.27% for deposits. Since RUPAY cards do not involve biometric authentication, the biometric failure rate, is expectedly zero. The overall level of technical failures is much lower than biometric failures under both the systems. Last section of the table presents statistics relating to non technical failures. Even these failures are substantial at 13.3% for AEPS and 12.84% for RUPAY cards.

3.2.1 Modified Failure

With a view to avoid over counting of several attempts of a single transactions as many failures, we create a new variable called modified failure. Under the modified definition of failure, a transaction is considered a failure only if it does not eventually succeed within the same day. Also repeated attempts of the same transaction on the same day that eventually do not succeed are considered as a single failure; for example, if a user makes five attempts in a day to deposit and eventually succeeds, then the entire set of six transactions are considered as a success and counted as one transaction and given the Rupee value of successful transaction. If, on the other day, the user is unable to make a successful deposit transaction on that date despite those six attempts, then the six failures are considered as one failed transaction as all the failures are related to one transaction. The modified failure variable is likely to provide a more realistic picture of failures. However, from the point of view of conservatism, we continue to use transaction wise definition of failure, where each attempt is treated as a separate failure, in our main tests.

In Table A.2, we report the summary statistics relating to failures using the modified failure rate. We find that the modified failure rate is close to 31.29% for AEPS. Biometric and technical failures average close to 19%. Non technical failures average close to 13%. As before, RUPAY card failures are substantially lower due to absence of biometric failures.

4 Learning With Experience

Failure rate of close to 35% sounds alarming to start with. However, it is important to note that most of the users are being exposed to both banking as well as technology for the first time. Therefore, two questions become critical at this stage. First, whether users learn from experience ? Second, whether users continue to use BC services despite failures ?

4.1 Learning with experience-Failure Rate

Many failures such as keying in incorrect numbers or pressing wrong buttons, could be a result of lack of experience in dealing with equipments. This applies to biometric failures as well. As noted in Section 2.1, Aadhaar captures impressions from all ten fingers. It is possible that chances of a successful match are higher when a particular finger is used. In addition, it is possible that the chances of biometric match go down immediately after heavy manual labor or when the fingers are wet or when there is high level of moisture in the air. The users are likely to learn about using equipments with experience. In such a case, the failure rate is likely to decrease with experience. On the other hand, if users remain averse to technology and do not attempt to learn, then failure rate may not improve with experience.

4.1.1 Summary evidence For Users

In figure 3, we depict the failure rate of AEPS transactions with user experience. We detect a steep learning curve as shown by the downward sloping failure rate curve. The failure rate falls from about 35% in quarter 1 to about 20% in quarter 10. We detect a similar learning with experience effect with respect to biometric and non-technical failures. Expectedly and reassuringly from a data sanctity point of view, technical failures do not vary significantly with user age.

In figure A.5 presented in the online appendix, we depict failure rate of RUPAY transactions with user experience. The pattern here is directionally similar to the one seen in earlier graphs.

From the above discussion it appears that a significant proportion of failures under AEPS and RUPAY are a result of customer inexperience, and hence, decrease with user experience. Therefore, it is reasonable to expect failure rate to come down with time.

4.1.2 Transactions Failure With User Experience- Regression Based Evidence

Figures 3 clearly show that failure rates decline with experience of the user. We test the above summary findings using a regression framework. We estimate the following regression equation.

$$Failure_{\text{it}} = \alpha + \beta_1 \times \text{Last Quarter}_t + \beta_2 * X_{it} + \gamma_{it} + \epsilon_{it} \quad (1)$$

Each observation is organized at a user i quarter age t level. From the point of view of having sufficient within time variation and geographical spread, we limit the analysis to 10 full quarters although we have data for 16 quarters for some districts. This is because beyond ten quarters. Note that our data covers 779 villages. It took more than a year for AEPS to be launched in all 779 villages.

We estimate ten regression equations. In each regression, we compare the proportion of failure in a quarter-age t with the proportion of failure in all quarters starting from quarter-age 1 and ending in quarter-age $t-1$. Here, $LastQuarter_t$ refers to a dummy variable that takes the value of one for the t^{th} quarter. For example, the first regression compares the proportion of failure during the second quarter-age with the the proportion of failure of the first quarter-age. Similarly, the second regression compares the the proportion of failure of the third quarter-age with the proportion of failure of the first two quarter-ages. In this particular case, $LastQuarter_t$ refers to the 3^{rd} quarter. We also employ user level fixed effects.

A positive (negative) coefficient of $LastQuarter_t$ would mean that the failure proportion in quarter-age t is higher (lower) when compared to the failure proportion in quarter ages from quarter-age 1 to quarter age $t-1$. Increase in the economic magnitude in successive regressions would indicate an increasing rate of change.

Results For AEPS:

We start with AEPS transactions. We report the results in Table 4. In column 1 (4), we report the results for number (value) of failed transactions as a proportion of number (value) of total transactions. As shown in the table, the proportion of failures, both in terms of numbers and value, continuously decrease with user experience. For example, the proportion of failures in terms of numbers (value) during quarter-age 2 is lower by 3.1% (1.9%) when compared to the same in quarter-age 1. In fact, the decline in the proportion of failures shows a positive acceleration until quarter-age 8, where the decline in proportion of failures in terms of numbers (value) reaches 8.5% (11.7%). The rate of decline stabilizes after quarter-age eight but maintains its direction. Even at the end of quarter-age ten, the decline in failure proportion in terms of numbers (value) is as high as 5.6% (7.3%). High single digit rate of decline in failure rate when measured using number of transactions and a close to double digit decline when measured in terms of value of transactions suggests that account holders, who are probably undertaking banking and digital transactions for the first time in their life, learn quickly.

In columns 2 and 5, we report the results for the number (value) of failed deposit transactions as a proportion of number (value) of total deposit transactions, and in columns 3 and 6, we report the results for the number (value) of failed withdrawal transactions as a proportion of number (value) of total withdrawal transactions. The trend of declining failures with experience remains intact here as well.

Results For Rupay: In Table A.3 presented in the online appendix, we present the failure with experience results for RUPAY card transactions. The organization of the table mimics the organization of Table 4. As shown in column 4, when measured in terms of the value of failed transactions to total value of transactions, the proportion of failure declines continuously with time. For example, at the end of the 9th age-quarter, the proportion of failures is lower by 4.8% when compared to the same proportion in the first eight quarters.The general trend of decline is visible even when we measure failures in terms of number of transactions in column 1. As can be seen, the co-efficient is negative in all nine regressions. However, it is not statistically significant in two out of ten cases. The trend is broadly similar

even when we look at deposits and withdrawals separately in columns 2 and 3 (in terms of number of transactions), and in columns 5, and 6 (in terms of value).

4.1.3 Learning or Inactive Users ?

There could be a concern that our results showing that failure rate comes down with age suffers from survivorship bias. It is possible that a large number of users, who are either non learners or slow learners, stop transacting after their initial experience. In other words, only those who are quick learners continue transacting and hence learning with age is almost mechanically expected. It is important to note that we include fixed effects at the user level. Thus, the comparison is within a user. Nevertheless, we test whether drop-out rate increases with user experience.

We conduct two tests to rule out survivorship bias impacting our results. First, we test whether it is indeed the case that users show a higher tendency to be inactive with experience. We estimate regression equations similar to equation 1. The outcome variable is a dummy variable that takes the value of one if the user under consideration does not do any transaction during the age-quarter under consideration and zero otherwise. As in Section 4.1.2, we estimate 9 regression equations; each equation comparing the level of the outcome variable in an age-quarter with the level in all preceding age-quarters. A positive (negative) coefficient would indicate that the probability of a user remaining inactive in an age-quarter is higher (lower) when compared to the same in previous age-quarters.

The results are presented in Table 5. As shown in the table, the probability of a user remaining inactive is indeed higher in the second age-quarter when compared to the first age-quarter by 32.5%. As shown in the second row, even when we compare the third quarter with the first two quarters, we find a similar result. The probability of being inactive in the third age-quarter is higher by 9.3% when compared to the average level in the first two age-quarters. However, the trend reverses starting from the third regression. We find that the probability of a user remaining inactive is lower by 1.8% in the fourth age-quarter when compared to the first three age-quarters. Similarly, the fourth, fifth, sixth seventh eighth

and nineth regressions which compare the probability of being inactive in each subsequent age-quarters when compared to previous age-quarters produce negative coefficients with magnitudes 4.5%, 13.3%, 16.6%, 23.6%, 4.5% and 23.6% respectively.

It is important to note that, as shown in Table 4, the proportion of failures decrease continuously from the first age-quarter till the last age-quarter in the sample. On the other hand, increase in the probability of being inactive is seen only in the first two quarters. After that, as described above, failure rate declines despite a decline in drop outs. Therefore, the decline in failure rate cannot be attributed to users dropping out. For instance, in age-quarter 10, the probability of a person being inactive declines by 23.6% when compared to the average for the first nine quarters and, at the same time, the failure rate also declines by 5.6%.

In Table A.4 presented in the online appendix, we present the results for Rupay card transactions. The results for Rupay card are similar to the results presented in Table 5, both in terms of direction and magnitude.

4.1.4 Tackling Survivorship by freezing failure rate

Probing further on the possible survivorship bias angle, we combine a thought experiment with our empirical analysis. Note that in Section 4.1.3, we find that dropouts decline with time. However, there could always be a concern regarding the type of users who drop out.Therefore, it is not clear what would have happened if they had continued.

To address this concern, we make an extreme assumption that users who drop out would have experienced zero learning. The assumption goes against finding any learning effect. Operationally, we assume that a user who does not transact in an age-quarter is likely to have the same failure rate as he/she had in his last age-quarter when he/she transacted. For example: take a case where a user transacts in age-quarter 2 with a failure rate of 30% but does not transact in age quarters 3 and 4. In this case, we assume zero learning and consider 30% as the failure rate for age-quarters 3 and 4. If the user actually transacts during

age-quarter 5, then we use the actual failure rate for that quarter.

We estimate the regression equation 1 after making the above adjustment. We report the results in Table 6. The results are directionally similar to the results presented in Table 4: failure rate continuously declines with user experience. However, owing to the assumption of no learning of drop outs, the magnitude of decline in failure is expectedly lower in the initial phase.

4.1.5 Using Modified Failure Rate

We test the learning effect using the modified failure rate. We present the results in Table A.5 , which mimics the organization of Table 4. Here too, we detect a pattern of decline in failure rate with user experience. Table A.6 replicates Table A.5 for rupay card transaction and finds similar results in terms of magnitude and direction.

5 Transaction Failures and Drop Outs-Revealed Preference

We next proceed to test the impact of transaction failures on the users. If the cost of failures is higher than the convenience brought about by the BC channel, then the users may reduce voluntary activity using the BC channel after facing failures. Here the cost of failure could range from loss of time and efforts to severe liquidity issues due to inability to withdraw funds when required. Think of a situation where a farmer has to repay a high interest rate loan to a moneylender and he/she is unable to withdraw funds remitted to his account by his relatives. It is conceivable that such a farmer may stop using the BC channel for voluntary activity after such an experience in future.

If, on the other hand, the benefits of using the BC channel outweigh the costs or if the users consider failures as a learning experience, then failures are unlikely to deter voluntary activity. The most important benefit arising from the BC channel is that the user need not

travel all the way to the bank and wait for for hours for a banking transaction. Rural Banks in India are usually crowded and hence, it takes hours for a transaction to get completed (Chopra, Prabhala, and Tantri (2017)). Banks operate for limited hours during the day. The BC on the other hand is located in a village and is also likely to have flexible working hours. Therefore, it is conceivable that users may continue using the services of a BC despite transaction failures.

We test whether a user is less likely to do a voluntary transaction within a fixed time frame after a failed transaction when compared to a successful transaction. It is important to emphasize on voluntary transactions here. Otherwise, mechanically, it is possible that a person facing failures may attempt to do the same transaction in future, and hence, it may appear that a failure leads to higher transactions when compared to success.

We address this concern in three ways.First, for ascertaining future activity, we exclude the entire failed transaction category. For instance, if an attempted deposit transaction fails, then we consider a person to be active only if he/she does a deposit transaction.Also, we do not consider positive transactions such as balnce enquiry, mini statements etc. This rules out the possibility of our results being mechanically driven by repeated attempts. Second, we start counting the window for future transactions starting from the day following a transaction. Suppose a transaction fails on say 14th of October, 2016, our time window to test whether the user comes back to the BC channel starts from the 15th of October. In other words, repeated attempts made on the same day are not counted. Finally, as the most strongest specification we consider only cash deposits as future activity. A person to be considered active should do a cash deposit after any transaction. Note that cash deposits are absolutely voluntary. No rule of government forces users to deposit cash using the AEPS channel. A user who distrusts the BC or treats the BC channel as cumbersome, has the option of keeping the cash at home or using the nearby bank branch. Usage of BC channel despite failure is likely to be a sign of confidence in the BC channel.

We estimate the following regression equation.

$$\begin{aligned} Y_{\text{it}} &= \alpha + \beta_1 \times \text{Failure}_{it} + \beta_2 * \text{User Experience}_{it} + \beta_3 * \text{BC Experience}_{it} + \\ & \beta_5 * \gamma_i + \beta_8 * \theta_t + \epsilon_{it} \end{aligned} \tag{2}$$

The data are organized at a transaction level. The dependent variable is a dummy variable that takes the value of one if a user engages in a second transaction within a specified time limit from the date of the transaction under consideration. The main explanatory variable-Failure-is a dummy variable that takes the value of one if the transaction under consideration fails and zero otherwise. We control for both BC experience and user experience as on the date of a transaction. We include transaction amount as an explanatory variable. We interact the the amount variable with the failure dummy to test whether the response differs with the amount of the transaction. Finally, we include fixed effects at the user and year month level.

We present the results separately for AEPS and Rupay Card. In Table 7 considers only AEPS transactions. The main dependent variable takes three forms in different specifications. In columns 1, 4, and 7, the dependent variable takes the value of 1, if the user engages in any transaction starting from the next day (t+1) of transaction under consideration and ending on 91st (t+91) day after the transaction. As noted before, because we start from t+1, the measure is not affected by repeated attempts on the same day. However, it is possible that the user attempts the failed transaction the next day. In such a case the above measure will mechanically show higher activity after failure. To account for such a possibility, we define a second measure of activity in columns 2, 5, and 8. Here, a user is considered active only if he/she performs any other category of transactions other than the failed transaction within the interval of t+1 to t+91. In other words, if the transaction under consideration, done on day t, is a deposit, then only withdrawal transaction done between days t+1 and t+91 is considered. Similarly if a transaction is a balance enquiry or a ministatent then it will count both deposit and withdrawal transaction done between days t+1 and t+91.This

measure rules out the mechanical effect from the same transaction being tried the next day. Finally, for the purposes of columns 3, 6 and 9, we consider a user to be active only if he/she deposits cash within an interval of t+1 and t+90. As explained before, cash deposits are purely voluntary and the user has the option of not using the BC channel if he/she finds transaction failures to be costly. In columns 4, 5, and 6, we include other transaction level control variables. In columns 1, 2, and 3, we include user level and time fixed effects. We cluster the errors at BC level and adjust for heteroskedaticity.

In columns 1, 2 and 3, the main explanatory variable takes the value of one if the transaction under consideration fails because of biometric mismatch and zero for successful transactions. Here, we exclude transactions that fail for other two reasons as the purpose is to test the users' reaction to biometric failure when compared to success. As evident from the table, we find that, from an economic significance point of view, a transaction failure does not significantly impact the probability of a user doing either any transaction, transaction other than failed transaction or a cash deposit. For example; column 1 shows that there is 0.1% higher probability of a user engaging in an active transaction after a failure when compared to success. Column 2 (3) shows that there is a 0.5% (0.2%) higher (lower) probability of a user engaging in an active transaction after a biometric failure when compared to success. None of these results are significant either from an economic point of view or from a statistical point of view. The results do not change much even when we include other control variables. Interestingly, unlike in the case of failures, there is no significant incremental change with respect to either user experience or BC experience. The results indicate that users' willingness to engage with the BC channel is not impacted by failure.

Next, we examine the reaction to technical (in columns 4, 5 and 6) and non-technical failures (in columns 7, 8 and 9). In other words, the explanatory variable takes the value of one for technical failures (non-technical failures) in columns 4, 5 and 6 (7, 8 and 9) and zero otherwise. As before, we exclude other type of failures other than the type under consideration so that the comparison is between failed and succesful transactions. The results

broadly remain unchanged. As before, the economic magnitude of the difference is too small to make an impact. Therefore, from an economic significance perspective, the probability of a new active transaction being performed does not differ much between failed and successful transactions. Finally, in Table 8, we weigh the transactions using transaction amounts. The results remain largely unchanged.

5.1 Rupay

In Table A.7 and Table A.8 presented in the online appendix, we consider Rupay card transactions. The arrangement of panels, rows and columns mimics the arrangement made in Table 7 and 8. We find that Rupay card failures do not significantly impact the probability of a future active transactions within the next 90 days.

5.2 Success After Failure

Although economically small, some of the co-efficients of interest in Table 7 and 8 are positive. This shows that a probability of a user doing a second transaction within an interval of 90 days from the date of a transaction is slightly higher after a failure when compared to success. While the result is helpful in ruling out the possibility that users stop using an instrument after failure, the positive and significant coefficient needs further probing. It cannot be that users prefer failure or obtain higher utility from a failed transaction.

We estimate a regression equation similar to regression equation 2. We modify the dependent variable slightly; it takes the value of one only if a user performs a successful transaction within an interval of $t + 1$ to $t + 90$, otherwise, it takes the value of zero. All other details remain unchanged. We report the results in Table 9. We consider AEPS transactions and consider specific types of failures. In columns 2, 4 and 6, we consider the value of a transaction. In other words, we multiply the failure dummy with the value of the transaction. As shown in the table, we consistently find that the probability of executing a successful transaction is higher after a failure when compared to success. The economic

magnitude ranges between 0.6% to 2%. However, when we consider the value of failed transaction, we do not find any significant difference. Table A.9 presented in the online appendix presents similar results for the Rupay Card.

Note that the results cannot be explained by some sort of mean reversion where a failed transaction is mechanically followed by a successful transaction. As noted before, we start counting the future activity window from day $t+1$ and hence, any repeated attempts on the same day are not considered as activities. A second possibility is that the BC takes extra care of those users who have experienced failure during their previous visit and ensures that they face minimum failures. Extra care could range from noting the right finger that works to providing good network connectivity. However, given the data limitations, we cannot test this possibility directly.

5.3 Multiple Failures

Next, we examine if consecutive multiple failures lead to user inactivity in the future. To this end, we introduce additional regressors to equation 2. Two failures is a dummy variable that takes the value of one if two consecutive transaction, that is the transaction under consideration and the immediately preceding transaction, both fail and zero otherwise.[9] Similarly, the variable three failures represents three consecutive failure and so on. The dummy $morethanfive$ takes the value of one if the user faces more than 5 successive failures and zero otherwise. At this stage, it must be noted that very few users face consecutive failures. As shown in Figure 4, the proportion of users facing two consecutive failures at least once is 6%. The proportion keeps declining with increase in the number of failures. The number of users facing more than five consecutive failures is less than 1%.

We present the results in Table 10. The organization of the table exactly mimics the organization of Table 7 except for additional regressors. As before, we categorize failures into all, biometric, technical and non-technical and test if any of these failures result in a

[9]Note that the two failures is essentially an interaction term between current failure and lag of current failure. Therefore, we add up the value of coefficients to arrive at the economic impact of two failures.

user doing either an active transaction or a cash deposit. The economic magnitudes do not change much even when we consider more than two failures and specific types of failures.

Even when we consider multiple failures, the overall conclusion does not change much: the users do not show a higher probability of disengaging with the AEPS channel when faced with transaction failures when compared to a situation where a transaction is a success. Table A.10 presented in the online appendix presents similar results for the Rupay Card.

5.4 Small Users

It is possible that transaction failures have a higher impact on the poorest and hence, such users are likely to exit the BC channel when faced with failures. In this context, it is important to note that we include user level fixed effects and thereby account for any user level fixed characteristic. Nonetheless, we proceed to test the possibility of any differential impact on the poor. As stated in Section 3, we do not have any demographic information, and hence, cannot directly identify the poorest among the users. We use the historical transaction amount as a proxy. Abraham and Tantri (2018) show that LPG subsidies range between Rs.300 to Rs. 500. We consider users who never withdraw more than Rupees 300 as poor users. We identify such users as on a day of a transaction. Possibly, these are users who use the BC channel only to withdraw the LPG subsidy and do not engage in any other large transaction.

Using this subsample, we estimate the regression equations 1. We present the results in Tables A.11 and A.12 of the online appendix. As can be seen in the tables, the results largely remain similar to the main results. In other words, by revealed preference, even the small users do not seem to be deterred by transaction failures. In Table A.11, we consider a threshold of Rs. 500 and find similar results.

5.5 Robustness

We repeat the tests whose results are presented in Tables 7, 8 and 9 by using modified definition of failure where multiple attempts are considered as a single transactions. The results are presented in Table A.13 ,A.14 and A.15. The results are similar to the results presented in Tables 7, 8 and 9. As a robustness exercise, we vary the interval from $t+1$ to $t+91$ to $t+1$ to $t+181$. We present the results in Tables A.16, A.17, A.18 and A.19. These tables are presented in the online appendix. The results remain directionally unchanged when compared to the relevant results presented in Tables 7, 8 and 9.

5.6 Convenience ?

As hypothesized before, it is possible that the convenience offered by the AEPS platform is strong enough to negate the effect of failures. Here, we attempt to provide two indirect evidences in support of the above hypothesize.

Banks work during fixed working hours. Most rural banks close transactions by 4.00 P.M. However, from the point of view of conservatism, we consider 9.00 A.M. to 6 P.M. as working hours. In addition, banks are closed on Sundays, second Saturdays of a month and some other specified days.[10] On the other hand, the B.Cs's working hours are very flexible. In fact, most BCs live very close to their shops. Therefore, practically, it is possible to transact at any time using the B.C channel.

Given the above discussion, we ask whether higher proportion of AEPS transactions are executed during non-banking hours. We count transactions done between 6.00 PM to 9 AM of working days and all transactions done on non-working days as transactions done during non working hours. We present the results in Panel A and B of Table 11. We find that close to 60% of the transactions are executed during non-banking hours. We then examine if failures rates of transactions done during banking and non-banking hours are any different. We do not find an economically meaningful difference in failure rates. In Panels C and D, we

[10]Declared as banking holidays at the beginning of the year

examine RUPAY cards and find directionally similar results. The above result provides an instance of convenience offered by the AEPS channel because of which users may be willing to tolerate higher failures.

Finally, we examine whether users transacting with BCs located in areas with low banking penetration transact more using the BC channel ? We calculate the distance between a BC set up and the nearest bank branch. Organizing the data at a BC-year-month level, we regress the total number of transactions handled by a BC on the distance so calculated. We report the result in Table 12. As shown in the table, there is a positive association between the two variables. The convenience value of the BC is likely to be higher in locations where bank branches are not present.

6 Conclusion

The impact of technology on the financial lives of the poor has not received much scholarly attention. The extant discussion on fintech is mostly confined to its application to "high end"finance where the users of technology are either firms or reasonably rich individuals. In this paper, we study the working of a biometric enabled payment system (AEPS) that was introduced in India to facilitate banking by the poor. Specifically, we look at transaction failures and test whether transaction failures decrease with experience. We also examine whether the usage of the system increases with user experience. Finally, using a revealed preference framework, we also examine whether transaction failures lead to users abandoning the payment system and opting into to more traditional channels.

We first document that the failure rate is quite high at about one third of all transactions by numbers. However, we detect a noticeable trend of failures going down with experience of the user. In addition, we also detect a pattern of increasing usage with time. We find similar results even when we look at trannsactions done using newly designed debit card known as the Rupay card.

Finally, we find that transaction failures do not reduce the probability of a user continuing

to use the AEPS system. Even the tendency to engage in purely voluntary transactions does not reduce after transaction failures. The result shows that the AEPS system, although prone to high failure rate, provides higher convenience to the users when compared to both traditional formal banking channel. Our results show that poor are not only capable of learning but also sticking with new technology despite its high initial failure rate and hence, holds promise for introduction of fintech in more such areas.

References

Abraham, J., and P. Tantri (2018): "In Kind Transfer of Subsidy and Economic Cycles," Discussion paper, Indian School of Business, Working Paper.

Agarwal, S., S. Alok, P. Ghosh, S. Ghosh, T. Piskorski, and A. Seru (2017): "Banking the Unbanked: What Do 255 Million New Bank Accounts Reveal about Financial Access?," .

Agarwal, S., W. Qian, B. Y. Yeung, and X. Zou (2018): "Mobile Wallet and Entrepreneurial Growth," *Available at SSRN 3298266*.

Ashraf, N., D. Karlan, and W. Yin (2006): "Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines," *The Quarterly Journal of Economics*, 121(2), 635–672.

Bachas, P., P. Gertler, S. Higgins, and E. Seira (2017): "How debit cards enable the poor to save more," Discussion paper, National Bureau of Economic Research.

——— (2018): "Digital financial services go a long way: Transaction costs and financial inclusion," in *AEA Papers and Proceedings*, vol. 108, pp. 444–48.

Banerjee, A., E. Duflo, C. Imbert, S. Mathew, and R. Pande (2014): "Can e-governance reduce capture of public programs? Experimental evidence from a financial reform of India's employment guarantee," *Accessed February*, 15, 2017.

Banerjee, A. V., and E. Duflo (2007): "The economic lives of the poor," *Journal of economic perspectives*, 21(1), 141–168.

Behrman, J. R., O. S. Mitchell, C. K. Soo, and D. Bravo (2012): "How financial literacy affects household wealth accumulation," *American Economic Review*, 102(3), 300–304.

Biais, B., C. Bisiere, M. Bouvard, and C. Casamatta (2018): "The blockchain folk theorem," .

Blumenstock, J., M. Callen, and T. Ghani (2018): "Why do defaults affect behavior? Experimental evidence from Afghanistan," *American Economic Review*, 108(10), 2868–2901.

Brown, M., J. Grigsby, W. Van Der Klaauw, J. Wen, and B. Zafar (2016): "Financial education and the debt behavior of the young," *The Review of Financial Studies*, 29(9), 2490–2522.

Buchak, G., G. Matvos, T. Piskorski, and A. Seru (2018): "Fintech, regulatory arbitrage, and the rise of shadow banks," *Journal of Financial Economics*.

Chopra, Y., N. Prabhala, and P. L. Tantri (2017): "Bank accounts for the unbanked: Evidence from a big bang experiment," .

Cole, S. (2009): "Financial development, bank ownership, and growth: or, does quantity imply quality?," *The Review of Economics and Statistics*, 91(1), 33–51.

Cole, S., X. Giné, J. Tobacman, P. Topalova, R. Townsend, and J. Vickery (2013): "Barriers to household risk management: Evidence from India," *American Economic Journal: Applied Economics*, 5(1), 104–35.

Cole, S., T. Sampson, and B. Zia (2011): "Prices or knowledge? What drives demand for financial services in emerging markets?," *The journal of finance*, 66(6), 1933–1967.

Cong, L. W., and Z. He (2018): "Blockchain disruption and smart contracts," Discussion paper, National Bureau of Economic Research.

D'Acunto, F., N. Prabhala, and A. Rossi (2017): "The Promises and Pitfalls of Robo-advising," .

De Mel, S., C. McIntosh, K. Sheth, and C. Woodruff (2018): "Can Mobile-Linked Bank Accounts Bolster Savings? Evidence from a Randomized Controlled Trial in Sri Lanka," Discussion paper, National Bureau of Economic Research.

de Roure, C., L. Pelizzon, and A. V. Thakor (2018): "P2P lenders versus banks: Cream skimming or bottom fishing?," .

Drexler, A., G. Fischer, and A. Schoar (2014): "Keeping it simple: Financial literacy and rules of thumb," *American Economic Journal: Applied Economics*, 6(2), 1–31.

Einav, L., P. J. Klenow, B. Klopack, J. D. Levin, L. Levin, and W. Best (2017): "Assessing the gains from e-commerce," Discussion paper, Working paper, Stanford University.

Fernandes, D., J. G. Lynch Jr, and R. G. Netemeyer (2014): "Financial literacy, financial education, and downstream financial behaviors," *Management Science*, 60(8), 1861–1883.

Foley, S., J. Karlsen, and T. J. Putniņš (2018): "Sex, Drugs, and Bitcoin: How Much Illegal Activity is Financed Through Cryptocurrencies?," .

Fuster, A., M. Plosser, P. Schnabl, and J. Vickery (2018): "The role of technology in mortgage lending," Discussion paper, Review of Financial Studies.

Gomber, P., J.-A. Koch, and M. Siering (2017): "Digital Finance and FinTech: current research and future research directions," *Journal of Business Economics*, 87(5), 537–580.

Higgins, S. (2018): "Financial Technology Adoption," .

Hoff, K., and J. E. Stiglitz (1998): "Moneylenders and bankers: price-increasing subsidies in a monopolistically competitive market," *Journal of Development Economics*, 55(2), 485–518.

Kenny, C. (2002): "Information and communication technologies for direct poverty alleviation: costs and benefits," *Development policy review*, 20(2), 141–157.

Lusardi, A., P.-C. Michaud, and O. S. Mitchell (2017): "Optimal financial knowledge and wealth inequality," *Journal of Political Economy*, 125(2), 431–477.

Lusardi, A., and O. S. Mitchell (2014): "The economic importance of financial literacy: Theory and evidence," *Journal of economic literature*, 52(1), 5–44.

Malinova, K., and A. Park (2017): "Market Design with Blockchain Technology," .

Miller, M., J. Reichelstein, C. Salas, and B. Zia (2015): "Can you help someone become financially capable? A meta-analysis of the literature," *The World Bank Research Observer*, 30(2), 220–246.

Mukherjee, S., K. Subramanian, and P. Tantri (2018): "Costs and Benefits of Debt Moratoria: Evidence from a Natural Experiment in India," *Journal of Law And Economics, forthcoming*.

Muralidharan, K., P. Niehaus, and S. Sukhtankar (2016): "Building state capacity: Evidence from biometric smartcards in India," *American Economic Review*, 106(10), 2895–2929.

Philippon, T. (2016): "The fintech opportunity," Discussion paper, National Bureau of Economic Research.

Riley, E. (2018): "Mobile money and risk sharing against village shocks," *Journal of Development Economics*, 135, 43–58.

Rogoff, K. (2015): "Costs and benefits to phasing out paper currency," *NBER Macroeconomics Annual*, 29(1), 445–456.

Saloner, G., and A. Shepard (1995): "Adoption of technologies with network effects: an empirical examination of the adoption of automated teller machines," *The RAND Journal of Economics*, 26(3), 479–501.

Skimmyhorn, W. (2016): "Assessing financial education: Evidence from boot camp," *American Economic Journal: Economic Policy*, 8(2), 322–43.

Slemrod, J., B. Collins, J. L. Hoopes, D. Reck, and M. Sebastiani (2017): "Does credit-card information reporting improve small-business tax compliance?," *Journal of Public Economics*, 149, 1–19.

Suri, T., and W. Jack (2016): "The long-run poverty and gender impacts of mobile money," *Science*, 354(6317), 1288–1292.

Tang, H. (2018): "Peer-to-Peer Lenders versus Banks: Substitutes or Complements?," Discussion paper, Working Paper.

Figure 1: Comparison Between National and Sample Statistics - AEPS

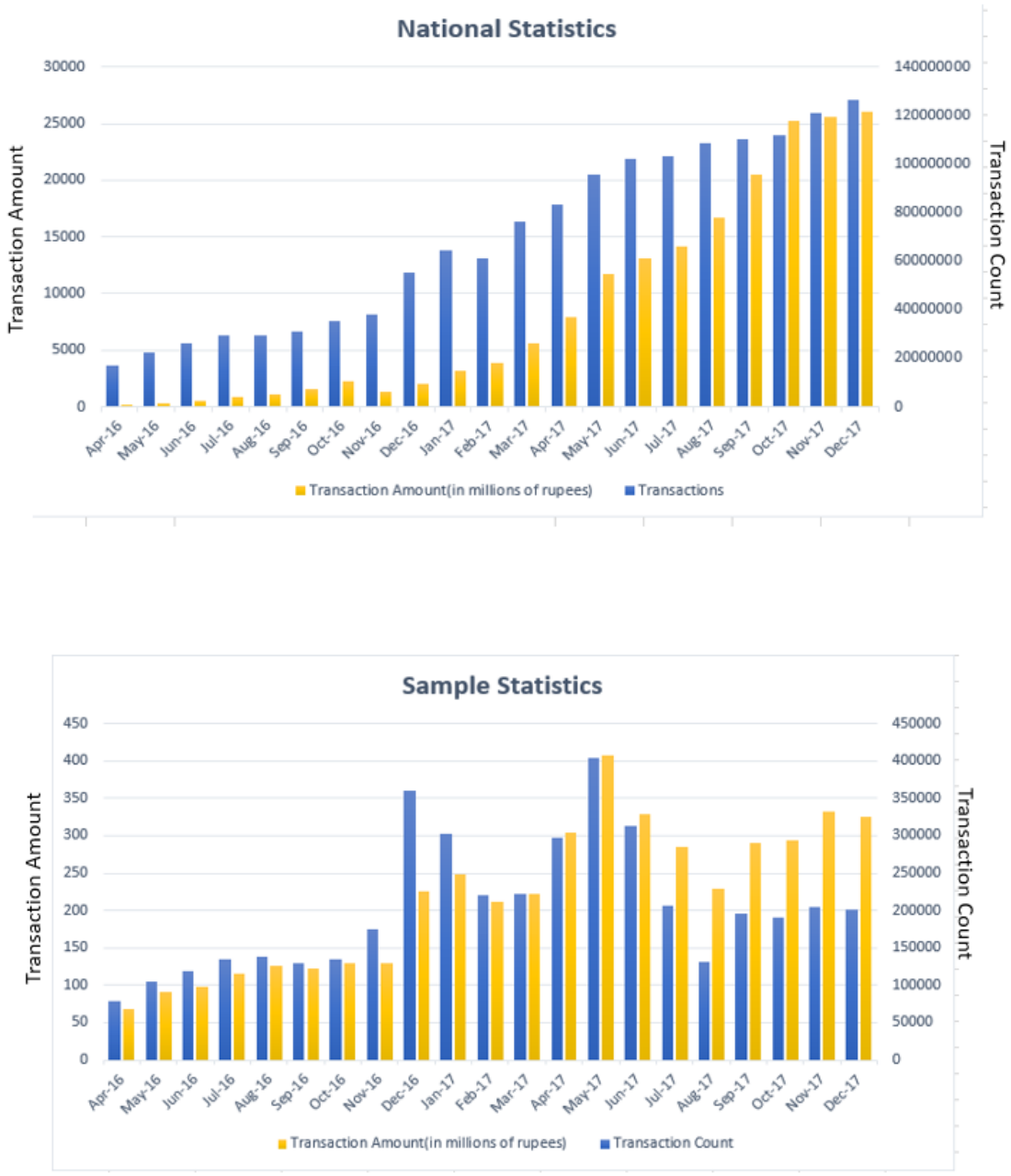

Figure 2: Data Coverage
In this map of India, we depict the geographical coverage our data.

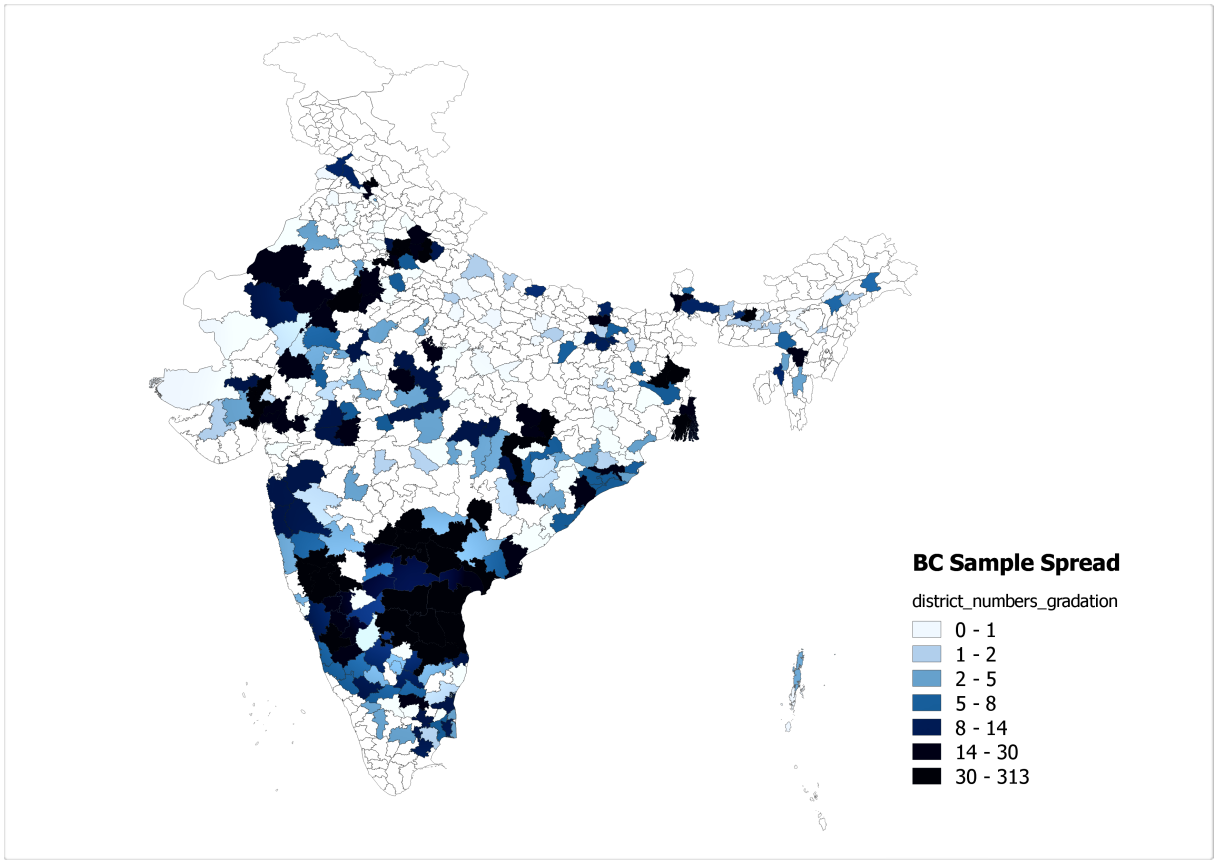

Figure 3: Failure rate with User Experience - AEPS

In this graph, we depict the modified failure rate (where we do not consider attempts leading to a success as a failure and consider repeated attempts in a day as one failure) with experience of the user. We depict experience, in terms of quarter-age, in the horizontal axis and the failure rate in the vertical axis.

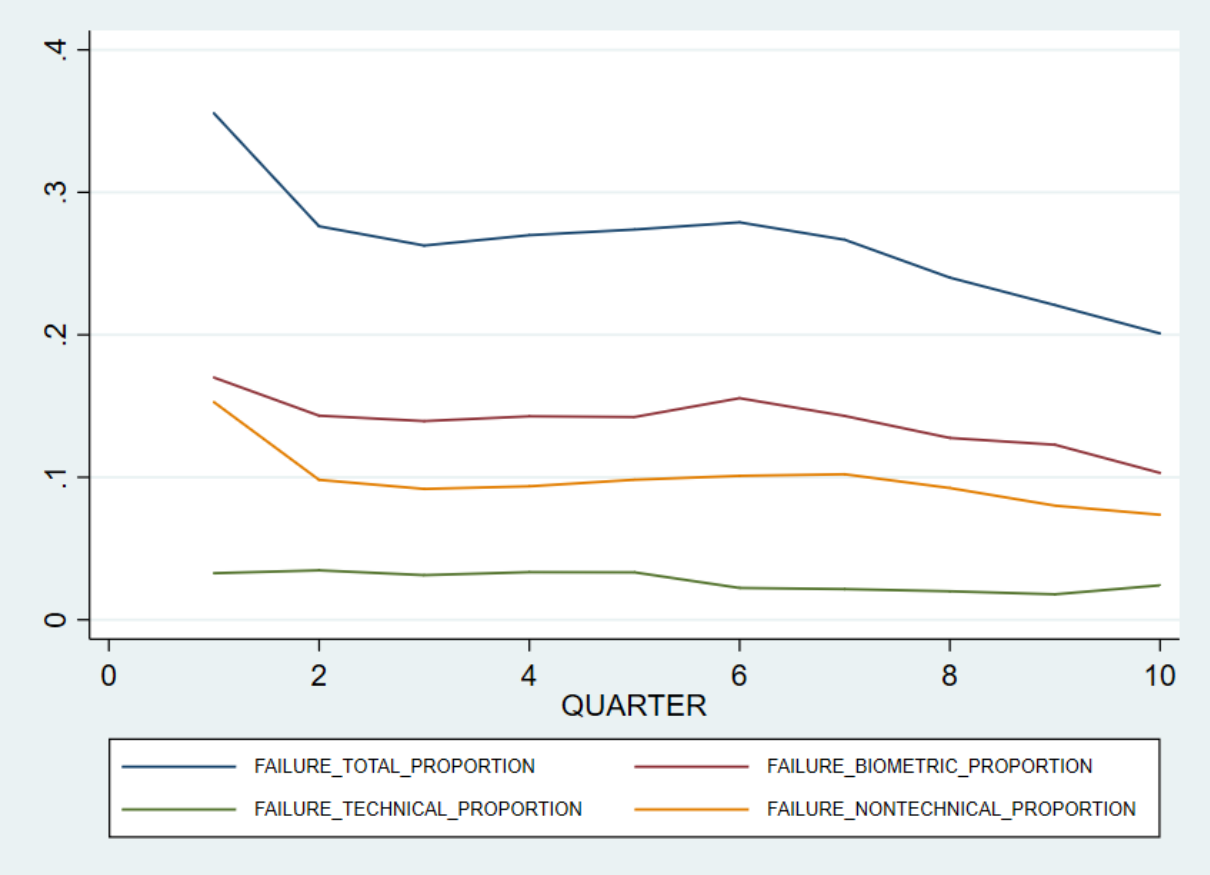

Figure 4: User count by Failure - AEPS

In this graph, we depict the count of users with the number of failures in the entire life of the user. We depict the frequency, in the horizontal axis and the user count in the vertical axis.

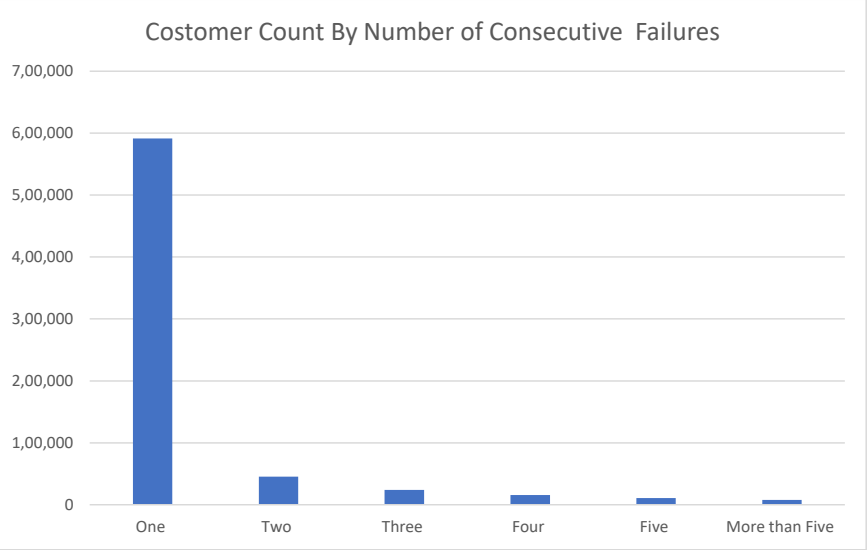

TABLE 1: Sample Details

We present the key details of the sample in this table.

Sample Period	Transaction level data from Dec 2014 to Dec 2018	Observations
Number of Unique ID's	AADHAAR Enabled Payment Services (AEPS)	917,696
	RUPAY CARD	95,039
	Total	**1,012,735**
Transaction Count	Deposits	1,149,842
	Withdrawal	4,753,319
	Banlance Enquiry	3,017,679
	Mini Statement	11,514
	Others	117,035
	Total	**9,049,389**
Number of Banks	A	37,823
	B	12,218
	C	8,999,348
	Total	**9,049,389**
Channels of Transaction	AEPS Deposits	792,237
	AEPS Withdrawal	3,711,140
	AEPS Balance Enquiry	2,570,656
	AEPS Other	117,035
	AEPS :	**7,191,068**
	RUPAY Deposits	357,605
	RUPAY Withdrawal	1,042,179
	RUPAY Balance Enquiry	447,023
	RUPAY Mini statement	11,514
	RUPAY Card:	**1,858,321**
Number of Business Correspondents		2416
Number of Unique Pincodes		779

TABLE 2: Summary Statistics - Transaction Amount

We present summary statistics relating to transaction amount. In panel A, we present summary relating successful transactions. In Panel B, we present summary relating to failed transactions.

Panel A -Success							
	Mean	Standard Deviation	25th Quartile	75th Quartile	Median	Minimum	Maximum
AEPS Transaction							
All	1523.66	2538.51	0	2000	400	0	360000
Withdrawal	2436.97	2742.89	500	3300	1100	1	20010
Deposit	1489.08	2292.45	100	2000	300	1	60000
Rupay Card Transaction							
All	1563.28	2595.48	50	2000	200	1	10000
Withdrawal	1736.41	2728.52	65	2000	500	1	10000
Deposit	1087.21	2116.56	50	700	100	1	10000

Panel B -Failure							
	Mean	Standard Deviation	25th Quartile	75th Quartile	Median	Minimum	Maximum
AEPS Transaction							
All	1395.67	3022.56	0	1500	200	0	600013
Withdrawal	2300.53	3190.49	500	3000	1000	1	600013
Deposit	1249.55	3542.86	50	1000	100	5	411000
Rupay Card Transaction							
All	1469.34	3483.49	0	1500	100	0	505458
Withdrawal	2068.61	3954.29	100	2500	500	1	505458
Deposit	1681.33	3785.61	50	2100	100	1	500045

TABLE 3: Failure Summary - Frequency

In this table, we present the key summary statistics relating to failures count

All Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	34.03	33.93	32.17	34.99
Proportion of Failure (RUPAY)	18.81	19.68	14.87	19.91
Biometric Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	17.03	17.31	15.27	17.53
Proportion of Failure (RUPAY)	0	0	0	0
Technical Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	3.7	3.59	4.69	3.34
Proportion of Failure (RUPAY)	5.97	5.79	6.24	6.17
Non Technical Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	13.3	13.03	12.21	14.12
Proportion of Failure (RUPAY)	12.84	13.89	8.64	13.75

TABLE 4: Failure With User Experience - AEPS

In this table, we present regression results relating to the association between failure proportion and customer experience. The data are organized at an user age-quarter level. In the first four rows, we compare the proportion of failures in the second quarter age with the first quarter age. Similarly, in rows 5 to 8, we compare the proportion of failures in the third quarter-age with the level of activity in the first two quarter-ages and so on. Each column uses a separate metric. In column 1 (4), we report the results for number (value) of failed transactions as a proportion of number (value) of total transactions, in column 2(5), we report the results for the number (value) of failed deposit transactions as a proportion of number (value) of total deposit transactions, and in column 3(6), we report the results for the number (value) of failed withdrawal transactions as a proportion of number (value) of total withdrawal transactions. We include user level fixed effects in all regressions. Standard errors are clustered at the BC level and adjusted for heteroscedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 4: Failure With User Experience - AEPS

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Withdrawal Amount Failed
Quarter =2	-0.031***	-0.041***	-0.016***	-0.019***	-0.038**	-0.014**
Standard Error	(0.004)	(0.015)	(0.006)	(0.005)	(0.016)	(0.006)
Observation	659214	101977	453132	507006	101977	453132
R-squared	0.889	0.944	0.898	0.890	0.942	0.895
Quarter =3	-0.037***	-0.061***	-0.028***	-0.033***	-0.057***	-0.027***
Standard Error	(0.003)	(0.012)	(0.005)	(0.005)	(0.013)	(0.005)
Observation	773455	118939	539561	600258	118939	539561
R-squared	0.842	0.915	0.851	0.840	0.912	0.846
Quarter =4	-0.033***	-0.053***	-0.027***	-0.034***	-0.050***	-0.026***
Standard Error	(0.003)	(0.013)	(0.004)	(0.004)	(0.013)	(0.004)
Observation	860553	132343	604638	670617	132343	604638
R-squared	0.807	0.891	0.819	0.805	0.888	0.813
Quarter =5	-0.041***	-0.057***	-0.036***	-0.041***	-0.052***	-0.033***
Standard Error	(0.004)	(0.013)	(0.006)	(0.005)	(0.013)	(0.006)
Observation	911929	142645	642123	712368	142645	642123
R-squared	0.784	0.871	0.798	0.782	0.868	0.792
Quarter =6	-0.057***	-0.083***	-0.047***	-0.056***	-0.081***	-0.041***
Standard Error	(0.004)	(0.011)	(0.007)	(0.006)	(0.012)	(0.007)
Observation	954639	153152	672020	746706	153152	672020
R-squared	0.765	0.852	0.782	0.764	0.848	0.775
Quarter =7	-0.075***	-0.093***	-0.073***	-0.089***	-0.088***	-0.072***
Standard Error	(0.005)	(0.015)	(0.007)	(0.007)	(0.015)	(0.008)
Observation	985600	158960	693842	770795	158960	693842
R-squared	0.751	0.840	0.769	0.750	0.835	0.762
Quarter =8	-0.085***	-0.114***	-0.103***	-0.117***	-0.110***	-0.102***
Standard Error	(0.006)	(0.015)	(0.009)	(0.008)	(0.015)	(0.009)
Observation	1007170	163414	708183	786875	163414	708183
R-squared	0.741	0.830	0.761	0.740	0.826	0.754
Quarter =9	-0.069***	-0.113***	-0.092***	-0.097***	-0.109***	-0.091***
Standard Error	(0.006)	(0.017)	(0.010)	(0.009)	(0.017)	(0.010)
Observation	1019376	166539	716183	796100	166539	716183
R-squared	0.735	0.824	0.756	0.734	0.819	0.749
Quarter =10	-0.056***	-0.112***	-0.063***	-0.073***	-0.102***	-0.058***
Standard Error	(0.010)	(0.022)	(0.017)	(0.014)	(0.023)	(0.017)
Observation	1022324	167453	718107	798367	167453	718107
R-squared	0.734	0.822	0.754	0.733	0.816	0.747

TABLE 5: Quarters with No User Activity - AEPS

In this table, we present regression results relating to the association between probability of dropping out and user experience. The dependent variable takes a value of one, if a user doesn't transact in an age-quarter i, otherwise it takes the value of zero. Other details of the regression set up is similar to the regression set up used in Table 4. For example,in the first four rows, we compare the probability of dropping out in the second quarter age with the same in the first quarter age and so on. We include user level fixed effects in all regressions. Standard errors are clustered at the BC level and adjusted for heteroscedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

No Activity Quarter- AEPS	
	No Activity Quarter
Quarter=2	0.325***
Standard Error	(0.001)
Observation	820495
R-squared	0.617
Quarter=3	0.093***
Standard Error	(0.001)
Observation	1090207
R-squared	0.435
Quarter=4	-0.018***
Standard Error	-0.001
Observation	1287754
R-squared	0.407
Quarter=5	-0.045***
Standard Error	(0.001)
Observation	1404927
R-squared	0.397
Quarter=6	-0.133***
Standard Error	(0.002)
Observation	1486879
R-squared	0.380
Quarter=7	-0.166***
Standard Error	(0.002)
Observation	1546094
R-squared	0.362
Quarter=8	-0.236***
Standard Error	(0.002)
Observation	1584371
R-squared	0.347
Quarter=9	-0.045***
Standard Error	(0.001)
Observation	1404927
R-squared	0.397
Quarter=10	-0.236***
Standard Error	(0.002)
Observation	1584371
R-squared	0.347

TABLE 6: Failure with User Experience adjusting for Survivorship Bias - AEPS

The organization of the table mimics the organization of Table 4. In addition, to control of survivorship bias, we consider all existing users in all age quarters. For those who do not transact in an age quarter, we consider the failure rate experienced during the latest age-quarter in which they were active. A user enters into the data only after he/she makes the first transaction.

TABLE 6: Failure with User Experience adjusting for Survivorship Bias - AEPS

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Withdrawal Amount Failed
Quarter =2	-0.011***	-0.007***	-0.005***	-0.006***	-0.006***	-0.005***
Standard Error	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	752670	150935	547689	611425	150935	547689
R-squared	0.947	0.970	0.946	0.942	0.970	0.943
Quarter =3	-0.020***	-0.011***	-0.013***	-0.015***	-0.010***	-0.013***
Standard Error	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	983945	214970	735803	817871	214970	735803
R-squared	0.909	0.952	0.908	0.901	0.950	0.903
Quarter =4	-0.026***	-0.013***	-0.018***	-0.021***	-0.012***	-0.018***
Standard Error	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	1161895	272501	882910	979313	272501	882910
R-squared	0.879	0.936	0.879	0.871	0.935	0.873
Quarter =5	-0.037***	-0.017***	-0.028***	-0.032***	-0.016***	-0.027***
Standard Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	1271290	317088	972992	1079755	317088	972992
R-squared	0.857	0.923	0.860	0.850	0.921	0.853
Quarter =6	-0.061***	-0.033***	-0.045***	-0.054***	-0.033***	-0.043***
Standard Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	1349894	354994	1037809	1152389	354994	1037809
R-squared	0.838	0.907	0.843	0.831	0.905	0.836
Quarter =7	-0.081***	-0.039***	-0.061***	-0.075***	-0.038***	-0.060***
Standard Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	1407777	385198	1086691	1206381	385198	1086691
R-squared	0.822	0.896	0.829	0.815	0.893	0.822
Quarter =8	-0.096***	-0.048***	-0.078***	-0.097***	-0.047***	-0.079***
Standard Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observation	1445898	406805	1119563	1242226	406805	1119563
R-squared	0.810	0.886	0.819	0.803	0.884	0.812
Quarter =9	-0.104***	-0.061***	-0.087***	-0.108***	-0.060***	-0.086***
Standard Error	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observation	1466027	418704	1137239	1261263	418704	1137239
R-squared	0.802	0.881	0.812	0.795	0.878	0.806
Quarter =10	-0.095***	-0.074***	-0.078***	-0.099***	-0.070***	-0.075***
Standard Error	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Observation	1471383	422190	1141976	1266357	422190	1141976
R-squared	0.799	0.879	0.810	0.793	0.876	0.804

TABLE 7: User Revealed preference with failure - AEPS

In this table, we examine the future transaction activity of the user after a transaction. The window used is $t+1$ to $t+91$. The data are organized at a transaction level for all AEPS transactions. In column 1, 4, and 7, the dependent variable takes the value of one if the user does any transaction within the next three months after the current transaction and zero otherwise. Similarly, in columns 2, 5 and 8, the dependent variable takes the value of one if the user, within three months of the transaction under consideration, does any transaction other than the type of transaction under consideration and zero otherwise. Finally, in columns 3, 6 and 9, the dependent variable takes the value of one if the user, within three months of the transaction under consideration, does any cash deposit transaction and zero otherwise. The main independent variable takes the value of one if the current transaction fails and zero otherwise. We present the regressions results for all the three types of failures, biometric (in columns 1, 2 and 3), technical (in columns 4, 5 and 6) and non-technical (in columns 7, 8 and 9). We employ control variables such as the type of transaction(Deposit or Withdrawal), user experience, BC experience and transaction amount. We also employ fixed effects at the user and year-month level. The Standard errors are clustered at BC level and adjusted for heteroskedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	Biometric			Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure	0.001***	0.005***	-0.001*	0.022***	-0.005*	0.009***	0.006***	0.007***	0.006***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Deposit	0.006***	0.393***	-0.020***	0.006***	0.394***	-0.018***	0.007***	0.380***	-0.018***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.014)	(0.001)
Withdrawal	-0.020***	-0.138***	0.022***	-0.019***	-0.144***	0.020***	-0.019***	-0.145***	0.020***
	(0.001)	(0.012)	(0.001)	(0.001)	(0.013)	(0.001)	(0.001)	(0.013)	(0.001)
User Expereince	0.007***	-0.001**	0.003***	0.006***	-0.001***	0.003***	0.007***	-0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***	0.000**	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.852	0.712	0.920	0.849	0.690	0.923	0.842	0.704	0.918

TABLE 8: User Revealed preference with Failure Amount- AEPS

The organization of Table 8 mimics the organization of Table 7 except with respect to the definition of the main explanatory variable. Here the failure dummy, as defined in Table 7, is multiplied by the transaction amount.

	Biometric			Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure Amount	-0.000***	0.000***	-0.000***	0.000***	0.000**	0.000***	-0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Deposit	0.006***	0.393***	-0.020***	0.006***	0.394***	-0.018***	0.007***	0.381***	-0.018***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.013)	(0.001)
Withdrawal	-0.020***	-0.138***	0.022***	-0.019***	-0.143***	0.020***	-0.019***	-0.137***	0.020***
	(0.001)	(0.012)	(0.001)	(0.001)	(0.013)	(0.001)	(0.001)	(0.012)	(0.001)
User Expereince	0.007***	-0.001**	0.003***	0.006***	-0.001***	0.003***	0.007***	-0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.852	0.712	0.920	0.849	0.690	0.923	0.842	0.705	0.918

TABLE 9: Propensity of a Successful Activity with Failure - AEPS

In this table, we consider whether failure of a transaction is associated with execution of a successful subsequent transaction within 90 days. We consider biometric failures in columns 1 and 2 and technical (non-technical) failures in columns 3 and 4. In columns 2, 4 and 6, the transactions are weighted by the transaction amount. The other details are similar to Panel 7 of Table 8.

	Biometric		**Technical**		**Non Technical**	
	Success	**Success**	**Success**	**Success**	**Success**	**Success**
Failure	0.005***		0.029***		0.005***	
	(0.001)		(0.001)		(0.002)	
Failure Amount		-0.000***		0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Deposit	0.005***	0.005***	0.006***	0.006***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Withdrawal	-0.021***	-0.021***	-0.020***	-0.019***	-0.018***	-0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
User Experience	0.008***	0.008***	0.006***	0.006***	0.009***	0.009***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.003***	-0.003***	-0.002***	-0.002***	-0.003***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	4428530	4428530	5060962	5060962
Adjusted R- squared	0.771	0.771	0.731	0.731	0.747	0.747

TABLE 10: User Revealed preference with Multiple Failures - AEPS

In this panel, we include additional explanatory variables. Two(three)(four)(five)(more than five) fails is a dummy variable that takes the value of one if the user has faced two (three)(four)(five)(more than five) consecutive failures. Other details are similar to Panel A.

	Biometric			Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure	0.000	0.006***	0.000	0.019***	-0.013***	0.009***	0.001	0.006**	0.007***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)
Two Failure	0.001**	0.004***	-0.000	0.006***	0.006***	0.002**	0.005***	0.000	0.002***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Three Failure	0.002***	0.001	0.000	-0.000	0.006**	-0.001	0.003**	0.003	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)
Four Failure	0.002**	0.002	0.000	-0.001	-0.001	-0.003	0.003**	0.004	0.001
	(0.001)	(0.001)	(0.000)	(0.002)	(0.005)	(0.002)	(0.002)	(0.004)	(0.001)
Five Failure	0.001	0.000	0.000	-0.001	0.002	0.001	-0.001	-0.003	0.003
	(0.001)	(0.002)	(0.000)	(0.002)	(0.006)	(0.003)	(0.003)	(0.005)	(0.002)
More than Five Failure	0.001	0.001	0.001	-0.005	0.009	0.008	-0.001	-0.005	0.003
	(0.002)	(0.002)	(0.001)	(0.004)	(0.014)	(0.009)	(0.004)	(0.006)	(0.004)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.760	0.452	0.868	0.733	0.358	0.863	0.721	0.395	0.854

TABLE 11: Transaction Counts and Proportions - AEPS

In this table, we present key summary of the transactions during working and non-working hours. We take 9:00 AM to 6:00 PM IST on a week day as regular banking hours. In Panel-A, we present the count of transactions and in Panel-B, we show proportion of transactions. Panel-C and Panel-D present the results for RUPAY card.

Panel A					
	Transaction Count				
	Transaction	**Failures**	**Biometric**	**Technical**	**Non- Technical**
Working Hours	3,210,818	1,333,971	547,089	110,735	314,726
Non Working Hours	3,980,250	1,112,984	677,682	155,737	378,465
	Proportion				
		Failures	**Biometric**	**Technical**	**Non- Technical**
Working Hours		0.42	0.17	0.03	0.10
Non Working Hours		0.28	0.17	0.04	0.10

TABLE 11: Transaction Counts and Proportions - RUPAY

Panel B				
	Transaction Count			
	Transaction	**Failures**	**Technical**	**Non- Technical**
Working Hours	776,638	150,802	45,882	78,639
Non Working Hours	1,081,683	198,753	65,113	105,767
	Proportion			
		Failures	Technical	Non- Technical
Working Hours		0.19	0.06	0.10
Non Working Hours		0.18	0.06	0.10

TABLE 12: Transaction Activity and Distance from Bank

In this table, we present the association between transaction activity and the distance between the BC to the nearest bank branch. The data are aggregated at year, month and BC level. The dependent variable is the average transactions per user. We employ fixed effects at the BC and year-month level and adjust for heteroskedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)
	Average Transaction activity per Customer
Distance from Nearest Bank Branch	0.035***
	(0.005)
Observations	28435
Adjusted R-squared	0.011

ONLINE APPENDIX

FIGURE-A.1 IMAGES DEPICTING BIOMETRIC DEVICES AND AUTHENTICATION

Image showing the mobile device where user enters Aadhaar number.

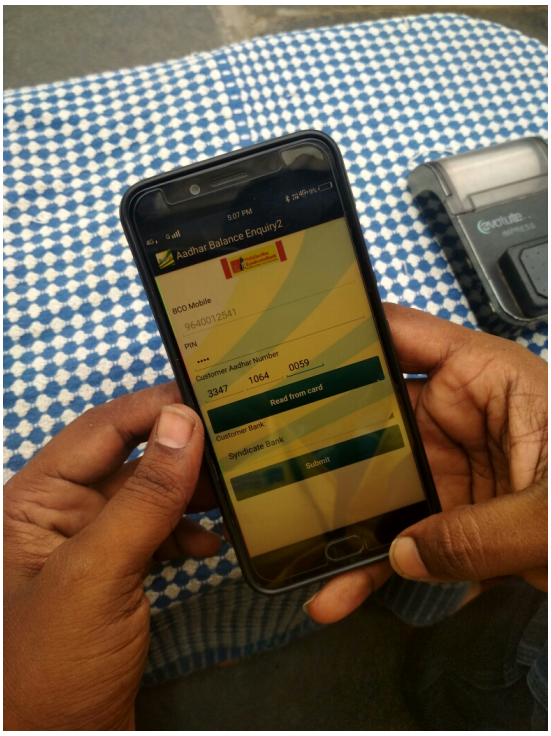

FIGURE-A.2 IMAGES DEPICTING BIOMETRIC DEVICES AND AUTHENTICATION

Image showing various services available for the user

Figure-A.3 Images depicting Biometric Devices and Authentication

Image showing a user using biometric authentication to do a transaction. This image shows the device which captures biometric impression and validates with UIDAI server to authenticate the user.

Figure-A.4 Images depicting Biometric Devices and Authentication

Image showing a BC assisting the user.

Figure-A.5 Failure rate with User Experience - RUPAY

In this graph, we depict the overall failure rate with experience of the user. We depict experience, in terms of quarter-age, in the horizontal axis and the failure rate in the vertical axis.

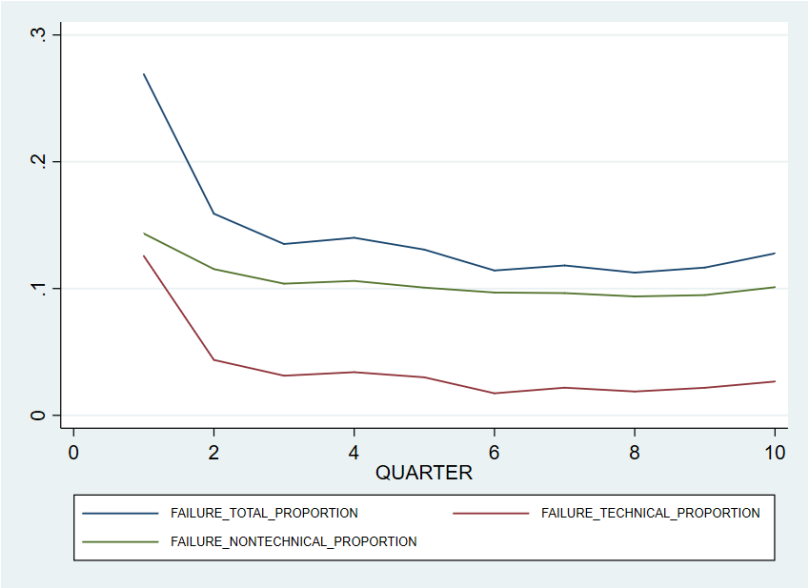

Figure-A.6 User count by Failure - RUPAY

In this graph, we depict the count of users with types of Transaction Failures. We depict Failure, in the horizontal axis and the user Count in the vertical axis.

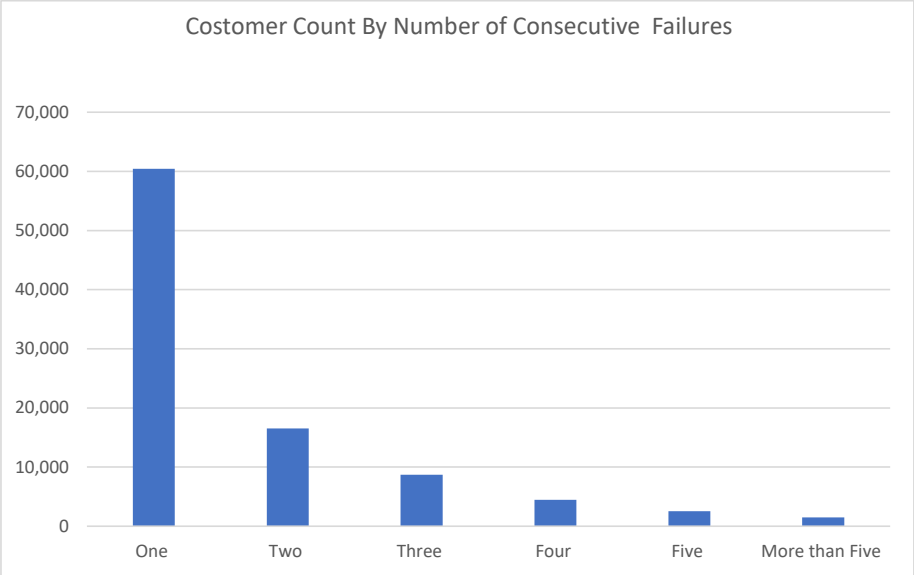

TABLE A.1: Sample of Response messages for different Failures

A sample of response messages have been shown in the table below. Transaction failures are categorized into three types on the basis of the text in the response messages

Biometric Failure
BIOMETRIC DATA DIDNOT MATCH
Technical Failure
SWITCH NOT AVAILABLE
DATABASE ERROR
REVERSAL TIMEOUT
SOCKET CONNECTION ERROR
SYSTEM DOWN
TRANSACTION TIME OUT
Non-Technical Failure
INSUFFICIENT FUNDS IN ACCOUNT:51
PLEASE SEED YOUR AADHAAR AND MOBILE NUMBER WITH YOUR BANK ACCOUNT WITHOUT FAIL FOR AVAILING UNINTERRUPTED SERVICES
DAILY AMOUNT LIMIT EXCEEDED. TRY TOMORROW
TRANSACTION AMOUNT EXCEEDED LIMIT
INVALID ACCOUNT. ERROR:52
INCORRECT PIN

TABLE A.2: Modefied Failure Summary- Frequency

In this table, we present the key summary statistics relating to modefied failures count

Panel B: Modified Failure Summary- Failure Frequency				
All Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	31.29	31.22	29.2	32.24
Proportion of Failure (RUPAY)	18.18	19.07	14.37	19.15
Biometric Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	15.28	15.55	13.45	15.75
Proportion of Failure (RUPAY)	0	0	0	0
Technical Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	3.47	3.36	4.39	3.13
Proportion of Failure (RUPAY)	5.57	5.41	5.83	5.72
Non Technical Failures				
Description	All	Withdrawal	Deposit	Others
Proportion of Failure (AEPS)	12.55	12.3	11.36	13.36
Proportion of Failure (RUPAY)	12.61	13.66	8.54	13.42

TABLE A.3: Failure With User Experience - RUPAY

In this table, we present regression results relating to the association between failure proportion and customer experience. The data are organized at an user age-quarter level. In the first four rows, we compare the proportion of failures in the second quarter age with the first quarter age. Similarly, in rows 5 to 8, we compare the proportion of failures in the third quarter-age with the level of activity in the first two quarter-ages and so on. Each column uses a separate metric. In column 1 (4), we report the results for number (value) of failed transactions as a proportion of number (value) of total transactions, in column 2(5), we report the results for the number (value) of failed deposit transactions as a proportion of number (value) of total deposit transactions, and in column 3(6), we report the results for the number (value) of failed withdrawal transactions as a proportion of number (value) of total withdrawal transactions. We include user level fixed effects in all regressions. Standard errors are clustered at the BC level and adjusted for heteroscedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE A.3: Failure by User Experience - RUPAY

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Deposit Amount Failed
Quarter =2	-0.032***	-0.032	-0.033***	-0.029***	-0.035	-0.031***
Standard Error	(0.010)	(0.021)	(0.012)	(0.011)	(0.022)	(0.012)
Observation	71036	11788	53919	58229	11788	53919
R-squared	0.809	0.926	0.818	0.805	0.922	0.811
Quarter =3	-0.062***	0.023	-0.068***	-0.056***	0.024	-0.064***
Standard Error	(0.009)	(0.017)	(0.011)	(0.010)	(0.018)	(0.011)
Observation	87228	17011	66990	72487	17011	66990
R-squared	0.718	0.883	0.730	0.717	0.877	0.722
Quarter =4	-0.030***	0.027*	-0.051***	-0.041***	0.025*	-0.052***
Standard Error	(0.009)	(0.015)	(0.010)	(0.010)	(0.015)	(0.009)
Observation	108846	26075	83539	91245	26075	83539
R-squared	0.616	0.778	0.638	0.619	0.771	0.628
Quarter =5	-0.002	0.032	-0.016*	-0.004	0.033*	-0.014
Standard Error	(0.008)	(0.019)	(0.009)	(0.009)	(0.019)	(0.009)
Observation	131994	36712	100917	111443	36712	100917
R-squared	0.531	0.661	0.555	0.535	0.654	0.546
Quarter =6	-0.017*	-0.014	-0.042***	-0.044***	-0.015	-0.046***
Standard Error	(0.010)	(0.020)	(0.009)	(0.009)	(0.021)	(0.009)
Observation	147618	42184	112684	124437	42184	112684
R-squared	0.490	0.619	0.519	0.500	0.612	0.510
Quarter =7	-0.017*	-0.017	-0.050***	-0.054***	-0.018	-0.053***
Standard Error	(0.010)	(0.019)	(0.012)	(0.012)	(0.019)	(0.013)
Observation	156124	44426	118974	131277	44426	118974
R-squared	0.473	0.607	0.503	0.485	0.599	0.493
Quarter =8	-0.027***	0.001	-0.069***	-0.055***	-0.002	-0.070***
Standard Error	(0.010)	(0.020)	(0.012)	(0.011)	(0.020)	(0.012)
Observation	160878	45737	122427	135075	45737	122427
R-squared	0.466	0.600	0.496	0.477	0.592	0.486
Quarter =9	-0.048***	-0.070***	-0.100***	-0.094***	-0.064***	-0.098***
Standard Error	(0.015)	(0.020)	(0.017)	(0.015)	(0.020)	(0.017)
Observation	164029	46639	124720	137565	46639	124720
R-squared	0.459	0.595	0.490	0.472	0.587	0.480
Quarter =10	-0.028	-0.038	-0.096***	-0.101***	-0.045*	-0.099***
Standard Error	(0.017)	(0.026)	(0.021)	(0.020)	(0.026)	(0.021)
Observation	166794	47215	126745	139707	47215	126745
R-squared	0.452	0.591	0.484	0.467	0.583	0.474

TABLE A.4: Quarters with No User Activity - RUPAY

In this table, we present regression results relating to the association between probability of dropping out and user experience. The dependent variable takes a value of one, if a user doesn't transact in an age-quarter i, otherwise it takes the value of zero. Other details of the regression set up is similar to the regression set up used in Table 4. For example,in the first four rows, we compare the probability of dropping out in the second quarter age with the same in the first quarter age and so on. We include user level fixed effects in all regressions. Standard errors are clustered at the BC level and adjusted for heteroscedasticity. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

No Activity Quarter- RUPAY	
	No Activity Quarter
Quarter=2	0.279***
Standard Error	(0.003)
Observation	84800
R-squared	0.598
Quarter=3	0.167***
Standard Error	(0.003)
Observation	113662
R-squared	0.485
Quarter=4	0.077***
Standard Error	(0.003)
Observation	139605
R-squared	0.462
Quarter=5	0.002
Standard Error	(0.003)
Observation	163525
R-squared	0.444
Quarter=6	-0.039***
Standard Error	(0.003)
Observation	185335
R-squared	0.419
Quarter=7	-0.023***
Standard Error	(0.003)
Observation	204425
R-squared	0.377
Quarter=8	0.093***
Standard Error	(0.003)
Observation	219733
R-squared	0.327
Quarter=9	0.162***
Standard Error	(0.004)
Observation	230838
R-squared	0.308
Quarter=10	0.163***
Standard Error	(0.004)
Observation	239850
R-squared	0.294

TABLE A.5 : Failure With Age - Modified Failures - AEPS

In this table, we present regression results relating to the association between failure proportion and customer experience. The organization of the table mimics the organization of Table 4, except that we use modified definition of failure. Under the modified definition of failure, a transaction is considered a failure only if it does not eventually succeed within the same day. Also repeated attempts of the same transaction on the same day that eventually do not succeed are considered as a single failure. For example: if a user makes five attempts in a day to deposit and eventually succeeds, then the entire set of six transactions are considered as a success and counted as one transaction with the value of successful transaction. If, on the other day, the user is unable to make a successful deposit transaction, then the five failures are considered as one.

TABLE A.5: Failure With Age - Modified Failures - AEPS

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Deposit Amount Failed
Quarter =2	-0.030***	-0.039**	-0.016***	-0.019***	-0.037**	-0.014**
Standard Error	(0.004)	(0.015)	(0.006)	(0.005)	(0.016)	(0.006)
Observation	658376	101945	452562	506405	101945	452562
R-squared	0.892	0.946	0.902	0.893	0.944	0.898
Quarter =3	-0.037***	-0.058***	-0.028***	-0.033***	-0.054***	-0.027***
Standard Error	(0.004)	(0.012)	(0.005)	(0.005)	(0.013)	(0.005)
Observation	772560	118904	538948	599612	118904	538948
R-squared	0.846	0.917	0.857	0.845	0.914	0.851
Quarter =4	-0.034***	-0.051***	-0.027***	-0.034***	-0.048***	-0.026***
Standard Error	(0.003)	(0.013)	(0.004)	(0.004)	(0.013)	(0.004)
Observation	859605	132306	603991	669936	132306	603991
R-squared	0.812	0.894	0.826	0.811	0.890	0.819
Quarter =5	-0.045***	-0.058***	-0.037***	-0.043***	-0.052***	-0.034***
Standard Error	(0.004)	(0.013)	(0.006)	(0.005)	(0.013)	(0.006)
Observation	910960	142607	641467	711676	142607	641467
R-squared	0.789	0.875	0.806	0.788	0.870	0.799
Quarter =6	-0.062***	-0.089***	-0.050***	-0.061***	-0.087***	-0.045***
Standard Error	(0.004)	(0.011)	(0.007)	(0.006)	(0.012)	(0.007)
Observation	953646	153113	671350	745999	153113	671350
R-squared	0.770	0.855	0.789	0.770	0.851	0.782
Quarter =7	-0.076***	-0.091***	-0.072***	-0.088***	-0.087***	-0.071***
Standard Error	(0.005)	(0.015)	(0.007)	(0.007)	(0.015)	(0.008)
Observation	984585	158921	693157	770073	158921	693157
R-squared	0.756	0.843	0.777	0.756	0.838	0.769
Quarter =8	-0.087***	-0.116***	-0.101***	-0.116***	-0.111***	-0.100***
Standard Error	(0.006)	(0.015)	(0.009)	(0.008)	(0.015)	(0.009)
Observation	1006138	163375	707490	786145	163375	707490
R-squared	0.745	0.833	0.769	0.746	0.828	0.761
Quarter =9	-0.072***	-0.115***	-0.092***	-0.100***	-0.111***	-0.092***
Standard Error	(0.006)	(0.017)	(0.010)	(0.009)	(0.017)	(0.010)
Observation	1018328	166499	715478	795358	166499	715478
R-squared	0.740	0.827	0.764	0.740	0.821	0.756

TABLE A.6: Failure by User Experience - Modified Failures - RUPAY

The description of the table is same as Table A.5 except that the instrument being used here is Rupay card.

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Deposit Amount Failed
Quarter =2	-0.026***	-0.027	-0.027**	-0.023**	-0.030	-0.026**
Standard Error	(0.010)	(0.021)	(0.012)	(0.011)	(0.021)	(0.012)
Observation	70971	11786	53867	58175	11786	53867
R-squared	0.813	0.928	0.820	0.808	0.924	0.813
Quarter =3	-0.060***	0.022	-0.066***	-0.055***	0.023	-0.063***
Standard Error	(0.009)	(0.017)	(0.010)	(0.010)	(0.017)	(0.011)
Observation	87159	17009	66936	72431	17009	66936
R-squared	0.724	0.885	0.734	0.720	0.878	0.724
Quarter =4	-0.034***	0.023	-0.055***	-0.047***	0.022	-0.056***
Standard Error	(0.009)	(0.015)	(0.009)	(0.010)	(0.015)	(0.009)
Observation	108775	26072	83483	91187	26072	83483
R-squared	0.621	0.781	0.641	0.623	0.775	0.631
Quarter =5	-0.003	0.027	-0.017*	-0.007	0.029	-0.015*
Standard Error	(0.009)	(0.019)	(0.009)	(0.009)	(0.019)	(0.009)
Observation	131920	36708	100860	111383	36708	100860
R-squared	0.535	0.666	0.558	0.537	0.658	0.549
Quarter =6	-0.011	-0.010	-0.037***	-0.038***	-0.011	-0.041***
Standard Error	(0.010)	(0.020)	(0.009)	(0.009)	(0.021)	(0.009)
Observation	147544	42180	112627	124377	42180	112627
R-squared	0.494	0.624	0.522	0.502	0.616	0.512
Quarter =7	-0.013	-0.015	-0.045***	-0.051***	-0.017	-0.050***
Standard Error	(0.010)	(0.018)	(0.012)	(0.012)	(0.018)	(0.012)
Observation	156050	44422	118917	131217	44422	118917
R-squared	0.477	0.612	0.505	0.487	0.604	0.495
Quarter =8	-0.021**	-0.000	-0.062***	-0.049***	-0.004	-0.064***
Standard Error	(0.010)	(0.020)	(0.012)	(0.011)	(0.020)	(0.012)
Observation	160803	45732	122370	135014	45732	122370
R-squared	0.469	0.605	0.498	0.480	0.597	0.488
Quarter =9	-0.046***	-0.067***	-0.095***	-0.090***	-0.061***	-0.094***
Standard Error	(0.015)	(0.020)	(0.016)	(0.015)	(0.020)	(0.017)
Observation	163954	46634	124663	137504	46634	124663
R-squared	0.463	0.600	0.493	0.474	0.591	0.482
Quarter =10	-0.028	-0.037	-0.096***	-0.099***	-0.044*	-0.099***
Standard Error	(0.017)	(0.025)	(0.021)	(0.020)	(0.026)	(0.020)
Observation	166719	47210	126688	139646	47210	126688
R-squared	0.456	0.596	0.487	0.469	0.588	0.476

TABLE A.7: User Revealed Preference with Failure - RUPAY - Three Months

The organization of the Table mimics the organization of Table 7 except that the instrument under consideration is the RUPAY card also that there are no biometric failures.

	Technical			Non Technical		
	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity
Failure	0.001	0.016***	-0.008***	0.003***	0.014***	0.000
	(0.001)	(0.004)	(0.001)	(0.000)	(0.002)	(0.001)
Deposit	0.001	0.111***	-0.027***	0.001**	0.101***	-0.026***
	(0.001)	(0.011)	(0.001)	(0.001)	(0.011)	(0.001)
Withdrawal	-0.005***	-0.076***	0.023***	-0.005***	-0.077***	0.022***
	(0.001)	(0.014)	(0.001)	(0.001)	(0.013)	(0.001)
User Expereince	-0.039***	-0.028***	-0.043***	-0.059***	-0.036***	-0.053***
	(0.007)	(0.005)	(0.007)	(0.005)	(0.007)	(0.005)
BC Experience	-0.021***	0.004	-0.012**	0.003	0.011	-0.001
	(0.006)	(0.005)	(0.006)	(0.004)	(0.007)	(0.002)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	1490801	1490801	1490801	1608467	1608467	1608467
Adjusted R-Squared	0.830	0.659	0.923	0.828	0.676	0.924

TABLE A.8: User Revealed Preference with Failure Amount - RUPAY - Three Months

The organization of the Table mimics the organization of Table 8 except that the instrument under consideration is the RUPAY card also that there are no biometric failures.

	Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure Amount	0.000	0.000***	-0.000*	0.000	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Deposit	0.001	0.113***	-0.027***	0.001**	0.103***	-0.026***
	(0.001)	(0.011)	(0.001)	(0.001)	(0.011)	(0.001)
Withdrawal	-0.005***	-0.075***	0.023***	-0.005***	-0.075***	0.022***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.013)	(0.001)
User Expereince	-0.039***	-0.028***	-0.043***	-0.059***	-0.037***	-0.053***
	(0.007)	(0.005)	(0.007)	(0.005)	(0.007)	(0.005)
BC Experience	-0.021***	0.004	-0.012**	0.003	0.012*	-0.001
	(0.006)	(0.005)	(0.006)	(0.004)	(0.007)	(0.002)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	1490801	1490801	1490801	1608467	1608467	1608467
Adjusted R-Squared	0.830	0.660	0.923	0.828	0.677	0.924

TABLE A.9: Successful Activity with Failure - RUPAY - Three Months

The description of the table is same as Table 8 except for the instrument in this sample is Rupay card also that there are no biometric failures.

	Technical		**Non Technical**	
	Success	**Success**	**Success**	**Success**
Failure	0.013***		0.009***	
	(0.001)		(0.001)	
Failure Amount		0.000***		0.000**
		(0.000)		(0.000)
Deposit	0.002**	0.002***	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Withdrawal	-0.006***	-0.006***	-0.006***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
User Experience	-0.041***	-0.042***	-0.064***	-0.064***
	(0.008)	(0.008)	(0.005)	(0.005)
BC Experience	-0.021***	-0.021***	0.004	0.004
	(0.007)	(0.007)	(0.004)	(0.004)
Transaction Amount	0.000***	0.000***	0.000***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Observation	1490801	1490801	1608467	1608467
Adjusted R- squared	0.848	0.848	0.836	0.836

TABLE A.10: User Revealed Preference with Multiple Failures - RUPAY - Three Months

The organization of the Table mimics the organization of Table 10 except that the instrument under consideration is the RUPAY card and also that there are no biometric failures.

	Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure	0.002*	0.011**	-0.007***	0.003***	0.005***	0.002***
	(0.001)	(0.005)	(0.001)	(0.000)	(0.001)	(0.001)
Two Failure	0.009***	-0.001	0.004***	0.004***	0.001	0.002**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Three Failure	0.006***	-0.004	0.004***	0.002*	0.003*	-0.001
	(0.002)	(0.004)	(0.001)	(0.001)	(0.002)	(0.001)
Four Failure	0.004	0.002	-0.001	0.002	-0.002	0.002
	(0.003)	(0.006)	(0.002)	(0.001)	(0.003)	(0.001)
Five Failure	-0.001	0.008	0.002	-0.001	-0.004	0.001
	(0.004)	(0.010)	(0.003)	(0.001)	(0.004)	(0.002)
More than Five Failure	-0.003	-0.007	-0.003	-0.001	-0.001	0.007**
	(0.008)	(0.013)	(0.004)	(0.003)	(0.006)	(0.003)
Observation	1490801	1490801	1490801	1608467	1608467	1608467
Adjusted R-Squared	0.827	0.639	0.922	0.825	0.657	0.923

TABLE A.11: Users with Transaction amount less than 300 - AEPS

The organization of this table mimics the organization of Table 4. The sample is restricted to users whose maximum transaction value is Rupees. 300.

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Deposit Amount Failed
Quarter =2	-0.037***	-0.056**	-0.028	-0.035***	-0.055**	-0.027
Standard Error	(0.005)	(0.024)	(0.017)	(0.012)	(0.025)	(0.018)
Observation	389858	64706	92216	136822	64706	92216
R-squared	0.911	0.951	0.940	0.932	0.950	0.939
Quarter =3	-0.037***	-0.062***	-0.039***	-0.047***	-0.062***	-0.039***
Standard Error	(0.004)	(0.019)	(0.014)	(0.010)	(0.019)	(0.014)
Observation	453616	73417	108242	158048	73417	108242
R-squared	0.869	0.925	0.909	0.898	0.925	0.908
Quarter =4	-0.032***	-0.059***	-0.020	-0.038***	-0.058***	-0.021
Standard Error	(0.004)	(0.020)	(0.014)	(0.011)	(0.020)	(0.014)
Observation	503400	80230	121061	174895	80230	121061
R-squared	0.839	0.905	0.885	0.872	0.905	0.884
Quarter =5	-0.040***	-0.050**	-0.036**	-0.047***	-0.051**	-0.035**
Standard Error	(0.006)	(0.021)	(0.014)	(0.011)	(0.021)	(0.014)
Observation	533911	85882	130757	187939	85882	130757
R-squared	0.817	0.887	0.867	0.851	0.886	0.866
Quarter =6	-0.055***	-0.060***	-0.035**	-0.050***	-0.060***	-0.035**
Standard Error	(0.005)	(0.017)	(0.014)	(0.010)	(0.017)	(0.014)
Observation	561063	92254	139513	200551	92254	139513
R-squared	0.798	0.868	0.851	0.831	0.868	0.850
Quarter =7	-0.068***	-0.072***	-0.058***	-0.077***	-0.072***	-0.058***
Standard Error	(0.006)	(0.022)	(0.016)	(0.013)	(0.022)	(0.017)
Observation	580625	95287	144879	207648	95287	144879
R-squared	0.784	0.858	0.839	0.818	0.857	0.838
Quarter =8	-0.074***	-0.079***	-0.078***	-0.093***	-0.079***	-0.076***
Standard Error	(0.007)	(0.026)	(0.021)	(0.016)	(0.027)	(0.022)
Observation	594311	96928	147464	211285	96928	147464
R-squared	0.773	0.852	0.834	0.811	0.851	0.832
Quarter =9	-0.047***	-0.077**	-0.041	-0.084***	-0.078**	-0.044
Standard Error	(0.008)	(0.037)	(0.035)	(0.024)	(0.037)	(0.035)
Observation	601450	97783	148519	212903	97783	148519
R-squared	0.768	0.848	0.830	0.807	0.848	0.829
Quarter =10	-0.037***	-0.011	-0.146**	-0.080**	-0.015	-0.142**
Standard Error	(0.013)	(0.063)	(0.069)	(0.040)	(0.064)	(0.071)
Observation	603112	98012	148761	213319	98012	148761
R-squared	0.767	0.847	0.830	0.806	0.847	0.828

TABLE A.12: Users with Transaction amount less than 500 - AEPS

The organization of this table mimics the organization of Table 4. The sample is restricted to users whose maximum transaction value is Rupees. 500.

	Proportion of Failure	Proportion of Deposit Fails	Proportion of Withdrawal Fails	Proportion of Total Amount Failed	Proportion of Deposit Amount Failed	Proportion of Deposit Amount Failed
Quarter =2	-0.004	0.008	-0.004	-0.003	0.008	-0.003
Standard Error	(0.006)	(0.038)	(0.007)	(0.006)	(0.038)	(0.007)
Observation	299431	23817	287861	299431	23817	287861
R-squared	0.924	0.963	0.924	0.920	0.962	0.921
Quarter =3	-0.015***	-0.023	-0.015***	-0.015***	-0.024	-0.015***
Standard Error	(0.005)	(0.026)	(0.006)	(0.005)	(0.027)	(0.006)
Observation	355908	29446	342100	355908	29446	342100
R-squared	0.889	0.940	0.890	0.884	0.938	0.885
Quarter =4	-0.011**	-0.023	-0.011*	-0.011**	-0.022	-0.011**
Standard Error	(0.005)	(0.024)	(0.005)	(0.005)	(0.025)	(0.005)
Observation	397425	34023	381864	397425	34023	381864
R-squared	0.864	0.922	0.865	0.858	0.920	0.860
Quarter =5	-0.017**	-0.020	-0.017**	-0.016**	-0.022	-0.015*
Standard Error	(0.008)	(0.025)	(0.008)	(0.008)	(0.026)	(0.008)
Observation	420655	37292	403719	420655	37292	403719
R-squared	0.850	0.910	0.851	0.844	0.907	0.846
Quarter =6	-0.027***	-0.058**	-0.019***	-0.024***	-0.060**	-0.015**
Standard Error	(0.006)	(0.024)	(0.007)	(0.007)	(0.024)	(0.007)
Observation	438636	40405	420424	438636	40405	420424
R-squared	0.839	0.899	0.840	0.833	0.896	0.835
Quarter =7	-0.044***	-0.046*	-0.042***	-0.042***	-0.042	-0.041***
Standard Error	(0.008)	(0.026)	(0.009)	(0.008)	(0.027)	(0.009)
Observation	452190	42602	433111	452190	42602	433111
R-squared	0.831	0.887	0.832	0.825	0.884	0.827
Quarter =8	-0.062***	-0.042*	-0.072***	-0.061***	-0.043*	-0.073***
Standard Error	(0.010)	(0.024)	(0.011)	(0.010)	(0.025)	(0.011)
Observation	461759	44888	441816	461759	44888	441816
R-squared	0.825	0.877	0.826	0.819	0.873	0.821
Quarter =9	-0.054***	-0.043**	-0.062***	-0.053***	-0.043**	-0.062***
Standard Error	(0.010)	(0.021)	(0.012)	(0.010)	(0.021)	(0.012)
Observation	467707	46784	447055	467707	46784	447055
R-squared	0.821	0.869	0.823	0.815	0.865	0.817
Quarter =10	-0.042***	-0.050*	-0.031	-0.037**	-0.045	-0.029
Standard Error	(0.016)	(0.028)	(0.020)	(0.016)	(0.029)	(0.020)
Observation	469234	47385	448385	469234	47385	448385
R-squared	0.820	0.866	0.821	0.814	0.862	0.816

TABLE A.13: User Revealed Preference with Modified Failure - AEPS - Three Months

The table description is same as Panel-A in Table 7. Except that the independent variables assume modified failure

	Biometric			Technical			Non Technical		
	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity
Failure	0.001**	0.004***	-0.001*	0.019***	-0.007***	0.008***	0.004***	0.004***	0.005***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Deposit	0.006***	0.394***	-0.020***	0.006***	0.395***	-0.018***	0.007***	0.381***	-0.019***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.013)	(0.001)
Withdrawal	-0.020***	-0.139***	0.022***	-0.019***	-0.143***	0.020***	-0.019***	-0.144***	0.020***
	(0.001)	(0.012)	(0.001)	(0.001)	(0.013)	(0.001)	(0.001)	(0.013)	(0.001)
User Expereince	0.007***	-0.000*	0.003***	0.007***	-0.001***	0.003***	0.008***	-0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	-0.000	0.002***	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***	0.000**	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5368068	5368068	5368068	4609647	4609647	4609647	5205019	5205019	5205019
Adjusted R-Squared	0.763	0.539	0.870	0.743	0.475	0.865	0.729	0.494	0.858

TABLE A.14: User Revealed Preference with Modified Failure Amount - AEPS - Three Months

The table description is same as Table 8. Except that the independent variables assume modified failure

	Biometric			Technical			Non Technical		
	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity
Failure Amount	-0.000***	0.000***	-0.000***	0.000***	0.000*	0.000***	-0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Deposit	0.006***	0.394***	-0.020***	0.006***	0.395***	-0.018***	0.007***	0.382***	-0.019***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.013)	(0.001)
Withdrawal	-0.020***	-0.139***	0.022***	-0.019***	-0.143***	0.020***	-0.019***	-0.137***	0.021***
	(0.001)	(0.012)	(0.001)	(0.001)	(0.013)	(0.001)	(0.001)	(0.012)	(0.001)
User Expereince	0.007***	-0.000*	0.003***	0.007***	-0.001***	0.003***	0.008***	-0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	-0.000	0.002***	-0.002***	0.000	0.002***	-0.002***	0.000	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5368068	5368068	5368068	4609647	4609647	4609647	5205019	5205019	5205019
Adjusted R-Squared	0.763	0.539	0.870	0.743	0.475	0.865	0.729	0.496	0.858

TABLE A.15: Propensity of a Successful Activity with Modified Failure - AEPS - Three Months

The table description is same as Table 9. Except that the independent variables assume modified failure

	Biometric		**Technical**		**Non Technical**	
	Success	**Success**	**Success**	**Success**	**Success**	**Success**
Failure	0.004***		0.026***		0.004**	
	(0.001)		(0.001)		(0.002)	
Failure Amount		-0.000***		0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Deposit	0.005***	0.005***	0.006***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Withdrawal	-0.021***	-0.021***	-0.020***	-0.020***	-0.018***	-0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
User Experience	0.009***	0.009***	0.008***	0.008***	0.010***	0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5368068	5368068	4609647	4609647	5205019	5205019
Adjusted R- squared	0.774	0.774	0.744	0.743	0.755	0.755

TABLE A.16: User Revealed Preference with Failure - AEPS - Six Months

The table description is same as Table 7. Except that dependant variables take a value of one, if a user does a transaction in the next six months.

	Biometric			Technical			Non Technical		
	Activity	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**	**Activity**	**Otheractivity**	**Voluntaryactivity**
Failure	-0.000	0.006***	-0.001***	0.014***	-0.006***	0.009***	0.001	0.007***	0.005***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Deposit	0.005***	0.406***	-0.011***	0.005***	0.405***	-0.010***	0.006***	0.392***	-0.010***
	(0.001)	(0.015)	(0.001)	(0.001)	(0.015)	(0.001)	(0.001)	(0.015)	(0.001)
Withdrawal	-0.015***	-0.200***	0.015***	-0.014***	-0.205***	0.013***	-0.013***	-0.208***	0.013***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.014)	(0.001)
User Expereince	0.005***	-0.001**	0.004***	0.004***	-0.001***	0.003***	0.005***	-0.000*	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	0.001**	0.002***	-0.002***	0.001***	0.002***	-0.002***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000**	-0.000***	-0.000***	0.000**	-0.000***	-0.000***	0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.779	0.573	0.893	0.752	0.502	0.888	0.742	0.521	0.880

TABLE A.17: User Revealed Preference with Failure Amount- AEPS - Six Months

The table description is same as Table 8. Except that dependant variables take a value of one, if a user does a transaction in the next six months.

	Biometric			Technical			Non Technical		
	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity
Failure Amount	-0.000***	0.000***	-0.000***	0.000***	0.000***	0.000***	-0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Deposit	0.005***	0.406***	-0.011***	0.005***	0.406***	-0.010***	0.006***	0.394***	-0.010***
	(0.001)	(0.015)	(0.001)	(0.001)	(0.015)	(0.001)	(0.001)	(0.015)	(0.001)
Withdrawal	-0.015***	-0.200***	0.015***	-0.014***	-0.205***	0.014***	-0.014***	-0.198***	0.014***
	(0.001)	(0.013)	(0.001)	(0.001)	(0.014)	(0.001)	(0.001)	(0.014)	(0.001)
User Expereince	0.005***	-0.001**	0.004***	0.004***	-0.001***	0.003***	0.005***	-0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.002***	0.001**	0.002***	-0.002***	0.001***	0.002***	-0.002***	0.001**	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	-0.000***	-0.000***	0.000*	-0.000***	-0.000***	0.000**	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.779	0.574	0.893	0.752	0.502	0.888	0.742	0.524	0.880

TABLE A.18: Propensity of a Successful Activity with Failure - AEPS - Six Months

The table description is same as Table 9. Except that dependant variables take a value of one, if a user does a transaction in the next six months.

	Biometric		**Technical**		**Non Technical**	
	Success	**Success**	**Success**	**Success**	**Success**	**Success**
Failure	0.000		0.018***		-0.005***	
	(0.001)		(0.001)		(0.002)	
Failure Amount		-0.000***		0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Deposit	0.004***	0.004***	0.005***	0.004***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Withdrawal	-0.015***	-0.015***	-0.014***	-0.014***	-0.012***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
User Experience	0.006***	0.006***	0.005***	0.005***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BC Experience	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Transaction Amount	0.000***	0.000***	0.000***	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	5297442	5297442	4428530	4428530	5060962	5060962
Adjusted R- squared	0.791	0.791	0.749	0.749	0.769	0.769

TABLE A.19: User Revealed Preference with Multiple Failures - AEPS - Six Months

The table description is same as Table 10. Except that dependant variables take a value of one, if a user does a transaction in the next six months.

	Biometric			Technical			Non Technical		
	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity	Activity	Otheractivity	Voluntaryactivity
Failure	-0.002***	0.009***	0.000	0.012***	-0.017***	0.009***	-0.003***	-0.002	0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)
Two Failure	0.000	0.003***	-0.000	0.004***	0.007***	0.001	0.004***	0.002	0.002***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Three Failure	0.002***	0.002**	0.000	0.000	0.006**	-0.001	0.002*	0.001	0.002**
	(0.001)	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)
Four Failure	0.000	0.001	0.000	-0.001	-0.002	-0.001	0.002	0.003	0.001
	(0.001)	(0.001)	(0.000)	(0.002)	(0.004)	(0.002)	(0.001)	(0.003)	(0.001)
Five Failure	0.001	0.001	0.000	0.002	0.006	0.002	-0.000	-0.003	0.002
	(0.001)	(0.002)	(0.000)	(0.002)	(0.006)	(0.002)	(0.002)	(0.005)	(0.002)
More than Five Failure	0.001	0.001	0.000	-0.001	0.002	0.003	0.001	-0.005	0.003
	(0.002)	(0.002)	(0.001)	(0.004)	(0.014)	(0.007)	(0.003)	(0.006)	(0.003)
Observation	5297442	5297442	5297442	4428530	4428530	4428530	5060962	5060962	5060962
Adjusted R-Squared	0.777	0.476	0.891	0.750	0.386	0.885	0.740	0.421	0.878