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The Impact of Mobile Money on Poor Rural Households

Experimental Evidence from Uganda

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Abstract

This paper studies the effect of rolling out mobile money agents in rural Northern Uganda. In a randomized experiment, 168 areas were randomly selected to receive an agent in 2017, with another 163 areas serving as a control group. Administrative data on mobile money transactions suggest that the agent rollout increased the probability of sending and receiving peer-to-peer transfers. Data from a 2018 survey of more than 4,500 households show that the agent rollout led to cost-savings for remittance transactions. It also doubled the nonfarm self-employment rate, from 3.4 to 6.4 percent, and reduced the fraction of households with very low food security from 62.9 to 47.2 percent, in areas far from a bank branch. The analysis finds no effect on savings, agricultural outcomes, or poverty. Overall, the findings add new evidence that mobile money can improve livelihoods even in poor and remote settings.

This paper is a product of the IFC-Mastercard Foundation Partnership for Financial Inclusion. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at cwieser@worldbank.org and mbruhn@worldbank.org.

The Impact of Mobile Money on Poor Rural Households: Experimental Evidence from Uganda[1]

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1. Introduction

Digital Financial Services (DFS) have spread rapidly in developing countries, enabling mobile phone users to make financial transactions on their phone, such as transferring money, buying airtime, and paying bills. Recent evidence suggests that mobile money has allowed households to smooth consumption in the face of shocks (Jack and Suri 2014) and that it has increased per capita consumption levels and decreased poverty in the long-run (Suri and Jack 2016; Munyegera and Matsumoto 2016).

The most commonly documented channel through which mobile money can affect consumption is increased remittance transactions and risk sharing. Jack and Suri (2014) show that M-PESA users in Kenya are more likely to receive remittances (particularly after experiencing shocks) and these come from more different senders (see also Jack, Ray, and Suri 2013). Blumenstock, Eagle and Fafchamps (2016) find that Rwandans used the mobile phone network to transfer airtime to those affected by an earthquake.[2] Munyegera and Matsumoto (2016) show that mobile money adopters in rural Uganda receive more and larger remittances than non-users.

We study the effect of mobile money in a setting where remittances are less prevalent than in previous studies: households in rural areas of Northern Uganda, where only 15 percent of households report receiving remittances compared to 40 percent in Jack and Suri (2014) and 65 percent in Munyegera and Matsumoto (2016). Apart from increasing remittance transactions, mobile money can potentially benefit households through other channels. For example, Sekabira and Qaim (2017) find that mobile money can increase the income of coffee farmers in Central Uganda by facilitating transactions with new buyers. The areas we study tend to be poorer than those in Sekabira and Qaim (2017)[3] and most agricultural households tend to focus on subsistence farming.

Apart from high poverty rates, areas in our sample also have low access to financial services, with the median distance to a bank branch being 25.2km. In this context, we ask whether and how rolling out mobile money agents affects households' financial behavior, occupational choices, food security, and poverty rates. Several studies have found that bringing financial services, bank accounts in particular to rural areas in developing countries can increase savings, business investment and income.[4] In contrast, Dupas et al. (2018) found households in their study in Malawi and Central Uganda were simply too poor to save in bank accounts. In their setting, the high transaction costs of having to go to a bank branch may also have played a role; so branchless banking such as through mobile money linked accounts may have higher impacts on savings (Suri and Jack 2016).

The underlying question in this study is whether the areas in our sample are too remote and poor to benefit from mobile money (since they receive few remittances and may not have enough income to save)

[2] Rwanda did not have a functioning mobile money system at the time, hence the focus on transferring airtime. These findings are also in line with Yang and Choi (2007) who document that Philippine households receive more overseas remittances when they experience income shocks, so that those remittances could be used to smooth consumption.

[3] The proportion of the population living in poverty in Uganda increased from 19.7 percent in 2012/13 to 21.4 percent in 2016/17, an equivalent of about 10 million people living below the poverty line. The Northern region is among the poorest regions in the country with poverty rates decreasing from 43.7 to 32.5 percent between 2012/13 and 2016/17 (UBOS, 2018).

[4] See Burgess and Pande (2005) and Young (2015) for India, Bruhn and Love (2014) for Mexico, Dupas and Robinson (2013) for Kenya, Brune et al. (2016) for Malawi, and Prina (2015) for Nepal.

or whether mobile money can help households to increase remittance receipts and/or increase savings in mobile accounts. If so, whether increased financial flows into rural areas have measured impact on beneficiary livelihoods. Another potential benefit of mobile money in our remote sample is that it implies non-negligible cost savings for financial transactions. For example, households who receive remittances typically paid 4,000 Ugandan shillings (US$1) per transaction in transportation costs, which in our study area represents about 10 percent of per capita daily household expenditures.

To measure the effect of mobile money in poor and remote areas, the International Finance Corporation (IFC) collaborated with Airtel Uganda to implement a field experiment in Northern Uganda covering a geographic area of approximately 125,000km^2 where 334 clusters of enumeration areas (EAs) were randomly assigned to a treatment or a control group, stratified by distance to a bank branch. None of the clusters had Airtel Money agents at baseline. In the treatment group, Airtel Money agents were rolled out in 2017, with 46 percent of clusters receiving at least one agent.

Data on about 4,000 households from a 2018 follow-up survey show that the agent rollout increased the percentage of households using mobile money by about 4.2 percentage points. That is, the agent rollout increased the percentage of households using mobile money from 12.6 percent in the control group to 16.8 percent in the treatment group, in clusters farther away than 25.2km from a bank branch,[5] with no effect in areas closer to a bank branch.

However, in areas far from a bank branch, we find that those who receive or send remittances were less likely to report high costs in treatment clusters than in control clusters, after the rollout. These decreased costs reflect lower transportation costs, as those who received remittances in treatment clusters were 13 percentage points less likely to pay transportation costs, such as motorcycle or mini-bus taxi fees, associated with the transaction. That is, in the follow-up survey, 82 percent of remittance receivers in treatment areas far from a bank branch reported not paying transportation costs for the transaction, compared to 69 percent not paying transportation costs in the control group. In line with the previous literature, administrative data from Airtel on mobile money transactions also suggest that the agent rollout increased the probability of sending and receiving peer-to-peer (P2P) transfers.

In contrast to Suri and Jack (2016) we find no effect of the agent rollout on savings. We also do not see an effect on the probability of owning livestock or agricultural outcomes, including the amount spent on seeds or fertilizer use. However, in areas far from a bank branch, the agent rollout statistically significantly increased the fraction of survey respondents who work in non-farm self-employment, by 3 percentage points. That is, in the follow-up survey, 6.4 percent of households in treatment areas far from a bank branch reported working in non-farm self-employment, compared to 3.4 percent in the control group. In line with this finding, we observe that the agent rollout changed the way in which households respond to negative shocks, such as a drought or flood. The rollout increased the probability of taking work to cope with the shock and it reduced the probability of changing the household's diet. Further, consistent with this result, we find a strong effect of the agent rollout on food security. In areas far from a bank branch, the agent rollout lowered the probability of having to reduce the number of meals in the last 7 days by 11.8 percentage points. That is, in treatment areas far from a bank branch, 36.8 percent of households reported having to reduce meal, compared to 48.6 percent in the control group. However, we do not find

[5] We picked 25.2km to look at heterogenous treatment effects in the analysis since it is the median distance to a bank branch across the clusters in our sample.

an effect of the agent rollout on our measure of poverty, which is computed based on the SWIFT (Survey on Well-being via Instant and Frequent Tracking) imputation approach.

Our finding that the agent rollout increased non-farm self-employment mirrors the results in Sekabira and Qaim (2017) who also conclude that mobile money increased non-farm income. Sekabira and Qaim do not pin down the channel through which mobile money increased non-farm income. The channel in our setting is likely that households used their increased P2P transfer receipts and cost savings from remittance transactions to invest in self-employment, which in turn generated income that raised food security. The fact that most of our statistically significant effects come from clusters far from a bank branch supports the argument that transaction cost savings contribute to the effect.

Thus, overall, we find that mobile money stimulates self-employment and increases food security in rural Northern Uganda. We conclude that mobile money services can improve livelihoods even in very poor and remote areas.

The rest of this paper proceeds as follows. Section 2 provides background information on mobile money in Uganda. Section 3 discusses the study design and agent rollout. Section 4 describes the data and methods. Section 5 presents the results and Section 6 concludes.

2. Mobile Money in Uganda

According to a recent study, 70.9 percent of Ugandans owned a mobile phone; with higher penetration rates in urban (78.5 percent) compared to rural areas (65.7 percent) in 2017 (CIPESA 2018). Most mobile phone owners (73.7 percent) used MTN as their service provider, followed by Airtel (61.4 percent) and Africell (7.3 percent) (multiple selections possible).

Our study focuses on rural Northern Uganda, where penetration of mobile phones is much lower. Data from our follow-up survey, conducted in early 2018 show only 27.6 percent of households own a mobile phone. However, we observe that people tend to share or use someone else's phone since a higher proportion (39.9 percent) of households reported that they have access to a mobile phone. Our study also shows that the most popular mobile phone provider in rural Northern Uganda is MTN. Conditional on access to a mobile phone, 74.7 percent of households use MTN, 7.9 percent use Airtel, and 9.9 percent use Africell as their service provider. Airtel's presence in rural areas of Northern Uganda thus falls short compared to their national presence (table 1).

In 2009, MTN launched its mobile money platform and it has since then dominated the mobile money market in Uganda. However, several competitors have entered the market, including three mobile network operators (MNO) – Airtel, Africell, and Uganda Telecom through M-Sente – and a few non-MNO mobile payment providers, such as M-Cash, Ezee Money, and Micro-pay.

Mobile financial services have seen sharp growth in recent years, reaching 22.9 million registered customers in June 2017 being served by 147,146 agents and accumulating into 1,111 million transactions and 52.8 trillion Ugandan shillings (approx. 14.6 billion USD) in transaction value from June 2016 to June 2017. Nationwide, 62.1 percent of mobile phone owners sent or transferred money using electronic methods (Bank of Uganda 2017). Northern Uganda lags behind the rest of the country in terms of

availability and use of digital financial services with less than 3 percent of all agents operating in Northern Uganda, the majority of which (76 percent) were MTN mobile money agents.[6]

For this study, IFC collaborated with Airtel to roll-out Airtel Money agents in Northern Uganda in geographical areas not yet served by Airtel Money. Airtel Money was launched in January 2012, and its agents offer a variety of services including cash withdrawals, cash deposits, purchase of airtime, sending and receiving money, bill payment (such as school fees and utilities), and payment for goods and services. Despite Airtel Money's ambition to increase the delivery of financial services to the Ugandan population, growth in Northern Uganda has been slow. IFC has had an interest in increasing Airtel's mobile money market share by improving and strengthening its operations for two reasons: (i) to increase the outreach of mobile money into remote communities and (ii) to strengthen the competitive environment of mobile money in Uganda, avoiding a monopolistic environment, with active competition, and to improve pricing, sharing of agents and the potential for interoperability of mobile money providers.

3. Study Design and Agent Rollout

3.1 Study Design

The study was conducted in rural areas in the North of Uganda, covering the three regions West Nile, Mid-North and Karamoja. The Ugandan Bureau of Statistics (UBOS) helped to define the study sample. As a starting point, all rural enumeration areas in all sub-counties in the West Nile, Mid-North and Karamoja regions were used. From this list, sub-counties that had an Airtel Money agent present were dropped, based on an agent database provided by the Bill and Melinda Gates Foundation. A random sample of 1,200 enumeration areas (EAs) was drawn from all rural enumeration areas in the remaining 249 sub-counties using population proportional to size sampling. The sample was implicitly stratified by sub-county to ensure that it included enumeration areas from all sub-counties.

In September and October 2015, a household listing exercise was conducted in the EAs selected for the study to generate a sampling frame that could be used for the baseline survey. At the same time, all businesses in each EA were listed to gain information on potential mobile money agents in the EA. To minimize potential spillovers of agents to control group EAs, the selected EAs were mapped and grouped into clusters based on proximity. A 0.5km buffer was drawn around the boundary of each EA and EAs whose buffers overlapped were grouped. Clusters were thus at least 1km apart from each other.

In this process, some EAs were dropped from the sample since either the listing exercises could not be conducted (for logistical or security reasons), the listing did not yield any businesses and thus no potential agents, or the maps were missing from the software to group EAs into clusters. As a result, there were 929 EAs that were grouped into 658 clusters.

Using a computer assisted stratified randomization approach, 329 clusters were assigned to a treatment group and 329 clusters to a control group. The treatment clusters formed the list of EA clusters where Airtel Money agents were to be rolled out. No such agents were to be rolled out in control clusters.

The randomization strata were based on three variables. First, a variable equal to one if the cluster included more than one EA (which was the case for 16 percent of clusters) and equal to zero if the cluster

[6] Based on an agent map provided by the Bill and Melinda Gates foundation, available at: http://www.fspmaps.com/#/Uganda/finance.

included only one EA. Second, a variable equal to one if the distance to the nearest bank branch was greater than the median distance across all clusters (25.2km) and equal to zero otherwise. These bank branches refer to Airtel partner banks and the distance was calculated as the closest distance from any point on the cluster boundary. The main reason for stratifying on this variable was that Airtel raised concerns as to whether agents that are further away from these banks can operate well since they may have a harder time maintaining liquidity. On the other hand, distance to an Airtel partner bank is likely also correlated with distance to urban centers and other financial services, so that clusters that are further away from a branch may see greater benefits from obtaining an agent. The third stratification variable was based on a strategic priority rating provided by Airtel, ranging from 1 to 4. In clusters with greater priority, more time was to be spent on rolling out agents than in areas with low priority. In total, 16 strata were created.

3.2 Agent Rollout

The Airtel Money agent rollout took place in treatment clusters between January and June 2017. A professional services firm was hired to assist with identifying potential agents.[7] This firm also helped agents with the logistics of signing-up to become Airtel Money agents and provided them with the necessary equipment, training, and marketing materials. The research team closely supervised the professional services firm and quality-checked information provided by them.

During the roll-out, the professional services firm activated 400 agents who undertook a successful first transaction. To further assess the extent of activity among these agents, we matched the phone numbers associated with these agents with Airtel Money transactions data. The records provided by the professional services firm do not fully line up with the Airtel data: only 370 of the 400 agents were found in the Airtel data, which could potentially be due to typos in the recorded phone number.

Based on the matched 370 phone numbers, panel A of figure 1 shows the number of active agents in the Airtel Money transactions data per month from December 2016 to November 2017. The number of active agents steadily increased, reaching a high of 285 in August 2017 with a relatively stable number of agents through November 2017.[8] Usage for the active agents grew steadily as can be seen in panel B of Figure 1. The total number of transactions across all agents reached over 24,000 transactions, with an average of 70 transactions per agent per month (conditional on having any transactions that month).[9]

Although the agent rollout specifically targeted treatment areas, the implementation was not exact. The administrative records from the agent roll-out list the EA cluster where the agent is located. To verify these locations, we used GPS coordinates that were available for 375 agents. About 45 percent of GPS locations are inside a treatment cluster and another 39 percent were within 1km of a treatment area, with

[7] As a starting point to identify agents, information from the 2015 business listing exercise was used. The following information was collated into an index: (i) Number of employees; (ii) Type of business (service, retail, others); (iii) Annual turnover; (iv) Proximity to closest bank branch; (v) Business closed when visiting bank branch; and (vi) Business used mobile money before. In treatment areas with more than one listed business, the business with the highest index score was selected to be the first business to be approached.

[8] Not all 370 rolled-out agents transacted at the same time in any of the months, therefore the highest number of agents shown for August 2017 is lower than 370.

[9] Agent transactions in the transaction database include cash-in and cash-out transactions, peer-to-peer transfers, and top ups.

a total of 94 percent falling within 2km of a treatment area. Two GPS locations were inside a control area, about 2 percent were within 1km of a control area and 13.6 percent fell within 2km of a control area.

Agents were not evenly distributed across clusters. Among the 161 treatment group clusters with a low priority rating from Airtel (a rating of 1 or 2), only 24 percent of clusters received at least one agent during the rollout. None of the 163 control group clusters with a low priority rating received an agent. Among the 168 treatment clusters with a high priority rating (3 or 4), 46 percent of clusters received at least one agent. Close to 2 percent of the 166 control clusters with a high priority rating also received an agent.

Since the rollout resulted in such low agent penetration for low priority clusters, the impact analysis focuses only on high priority clusters. Given this, the 168 low priority clusters were dropped from the sample and only the 334 high priority clusters were retained. Our results here thus apply to areas that were deemed high priority based on Airtel's business strategy. Figure 2 shows the 334 high priority clusters.

According to 2015 data provided by the Bill and Melinda Gates Foundation, in the study sample of 334 clusters, only three clusters had a mobile money agent before the agent rollout. All three were MTN agents. For 39 clusters, an agent was located within 1km of the cluster border (again mostly MTN agents), but for the remaining 295 clusters, the closest agent was more than 1km away, with an average distance of 8km to the closest agent. Figure 3 shows the Gulu district as an example, illustrating the location of treatment and control clusters, along with pre-existing agents and Airtel agents that were rolled out as part of this study.

4. Data and Methods

4.1 Survey Data

We use panel data collected in two survey rounds from randomly selected households in rural Northern Uganda. Based on the household listing exercise conducted in September and October 2015 (see section 3.1), we randomly selected 8 households in each EA for a baseline survey to be conducted in December 2015 and January 2016, giving a total sample of 3,720 households across the 334 clusters (466 EAs) included in the analysis.[10]

In the follow-up survey conducted two years after the baseline, in January and February 2018, we interviewed 9 households in each EA, increasing the sample size to a total of 4,541 households.[11] We

[10] For each EA, 8 "original households" and 7 "substitute households" were randomly drawn from the household list collected during the listing exercise. During fieldwork, interviewers were provided with a list of only the 8 original households to be interviewed in each EA. The survey interviewed household heads or household members aware or involved in making financial decisions within the household. In cases where such a respondent was not available, the interviewer made 3 call-backs to the household before it was replaced with a substitute household from the substitution list. In cases were the household declined to participate or had moved to another location, the interviewer substituted that household without making 3 call-backs. Overall, 91.3 percent of the households interviewed were original households while 8.7 percent were substitute households.

[11] The baseline survey had also interviewed households in EAs that were dropped prior to randomization for the reasons described in section 3. Instead of re-interviewing households in the dropped EAs, we increased the sample size in the 929 EAs included in the randomization. For each EA, field supervisors were provided with a list of 8 households interviewed during the baseline as well as one or two additional households randomly drawn from the household listing. In addition, they were provided with 15 randomly drawn substitution households. The larger

aimed to re-interview baseline households in the second round. Of the 3,720 households interviewed in the baseline survey, we re-interviewed 3,082 households during the follow-up survey, implying an attrition rate of 17 percent (equally distributed in the treatment and control groups).[12] Households that could not be re-interviewed were replaced with other randomly sampled households in the same EA. Additional households (1 per EA) were also sampled randomly in the same locations.

In both survey rounds, we conducted face-to-face interviews. The questionnaire focused on details of sociodemographic details of households, labor outcomes of the respondents, information on usage of mobile phones and mobile money, financial transactions, as well as food security and shocks. Some of these questions were added in the follow-up survey and were thus not available at baseline.

4.2 Airtel Transactions Data

We obtained monthly data from Airtel on mobile money transactions for the years 2016 and 2017 (going up to November 2017), including seven types of transactions: sending a P2P transfer, receiving a P2P transfer, cash-in, cash-out, bill pay, airtime top-up and data top-up.

To analyze these data, we had to map them to our study clusters, which was not a straightforward exercise. We have the phone number associated with each transaction, however, we do not have information on who owns the phone number or where the owner is located. The location can be approximated by the location of the cell phone tower the number uses the most. However, the radius of cell phone towers is rather large (up to 40km) which means that it could cover multiple clusters in our study.

We thus mapped the transaction data to our study locations by using the phone numbers households reported in our baseline and follow-up surveys. That is, we complied a list of all phone numbers ever reported by the households in our follow-up survey and merged these data with the call records. We then sum the number of transactions in each category across all phone numbers associated with a study cluster to get the total number of transactions per cluster. Taking all categories together, this gives us only 2.4 transactions per cluster per month, on average. Since the agent data discussed in section 3.2 suggest that not all agents transact each month, we further sum the data across months, to obtain yearly totals for 2016 and 2017.

Table 2a displays the average number of transactions in the different categories for our 334 study clusters in 2016 and 2017, with all transactions combined, showing an average of 15.5 in 2016 and 24.9 in 2017. The table also shows that less than 15 percent of clusters had any transactions each year. In the impact analysis below, we thus use dummy variables as outcome variables, where the dummy variables are equal to one if a cluster had any transactions, in a given category, and equal to zero otherwise. Table 2b shows that these dummy variables were not statistically significantly different across treatment and control clusters before the agent rollout took place, i.e. in 2016.

number of substitution households provided reflects the expectation that more households might have moved or dissolved due to the two-year time gap since the household listing.

[12] Around 90 percent of all attrition cases were due to the household having left the enumeration area since the baseline survey was conducted. The remaining cases were the result of respondents being temporarily unavailable or refusing to participate, or the household having dissolved (e.g. because of the death of the household head).

4.3 SWIFT Poverty Measure

To gauge and understand households' welfare trends and the impact of mobile financial services on poor rural households, the SWIFT approach was used. SWIFT is a rapid poverty assessment tool. It produces accurate household expenditure and poverty data in a timely, cost-effective and user-friendly manner. It has been used to improve availability of official poverty statistics and monitoring welfare impact of projects prepared by various Global Practice Groups of the World Bank and IFC. Compared with typical household consumption data collection in which household consumption or income data are collected via a complex and long consumption module, SWIFT collects information on poverty correlates, which are then used to impute household expenditure via a survey-to-survey imputation technique. Subsequently, poverty estimates from the imputed expenditure data are calculated.[13]

4.4 Impact Estimation

We estimate the impact of the Airtel Money agents with the following intention-to-treat (ITT) equation

$$y_{i,c,s} = \alpha + \beta \mathrm{Agent}_{c,s} + \sum \gamma_s d_s + \delta \mathrm{Male}_{i,c,s} + \varepsilon_{i,c,s} \qquad (1)$$

where $y_{i,c,s,}$ is a follow-up survey measure of mobile money usage, financial behavior, or other outcome of household i, in cluster c and randomization strata s. The variable $\mathrm{Agent}_{c,s}$ indicates whether the cluster was randomly selected for the agent rollout and is thus equal to one for the treatment group and equal to zero for the control group. We control for randomization strata dummies d_s, as well as for whether the household head is male $\mathrm{Male}_{i,c,s}$ since table 2a shows that the fraction of male household heads is slightly larger in the treatment group than in the control group. When data on the outcome were collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing (because the household was not interviewed at baseline or due to nonresponse), we replace this value with zero and include a dummy variable indicating that the value is missing, to keep the observation in the sample. Standard errors are clustered at the EA cluster level.

The main coefficient of interest is β, which represents the treatment effect of the cluster being selected for the agent rollout. The coefficient β in equation 1 is also equal to the difference in means of the outcome variable $y_{i,c,s,}$ across the treatment and control groups, conditional on strata dummies and household head gender.

In heterogenous treatment effect regressions, we examine whether the effect of the agent rollout varies by distance to a bank branch. As described in section 3, we stratified the randomization by whether the distance from the cluster to the nearest bank branch was greater than 25.2km or not. In equation 1 we replace the treatment variable $\mathrm{Agent}_{c,s}$ with two interaction terms, as follows

[13] The basic idea of the SWIFT methodology is to first create consumption models based on a national household survey in which both consumption data and data on poverty correlates are available and reliable. The model identifies the most closely correlated variables to poverty estimates. We then identify the corresponding survey questions to the variables included in the model and collect data on these variables. The marginal cost of adding these, typically 10-15, survey questions is negligible. Once the consumption model is obtained, the Multiple Imputation method that performs repeated drawings on different random components as well as coefficients was employed to detect the accuracy of prediction and stability of the model over time.

$$y_{i,c,s} = \alpha + \beta^{Far} Agent_{c,s} * Far_{c,s} + \beta^{Near} Agent_{c,s} * Near_{c,s} + \sum \gamma_s d_s + \delta Male_{i,c,s} + \varepsilon_{i,c,s} \quad (2)$$

where $Far_{c,s}$is a dummy variable equal to one if the distance from the cluster to the nearest bank branch was greater than 25.2km and equal to zero otherwise. Similarly, $Near_{c,s}$ is a dummy variable equal to one if the distance from the cluster to the nearest bank branch was smaller than or equal to 25.2km and equal to zero otherwise. The coefficient β^{Far} represents the effect of the agent rollout for clusters that are more than 25.2km away from a bank branch, while β^{Near} gives the effect of the agent rollout for clusters that are less than or equal to 25.2km away from a bank branch.

5. Results

5.1 Descriptive Statistics

Table 3a shows summary statistics. Column 2 reports the sample size, which can vary from question to question due to nonresponse and since some questions were only asked conditional on answers to other questions. Columns 2 through 4 report averages and standard deviations separately for the control group and then the treatment group. Column 5 shows the p-value of the difference in treatment and control group means, conditional on strata dummies.

Since the sample at follow-up included some households that were different from the baseline sample, panel A in table 3a shows data from the baseline survey, and then panel B shows data from the follow-up survey to check whether background characteristics were balanced across the treatment and control groups in the follow-up sample. The background data from the follow-up survey look very similar to those from the baseline survey.

Overall, the control and treatment group means are close to each other for all variables, as can be expected due to random assignment. The p-values are higher than 0.1 for all except one variable, implying that the differences between treatment and control group means are, for the most part not statistically significant at conventional levels. The only variable that shows a statistically significant difference is the dummy variable for whether the household head is male or not. In the treatment group, 75 percent of household heads are male, as opposed to 71 percent in the control group. To ensure that this difference does not influence our results, we control for gender of the household head in our impact analysis, as described in section 4.

The background characteristics listed in panel A of table 3a show that household heads were on average 42 years old at baseline. Only about 45 percent of households had at least one member with completed primary education. The average household size was 5.4. In terms of phone and mobile money usage, only about 45 percent of respondents had access to a phone and 14 percent report that they used mobile money in the last 3 months. Although close to 80 percent of respondents reported saving some money, only 6 percent saved in a mobile money account during the last 6 months.

The surveys included modules on remittances, asking if households had received money from or sent money to somebody outside the household during the past 6 months, since the previous literature has documented that mobile money can facilitate remittance transactions (see Jack, Ray, and Suri 2013). Only 15 percent of respondents reported that they received money from somebody outside the household,

but in about 45 percent of cases they received the transfer via mobile money (this percentage increased to almost 75 percent in the follow-up survey).[14]

For households who received money, the surveys asked for details of the transaction only for the person they received money from most frequently. About half of the households who received money reported receiving it more than once and about one-third of these households reported receiving more than 100,000 shillings (approximately US$25). Similarly, about half of the households who sent money reported sending it more than once and one-third reported sending more than 100,000 shillings. About 30 percent of households who received money and 25 percent of households who sent money report paying no fees. Average fees for receiving or sending money were around 3,500 shillings, but this variable has a large standard deviation and includes some outliers. The median fee was 2,000 shillings. About half of the households receiving or sending money paid no transportation costs (because they walked or biked). The average amount paid by those who paid transportation costs was around 5,500 shillings. The higher means in some groups reflect outliers. The median transportation cost was 4,000 shillings.

Households that had either received or sent money were asked which problems they encountered when making the transaction. Table 3a shows some frequently mentioned problems: about 30 percent of respondents reported high prices, 20 percent said the agent was far, 20 percent encountered a technical problem, and about 10 percent reporting being charged the wrong amount.

Close to two-thirds of respondents reported that they have a job that earns income. Most of these jobs were in farming. Only 11 percent of the sample worked outside farming, split almost evenly between wage employment and self-employment. That is, about 5 percent were self-employed doing work other than farming.

Finally, since the previous literature has found that mobile money can help households cope with shocks and smooth consumption (Blumenstock, Eagle and Fafchamps 2016; Jack and Suri 2014), the survey included questions on coping with shocks and on food security. Most of these questions were only added at follow-up. Table 3a reports that, at baseline, about 80 percent of households reported having experienced a shock in the past 6 months, with the most common shock being a drought.

Table 3b displays the predicted poverty rates and we observe that poverty stood at over 40 percent. Poverty rates in the study areas essentially remained unchanged between the baseline and follow-up survey with point estimates of 42.0 and 42.5 percent respectively (difference is not statistically significant).[15] In line with findings of previous studies and census data, poverty rates were highest in the North-East region (Karamoja) and lowest in the Mid-North (around Gulu and Lira).

In accordance with these high poverty rates, we observe that (at follow-up), only two-thirds of Ugandans in the rural North had ever attended school and in 45.9 percent of households, no household members had completed at least primary education (table 3c). Only 22.7 percent of households had access to electricity and a large increase can be observed between the baseline and follow-up survey which is likely associated with the spread of solar panels in rural Northern Uganda. Access to improved drinking water was less of a challenge for rural dwellers in Northern Uganda with access rates of 80.5 percent. The vast

[14] Almost all other transfers were hand or bus delivered by somebody in the households or a friend.

[15] Poverty estimates were calculated using the most recent poverty line for rural Northern Uganda based on Uganda National Household Survey (UNHS) 2016-17.

majority of rural dwellers were engaged in agricultural activities: 91.6 percent of households indicated that they engaged in agriculture in the last 12 months and 51.0 percent owned livestock. Furthermore, 43.5 percent of households experienced a situation in which they did not have enough food in the past 12 months and 55.9 percent of households have a very low food security index. Despite high needs and vulnerability, only 11.0 percent of households think they are able to come up with emergency cash[16] if needed.

Table 4 shows the poverty rates at follow-up for households with different characteristics. Mobile money users were on average less poor than non-users: The poverty rate among mobile money users was 35 percent while that of non-users was 45 percent. This relationship is hardly surprising given that usage of mobile money requires access to a mobile phone, which is an expensive good, though we do find slightly smaller differences in mobile phone ownership. Similarly, households which sent or received remittances were less likely to be poor.

Households who have had the opportunity to save (with or without mobile money), who did not have to take out loans, and have not had to incur a shock in the past 6 months, had lower poverty rates. Similarly, households with low food security and no opportunity to access cash in case of an emergency, were about 7 percentage points more likely to be poor.

5.2 Impact on Usage and Financial Behavior

5.2.a. Impact on Usage and Financial Measures from Survey Data

We start by examining the effects of the Airtel Money agent rollout on mobile money usage. Table 5 reports the effects of the rollout on a dummy variable that is equal to one if the respondent said they used mobile money in the last 3 months. We find no effect on this variable in the full sample (panel A of table 2), but the heterogenous treatment effect regressions in panel B of table 3 show that the agent rollout significantly increased mobile money usage by 4.2 percentage points in clusters that are far from a bank branch, compared to a control group usage rate of 12.6 percent. There is no statistically significant effect of the agent rollout on mobile money usage in clusters that are near a bank branch. These areas already had slightly better access to mobile money agents before the roll-out, with an average distance to the closest agent of 6.6km, compared to 9.8km for areas far from a bank branch. The finding here suggests that there is demand for mobile money in remote areas if services are made available.

Columns 2 and 3 of table 3 examine the effect of the agent rollout on savings. Households may increase their overall savings or shift savings held in other places into mobile money accounts since mobile money provides a relatively safe and easily accessible way of storing money. In fact, over two-thirds of respondents who save, report keeping the money on their person or at home, which may be less safe compared to mobile money. However, we do not find an effect of the agent rollout on savings.

In the follow-up survey, about 97 percent of mobile money users report that they use mobile money to receive or send money, followed by 41 percent who use it to buy airtime. Only 4 percent say they use mobile money in their business and 3 percent say they use it to pay bills. In tables 6a and 6b, we thus

[16] Households were asked the following question: “Imagine that you have an emergency and you need to pay 126,000 shillings. How possible is it that you could come up with 126,000 shillings within the next month?”

investigate the effect of the agent rollout on receiving or sending money. We find no significant effect of the rollout on the probability of receiving or sending money.

Tables 6a and 6b also report effects on the characteristic of the transfers for the person with whom households transacted with most frequently. The effects on receiving or sending money via mobile money (as opposed to other channels, such as hand carrying the money) are positive for clusters far from a bank branch, but they are not statistically significant. While we find no effect on the frequency of sending money, column 4 of table 3b shows a positive effect of the rollout on the probability of sending an amount over 100 shillings for clusters that are far from a bank branch. In addition, column 7 of table 6a shows that the rollout increased the probability of not paying any transportation cost for receiving money by 13 percentage points, compared to 69 percent in the control group, for clusters far away from a bank branch. This finding likely reflects the fact that the agent rollout brought agents closer to the treatment clusters and thus allowed respondents to walk or bike to the agent instead of having to pay for a motorcycle taxi or mini-bus taxi. The median transportation cost paid by respondents who had to pay this cost was 4,000 shillings at follow-up in clusters far from a bank branch. This amount corresponds to about 10 percent of daily household expenditures (median of 32,859 shillings, with a mean of 41,995 shillings).

Overall, although the agent rollout lowered the transportation costs of receiving money, table 6a and 6b do not show that it increased the likelihood or frequency of receiving or sending money. It may be the case that these effects occur for transacting with more people outside the household, which is not captured in the survey data since it only asked for transactions with one person, i.e. the person respondents received money from or sent money to most frequently. In section 5.2.b, we thus also examine the effect of the agent money rollout on transactions recorded in Airtel's administrative data.

Table 7 reports effects of the agent rollout on problems encountered when receiving or sending money. In the full sample, respondents in treatment clusters are 5.7 percentage points less likely to say that the agent was far, relative to 17.8 percent reporting the agent was far in control clusters. This effect is driven by clusters far from a bank branch, where the agent rollout reduced the percentage of respondents saying the agent was far by 14.5 percentage points (relative to 21.6 percent). For clusters far from a bank, the agent rollout also reduced the percentage of respondents reporting high prices or fees by 10.5 percentage points (relative to 28.1 percent in the control group). The results in table 7 are consistent with those in table 6a that show that the agent rollout reduced transportation costs for receiving money in clusters far from a bank branch.

In summary, we find that the agent rollout increased the probability of using mobile money in clusters that are far away from a bank branch. We do not see an effect of the rollout on savings or the probability of receiving or sending money as reported in the survey data. However, there is some evidence that respondents in treatment clusters that are far away from a bank branch sent larger amounts of money than those in control clusters and they pay lower transportation costs for receiving money. Finally, compared to the control group, respondents who received or sent money in treatment clusters far away from a bank branch are less likely to report that agents were far and that prices were high. Overall, the agent rollout seems to have facilitated receiving and sending money in clusters far from a bank branch.

5.2.b. Impact on Transactions in Administrative Data

In table 8, we study the effect of the agent rollout on transactions in Airtel's mobile money data. The analysis here is at the cluster level. As described in section 4.2, we matched the transactions data to our

study clusters using the phone numbers reported by follow-up survey respondents. The outcome variables are dummies that are equal to one if the cluster had any phone number conducting the respective transactions listed in columns 1 through 8 of table 8.

We do not find a statistically significant effect of the agent rollout on cash-in, cash-out, bill pay or top-up transactions. However, the agent roll-out led to a significant increase in the probability of sending a P2P transfer in the full sample (panel A of table 8) and in the probability of receiving a P2P transfer in clusters far from a bank branch (panel B of table 8). Here, treatment clusters are 6.3 percentage points more likely to have received a P2P transfer compared to control clusters. That is, in 9.3 percent of treatment clusters received a P2P transfer in 2017 compared to only 3 percent of control clusters.

We did not find a statistically significant effect on the probability of sending or receiving P2P transfers in the survey data (section 5.1), perhaps because the survey only asked about the individual the household transacted with the most and thus does not capture all transfers. In fact, Jack, Ray, and Suri (2013) show that remittances sent through M-PESA come from more different senders, implying that it is important to also consider results that include such transfers, as we do here with the transactions data.

The data here also have a caveat, namely that we see a relatively low number of clusters transacting, which is in part due to the fact that we have a limited number of Airtel phone numbers in our survey data. We are thus not capturing all Airtel mobile money transactions. Still, the results in table 8 provide suggestive evidence that the agent rollout increased the probability of sending and receiving remittance transfers, which is in line with the previous literature on mobile money agents (Blumenstock, Eagle and Fafchamps 2016, Jack and Suri 2014, and Munyegera and Matsumoto 2016).

5.3 Impact on Labor Outcomes

Since our study was conducted in rural areas, we first examine whether the agent rollout had an impact on households' investment in livestock or agriculture. Greater ease of receiving and sending money may have provided them with more liquidity for making these investments.[17] Table 9 shows no effect of the agent rollout on the probability that the household owns livestock or has engaged in agriculture.[18] We also do not see an effect on the number of different crops grown, the amount spent on seeds, or the probability of using fertilizer.

We now ask whether the agent rollout affected labor decisions. Column 2 in table 10 shows that the agent rollout increased the percentage of respondents who report doing non-farm work by 2.8 percentage points in clusters far from a bank branch, with no effect on clusters near a bank branch. The results in column 3 further illustrate that the effect on non-farm work is driven by self-employment. That is, respondents in treatment clusters far from a bank branch are 3 percentage points more likely to report that they are self-employed doing non-farm work than respondents in control clusters. This effect is

[17] To the extent that mobile money provides insurance against risk through increased remittance transactions, it can also provide incentives for increasing agricultural expenditures (see Karlan et al. 2014). This channel may not apply in our context though since we find no effect of the agent rollout on the probability or frequency of remittance transactions.

[18] Due to a faulty skip-pattern, questions about agriculture were only asked if respondents reported they owned livestock.

statistically significant and is almost equivalent to a doubling in the percentage of respondents doing such work, i.e. going from 3.4 percent in control clusters to 6.4 percent in treatment clusters.

It thus appears that the agent rollout has allowed households to move from farm jobs into non-farm self-employment. A possible channel is that increased liquidity from remittances or cost-savings associated with remittance transactions allowed them to make this switch. The costs savings accrue to 13 percent of households who receive remittances, which in turn represents about 10 percent of households, giving only 1.3 percent of households. However, for these households the cost savings are substantial (10 percent of daily consumption, as calculated in section 5.2). About 56 percent of remittance receivers received a remittance only once in the last 6 months, 24 percent twice and 20 percent more than three times.

Another possible channel is that increased self-employment is caused directly by becoming Airtel agents. Although the agent rollout selected pre-existing businesses as agents, adding the mobile money service may have increased business survival. To check the feasibility of this channel, we merged the phone numbers that respondents provided with phone numbers of agents in Airtel's transactions data. We do not find any matches, suggesting that our survey respondents are not Airtel agents and the rollout thus did not have direct employment effects on them.[19]

5.4 Impact on Food Security

Based on the previous literature that has shown that mobile money can contribute to coping with shocks and consumption smoothing (Blumenstock, Eagle and Fafchamps 2016; Jack and Suri 2014), we examine the effect of the agent rollout on responses to shocks and food security. As shown in the last row of column 1 in table 11, 67.8 percent of respondents in control clusters reported that they experienced a shock in the last 6 months. This number is not significantly different in treatment clusters. The most commonly experienced shock was a drought (52.5 percent), followed by a flood (25.3 percent) and theft or fire on the respondent's property (17.3 percent).[20]

For respondents who reported experiencing a shock, table 11 examines the likelihood of using different coping strategies. The outcome variables in columns 2 through 8 are dummy variables that are equal to 1 if the respondents reported using the coping strategy listed in the column title and equal to zero otherwise. The most commonly used coping strategies were seeking help from local family, friends or government and seeking help from individuals that live far away, followed by relying on savings or selling assets (see control group means in table 11). The agent rollout did not have a significant impact on using these three coping strategies. However, it decreased the likelihood of households changing their diet to deal with shocks and increased the likelihood of households taking on work to deal with shocks. These effects are driven by clusters far from a bank branch. In these clusters, respondents were 10.6 percentage points less likely to adjust their diet to deal with a shock, compared to 23.5 percent in control clusters.

[19] It could, however, have indirect effects if other businesses located near agents see an increase in sales due to people using agents - either because people may use mobile money to pay for goods and services or because people may purchase goods and services during the trip they make to the agent. We do not have the necessary data on business activity to examine this channel more explicitly.

[20] Other shocks elicited in the survey were, in order of reported frequency: having to contribute to a funeral; illness or accident; increase in fuel price; interest rate increase; death; theft, fire or loss of vehicle; and job loss.

Similarly, respondents were 5.1 percentage points more likely to take work, compared to only 8.9 percent in control clusters.

To examine consumption smoothing further, the follow-up survey included a module on food security. Table 12 shows strong effects of the agent rollout on food security measures, which were again driven by clusters far from a bank branch. In these clusters, the agent rollout reduced the fraction of respondents that reported that they had to reduce the number of meals during the past 7 days by 11.8 percentage points from a control group mean of 48.6 percent. Similarly, the fraction of respondents who had a very low food security index dropped by 15.7 percentage points, compared to a control group mean of 62.9 percent. We find no effect of the agent rollout on food security in clusters near a bank branch.

In summary, we find that the agent rollout helped households in clusters far from a bank branch deal with shocks by taking work instead of having to adjust their diet. In the same vein, the agent rollout increased households' food security and reduced the likelihood of having to skip meals. These results are consistent with the previous finding that the agent rollout increased non-farm self-employment.

5.5 Impact on Poverty

Finally, we examine the effect of the agent rollout on households' poverty status in table 13. Here, the outcome variable is a dummy variable equal to 1 if the household was poor as estimated based on the SWIFT methodology and equal to zero otherwise. The results show that the agent rollout did not have a significant impact on being poor. This lack of an effect does not change with the distance of the cluster to the nearest bank branch.

In summary, even though in section 5.1 (table 4), we observe that households who used mobile money were better off than those who do not engage in mobile financial services, we do not find a causal effect of the agent rollout on poverty levels, at least in the short-run. A households' poverty status is likely to take more time to change than labor market outcomes or food security, so it is possible that the agent rollout would reduce poverty levels in the longer-run.

6. Conclusion

This paper studies the impact of rolling out mobile money agents in rural areas of Uganda. Compared to areas included in previous impact evaluations of mobile money agents, the areas here tend to be poorer, have lower access to financial services through bank branches and have almost no pre-existing mobile money agents.

In this setting, we find that the agent rollout significantly increased the percentage of households using mobile money in areas further than 25.2km from a bank branch, leading to cost savings for those sending or receiving remittances. Administrative data on mobile money transactions also suggest that the agent rollout increased the probability of sending and receiving P2P transfers.

We do not find an effect of the agent rollout on savings or agricultural outcomes. However, in areas far from a bank branch, the agent rollout statistically significantly increased the fraction of survey respondents who work in non-farm self-employment. This increase appears to be driven by the cost savings from remittance transactions and the increase in P2P transfer receipts, which households may use to invest in self-employment.

We also observe that the agent rollout changed the way in which households respond to negative shocks, such as a drought or flood. The rollout increased the probability of taking work to cope with the shock and it reduced the probability of changing the household's diet. In line with this result, we find a strong positive effect of the agent rollout on food security. However, we do not find an effect of the agent rollout on our measure of poverty.

In terms of numbers, the estimates suggest that the rollout of 121 agents provided self-employment to 257 households and improved food security for 1,345 households in areas far from a bank branch.[21]

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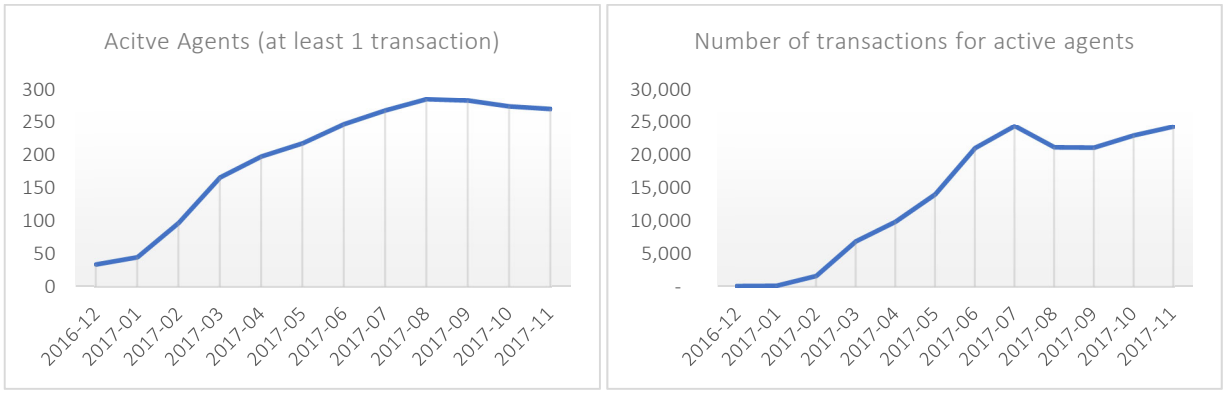
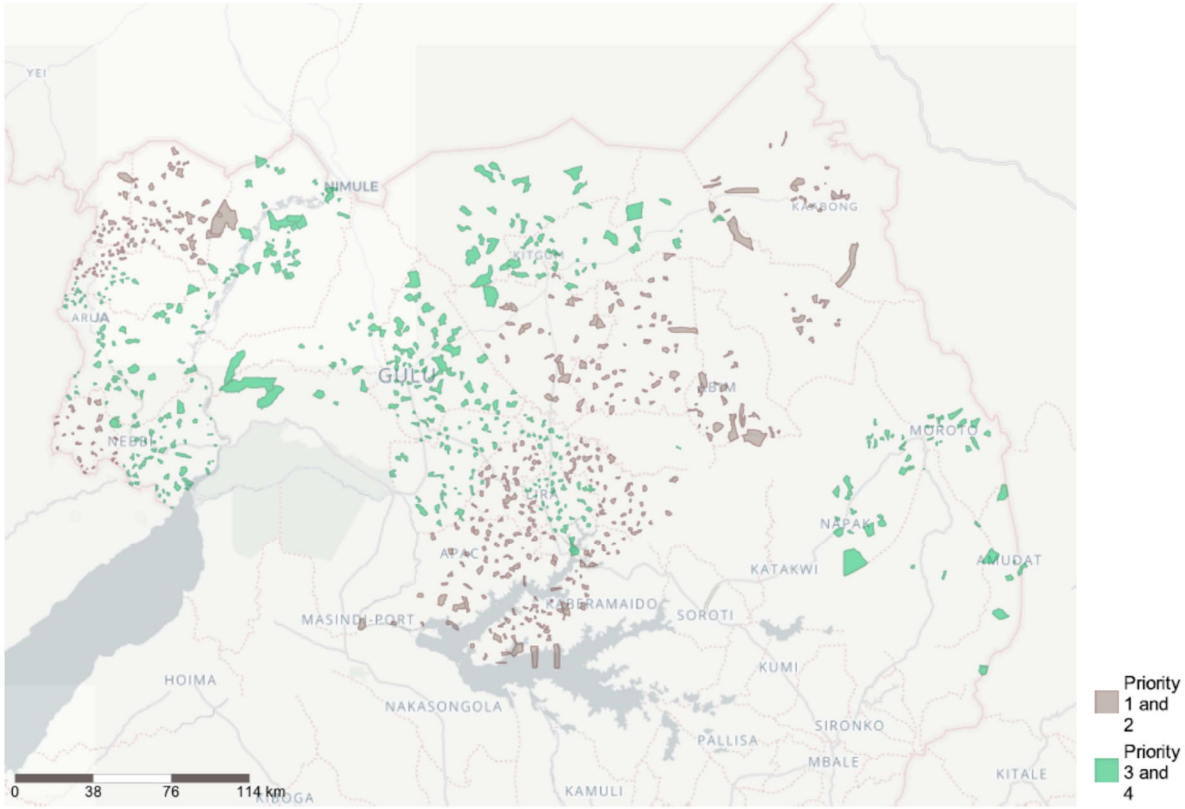
Figure 1: Number of Active Agents and Usage

Panel A: Number of Active Agents by month **Panel B: Number of Transactions by month**



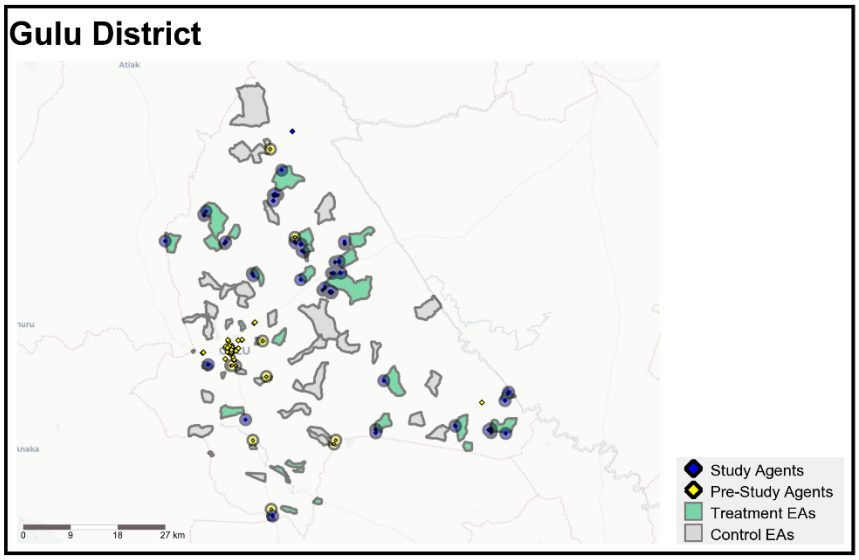
Source: Own calculations based on Airtel Money transaction data.

Figure 2: Areas Included in the Study



Note: The map shows 334 clusters of enumeration areas that were included in the study. These areas were assigned priority ratings 3 or 4 by Airtel. Areas with priority ratings 1 and 2 received few agents and are dropped in the analysis. Randomization into treatment and control groups was stratified by priority level.

Figure 3: Example of Treatment and Control Areas with Agents



Note: The mat shows treatment and control clusters in the Gulu district. Study agents are Airtel agents that were rollout out as part of this study. Pre-study agents are mostly MTN agents that existed in 2015.

Table 1: Mobile Phone Penetration in Uganda

	Areas in Uganda		
	Urban	Rural	Rural North
	(1)	(2)	(3)
Owns a mobile phone (%)	78.5	65.7	27.6
Has access to a mobile phone (%)			39.9
Service provider for phone owners is (%)			
MTN	73.7		74.7
Airtel	61.4		7.9
Africell	7.3		9.9

Note: Data in columns 1 and 2 from CIPESA (2018). National Information Technology survey: 2017/18 Report. Data in column 3 from 2018 follow-up survey.

Table 2a: Airtel Data on Mobile Money Transactions

	Average number of transactions across clusters		Dummy for clusters with non-zero transactions	
	2016	2017	2016	2017
Send P2P transfer	0.350	0.677	0.069	0.066
Receive P2P transfer	0.749	1.338	0.075	0.090
Cash-in	2.132	3.955	0.120	0.123
Cash-out	2.302	3.323	0.126	0.120
Bill pay	0.410	1.395	0.027	0.057
Airtime top-up	9.416	13.746	0.099	0.123
Data top-up	0.120	0.449	0.045	0.057
All	15.479	24.883	0.138	0.147

Note: Data for 334 clusters. Airtel transactions data was matched to study clusters based on phone numbers of survey respondents. The table does thus not include most Airtel mobile money transactions, which cannot be mapped to our study locations.

Table 2b: Airtel Data on Mobile Money Transactions (2016)

	Treatment group mean	Control group mean	P-value of difference in means
Dummy for clusters with non-zero transactions	(1)	(2)	(3)
Send P2P transfer	0.077	0.060	0.522
Receive P2P transfer	0.083	0.066	0.536
Cash-in	0.125	0.114	0.743
Cash-out	0.119	0.133	0.734
Bill pay	0.024	0.030	0.712
Airtime top-up	0.107	0.090	0.605
Data top-up	0.036	0.054	0.425
Any transaction	0.137	0.139	0.980

Note: Data for 334 clusters. Airtel transactions data was matched to study clusters based on phone numbers of survey respondents. The table does thus not include most Airtel mobile money transactions, which cannot be mapped to our study locations. Column 3 shows the p-value of the difference in treatment and control group means, clustered at the cluster level and conditional on strata dummies.

Table 3a: Summary Statistics

	Number of households	Control group		Treatment group		P-value of difference in means
		Mean	Standard deviation	Mean	Standard deviation	
Panel A: Baseline survey data	(1)	(2)	(3)	(4)	(5)	(6)
Household head is male	3638	0.71		0.75		0.081
Household head's age	3636	42.51	14.79	41.65	14.38	0.192
No household member completed primary	3710	0.46		0.44		0.45
Household size	3720	5.38	3.04	5.54	3.06	0.312
Has access to a phone	3720	0.43		0.46		0.423
Used mobile money in last 3 months	3720	0.14		0.14		0.605
Saved money in last 6 months	3720	0.78		0.79		0.503
Saved money in mobile account	3720	0.06		0.06		0.629
Received money in the last 6 months	3720	0.15		0.15		0.976
Received money via mobile money	557	0.42		0.46		0.454
Received money more than once	557	0.58		0.53		0.491
Avg. amount received over 100 shilling	557	0.33		0.37		0.526
Paid no fees for receiving money	557	0.32		0.28		0.593
Fee for receiving money (if not zero)	391	3342.12	6391.88	3596.39	7864.14	0.692
Paid no transp costs for receiving money	557	0.55		0.53		0.74
Transp costs for receiving money (if not zero)	256	9746.46	27868.97	5808.53	12752.35	0.135
Sent money in the last 6 months	3720	0.11		0.12		0.379
Sent money via mobile money	429	0.54		0.49		0.455
Sent money more than once	429	0.55		0.57		0.701
Avg. amount sent over 100 shilling	429	0.34		0.4		0.341
Paid no fees for sending money	429	0.22		0.25		0.423
Fee for sending money (if not zero)	326	9438.24	41563.1	3773.43	9088.3	0.149
Paid no transp costs for sending money	429	0.48		0.53		0.558
Transp costs for sending money (if not zero)	211	5442.26	5310.31	7094.31	11121.63	0.129
High prices/fees	805	0.32		0.3		0.458
Agent was far	805	0.2		0.17		0.516
Technical problem	805	0.2		0.22		0.862
Charged wrong amount	805	0.1		0.14		0.113
Has job that earns income	3720	0.6		0.66		0.104
Does non-farm work	3720	0.11		0.13		0.147
Self-employed (non-farm)	3720	0.05		0.07		0.144
Experienced shock in last 6m	3720	0.79		0.8		0.582
Panel B: Follow-up survey data						
Household head is male	4469	0.71		0.75		0.02
Household head's age	4461	44.56	15.12	44.64	15.17	0.838
No household member completed primary	4541	0.46		0.45		0.634
Household size	4384	5.57	3.19	5.76	3.17	0.261

Note: Column 6 shows the p-value of the difference in treatment and control group means, clustered at the cluster level and conditional on strata dummies.

Table 3b: Imputed Poverty Rates at Baseline and Follow-up

Panel A: Rural North

	Poverty rate	Confidence interval lower bound	Confidence interval upper bound
Baseline	42.0	39.6	44.5
Follow-up	42.5	39.9	45.2

Panel B: By region

	Poverty rate	Confidence interval lower bound	Confidence interval upper bound
Mid-North Baseline	35.9	32.7	39.0
North East Baseline	64.4	58.5	70.3
West Nile Baseline	42.9	39.4	46.4
Mid-North Follow-up	39.2	35.8	42.7
North East Follow-up	64.7	58.9	70.5
West Nile Follow-up	39.5	36.1	43.0

Note: Estimates based on survey-to-survey imputation technique (SWIFT) using poverty line of UNHS 2016-17 for rural Northern Uganda

Table 3c: Household Characteristics Over Time

	Baseline	Follow-up
Household size	5.4	5.4
HoH ever attended school	68.1	63.6
HoH completed primary education	45.0	45.9
HH uses electricity for lighting	7.8	22.7
Access to improved water	77.3	80.5
HH engaged in agriculture		91.6
HH engaged in non-farm work	11.7	8.6
HH owns livestock		51.0
HH experienced food shortage		43.5
HH has very low food security		55.9
HH has access to emergency cash	14.2	11.0

Note: HH=household; HoH= head of household

Table 4: Poverty Rates by MM Characteristics at Follow-Up

	Poverty rate	Confidence interval lower bound	Confidence interval upper bound
Phone ownership: no	44.5	41.7	47.4
Phone ownership: yes	37.3	33.2	41.5
Ever used mobile money: no	45.0	42.1	47.9
Ever used mobile money: yes	35.1	31.2	39.0
Received mobile money: no	42.6	31.5	53.6
Received mobile money: yes	34.1	29.9	38.4
Sent mobile money: no	38.1	29.3	46.9
Sent mobile money: yes	34.4	30.1	38.6
Saved in past 6 months: no	48.3	44.3	52.3
Saved in past 6 months: yes	40.8	37.9	43.7
Saved in past 6 months using mobile money: no	43.6	40.9	46.3
Saved in past 6 months using mobile money: yes	29.3	22.2	36.5
Taken loans in past 6 months: no	42.9	40.2	45.7
Taken loans in past 6 months: yes	40.4	35.2	45.5
Experienced shock in past 6 months: no	40.2	36.8	43.5
Experienced shock in past 6 months: yes	43.7	40.7	46.8
Very low food security: no	38.9	36.0	41.7
Very low food security: yes	45.4	42.1	48.8
Could get emergency cash: no	43.4	40.6	46.1
Could get emergency cash: yes	35.9	30.4	41.4

Note: Estimates based on survey-to-survey imputation technique (SWIFT) using poverty line of UNHS 2016-17 for rural Northern Uganda

Table 5: Effects of Agent Rollout on Usage and Financial Behavior

	Dependent variable:		
Panel A:	Used mobile money in last 3	Saved money in last 6	Saved money in mobile account
ITT for all clusters	(1)	(2)	(3)
Agent	-0.002	-0.017	-0.012
	(0.016)	(0.027)	(0.010)
R-squared	0.042	0.026	0.024
N	4469	4469	4469
Number of clusters	334	334	334
Control group mean	0.180	0.771	0.079
Panel B:			
ITT by distance from bank branch			
Agent*Far	0.042*	0.002	-0.015
	(0.022)	(0.043)	(0.014)
Agent*Near	-0.035	-0.031	-0.009
	(0.021)	(0.035)	(0.015)
R-squared	0.045	0.027	0.024
N	4469	4469	4469
Number of clusters	334	334	334
Control group mean - Far	0.126	0.716	0.061
Control group mean - Near	0.218	0.809	0.091

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 6a: Effects of Agent Rollout on Receiving Money

	Dependent variable:							
	Received money in the last 6 months	Received money via mobile money	Received money more than once	Avg. amount received over 100 shilling	Paid no fees for receiving money	Log fee for receiving money	Paid no transp costs for receiving money	Log transp costs for receiving money
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agent	0.010	0.016	0.023	0.040	-0.042	0.127	0.083**	-0.054
	(0.015)	(0.045)	(0.045)	(0.044)	(0.041)	(0.121)	(0.038)	(0.391)
R-squared	0.029	0.039	0.009	0.025	0.075	0.040	0.038	0.138
N	4469	606	606	606	420	345	604	122
Number of clusters	334	215	215	215	189	170	215	83
Control group mean	0.131	0.736	0.468	0.281	0.192	7.541	0.755	8.037
Panel B: ITT by distance from bank branch								
Agent*Far	0.013	0.051	-0.060	0.005	-0.105	0.274	0.130**	0.141
	(0.017)	(0.076)	(0.081)	(0.068)	(0.065)	(0.244)	(0.065)	(0.439)
Agent*Near	0.008	-0.001	0.062	0.056	-0.010	0.054	0.062	-0.175
	(0.022)	(0.057)	(0.054)	(0.056)	(0.052)	(0.133)	(0.046)	(0.541)
R-squared	0.029	0.040	0.012	0.026	0.078	0.043	0.039	0.140
N	4469	606	606	606	420	345	604	122
Number of clusters	334	215	215	215	189	170	215	83
Control group mean - Far	0.094	0.693	0.477	0.261	0.238	7.569	0.690	8.123
Control group mean - Near	0.157	0.754	0.464	0.290	0.170	7.529	0.783	7.986

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 6b: Effects of Agent Rollout on Sending Money

	Dependent variable:							
	Sent money in the last 6 months	Sent money via mobile money	Sent money more than once	Avg. amount sent over 100 shilling	Paid no fees for sending money	Log fee for sending money	Paid no transp costs for sending money	Log transp costs for sending money
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agent	-0.013	0.021	0.025	0.073	-0.042	0.135	0.021	0.107
	(0.014)	(0.054)	(0.048)	(0.048)	(0.039)	(0.155)	(0.055)	(0.199)
R-squared	0.027	0.059	0.022	0.039	0.035	0.039	0.033	0.133
N	4469	493	493	493	493	414	497	129
Number of clusters	334	191	191	191	191	181	193	78
Control group mean	0.115	0.688	0.477	0.342	0.185	7.717	0.725	8.147
Panel B: ITT by distance from bank branch								
Agent*Far	-0.001	0.121	-0.027	0.134*	-0.049	0.036	0.090	0.065
	(0.024)	(0.085)	(0.076)	(0.074)	(0.053)	(0.197)	(0.078)	(0.416)
Agent*Near	-0.023	-0.042	0.059	0.034	-0.038	0.196	-0.023	0.128
	(0.017)	(0.069)	(0.060)	(0.062)	(0.055)	(0.217)	(0.072)	(0.220)
R-squared	0.027	0.066	0.024	0.041	0.035	0.039	0.037	0.134
N	4469	493	493	493	493	414	497	129
Number of clusters	334	191	191	191	191	181	193	78
Control group mean - Far	0.096	0.678	0.444	0.300	0.178	7.546	0.725	8.203
Control group mean - Near	0.129	0.694	0.494	0.365	0.188	7.809	0.725	8.117

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 7: Effects of Agent Rollout on Problems with Receiving or Sending Money

	Dependent variable: Problems encountered when receiving or sending money			
	High prices/fees	Agent was far	Technical problem	Charged wrong amount
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)
Agent	-0.044	-0.057*	-0.009	0.006
	(0.032)	(0.030)	(0.024)	(0.024)
R-squared	0.040	0.017	0.024	0.031
N	867	867	867	867
Number of clusters	245	245	245	245
Control group mean	0.259	0.178	0.120	0.090
Panel B: ITT by distance from bank branch				
Agent*Far	-0.105**	-0.145***	-0.044	0.004
	(0.052)	(0.047)	(0.045)	(0.041)
Agent*Near	-0.012	-0.010	0.010	0.007
	(0.041)	(0.039)	(0.027)	(0.029)
R-squared	0.042	0.025	0.025	0.031
N	867	867	867	867
Number of clusters	245	245	245	245
Control group mean - Far	0.281	0.216	0.180	0.101
Control group mean - Near	0.249	0.160	0.092	0.085

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 8: Effects of Agent Rollout on Airtel Mobile Money Transactions (2017 Administrative Data)

	Dependent variable (dummy=1 if any phone number in the cluster made the following transactions):							
	Any type of transaction	Send P2P transfer	Receive P2P transfer	Cash-in	Cash-out	Bill pay	Airtime top-up	Data top-up
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agent	-0.019	0.048*	0.036	0.005	-0.012	-0.019	-0.007	-0.006
	(0.038)	(0.027)	(0.031)	(0.036)	(0.035)	(0.025)	(0.036)	(0.025)
R-squared	0.054	0.020	0.028	0.047	0.038	0.035	0.049	0.024
N	334	334	334	334	334	334	334	334
Control group mean	0.157	0.042	0.072	0.120	0.127	0.066	0.127	0.060
Panel B: ITT by distance from bank branch								
Agent*Far	-0.016	0.037	0.063*	0.011	0.012	0.011	0.023	0.012
	(0.047)	(0.033)	(0.037)	(0.044)	(0.044)	(0.028)	(0.043)	(0.028)
Agent*Near	-0.023	0.057	0.011	0.000	-0.034	-0.045	-0.034	-0.023
	(0.059)	(0.042)	(0.049)	(0.055)	(0.054)	(0.041)	(0.055)	(0.041)
R-squared	0.054	0.020	0.030	0.047	0.040	0.039	0.051	0.025
N	334	334	334	334	334	334	334	334
Control group mean - Far	0.103	0.021	0.030	0.077	0.077	0.026	0.064	0.026
Control group mean - Near	0.205	0.057	0.114	0.159	0.170	0.102	0.182	0.091

Note: Analysis at the cluster level. Airtel transactions data for 2017 that was matched to the 334 study clusters based on phone numbers of survey respondents. Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 9: Effects of Agent Rollout on Agricultural Outcomes

	Dependent variable:				
	Owns livestock	Has engaged in agriculture in last 12 months	Number of different crops	Amount spent on seeds	Uses fertilizer
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)	(5)
Agent	0.012	-0.020	0.018	-3922.246	-0.001
	(0.034)	(0.016)	(0.190)	(10302.628)	(0.009)
R-squared	0.014	0.010	0.026	0.010	0.009
N	4469	2275	2084	2084	2084
Number of clusters	334	307	293	293	293
Control group mean	0.501	0.925	3.870	67971.260	0.029
Panel B: ITT by distance from bank branch					
Agent*Far	0.039	-0.027	-0.417	-6523.055	0.003
	(0.054)	(0.030)	(0.313)	(14458.055)	(0.013)
Agent*Near	-0.008	-0.015	0.303	-2217.289	-0.004
	(0.044)	(0.017)	(0.228)	(14238.775)	(0.013)
R-squared	0.015	0.010	0.033	0.010	0.009
N	4469	2275	2084	2084	2084
Number of clusters	334	307	293	293	293
Control group mean - Far	0.457	0.909	4.049	67120.319	0.026
Control group mean - Near	0.532	0.934	3.763	68476.627	0.031

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 10: Effects of Agent Rollout on Occupation

	Dependent variable:		
	Has job that earns income	Does non-farm work	Self-employed (non-farm)
Panel A: ITT for all clusters	(1)	(2)	(3)
Agent	-0.023	0.004	0.01
	-0.032	-0.012	-0.009
R-squared	0.027	0.031	0.013
N	4469	4463	4463
Number of clusters	334	334	334
Control group mean	0.337	0.083	0.042
Panel B: ITT by distance from bank branch			
Agent*Far	-0.025	0.028*	0.030**
	(0.046)	(0.016)	(0.012)
Agent*Near	-0.022	-0.013	-0.006
	(0.044)	(0.017)	(0.012)
R-squared	0.027	0.033	0.015
N	4469	4463	4463
Number of clusters	334	334	334
Control group mean - Far	0.305	0.068	0.034
Control group mean - Near	0.360	0.094	0.048

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 11: Effects of Agent Rollout on Coping with Shocks

	Dependent variable:							
	Coped with shock through							
	Experienced shock in last 6m	Local help	Help from faraway	Relying on savings or selling assets	Changing diet	Obtaining credit	Taking work	Other
Panel A: ITT for all clusters	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agent	-0.024	-0.024	-0.007	0.019	-0.064**	0.015	0.029*	0.024
	(0.032)	(0.035)	(0.039)	(0.032)	(0.028)	(0.023)	(0.017)	(0.026)
R-squared	0.051	0.013	0.037	0.043	0.026	0.026	0.006	0.029
N	4469	2970	2970	2970	2970	2970	2970	2970
Number of clusters	334	313	313	313	313	313	313	313
Control group mean	0.678	0.681	0.509	0.324	0.230	0.129	0.097	0.212
Panel B: ITT by distance from bank branch								
Agent*Far	-0.043	-0.079	-0.046	0.009	-0.106***	0.012	0.051*	-0.000
	(0.052)	(0.055)	(0.057)	(0.048)	(0.038)	(0.029)	(0.027)	(0.038)
Agent*Near	-0.009	0.014	0.020	0.026	-0.035	0.017	0.014	0.041
	(0.040)	(0.045)	(0.054)	(0.043)	(0.040)	(0.033)	(0.022)	(0.035)
R-squared	0.051	0.015	0.038	0.043	0.028	0.026	0.006	0.029
N	4469	2970	2970	2970	2970	2970	2970	2970
Number of clusters	334	313	313	313	313	313	313	313
Control group mean - Far	0.662	0.705	0.515	0.306	0.235	0.085	0.089	0.190
Control group mean - Near	0.690	0.664	0.505	0.336	0.226	0.160	0.102	0.227

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clusterd at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 12: Effects of Agent Rollout on Food Security

	Dependent variable:	
	Had to reduce the number of meals in the last 7 days	Food security index is very low
Panel A: ITT for all clusters	(1)	(2)
Agent	-0.067**	-0.075**
	(0.033)	(0.033)
R-squared	0.037	0.047
N	4469	4469
Number of clusters	334	334
Control group mean	0.488	0.598
Panel B: ITT by distance from bank branch		
Agent*Far	-0.118**	-0.157***
	(0.046)	(0.048)
Agent*Near	-0.028	-0.014
	(0.045)	(0.044)
R-squared	0.039	0.052
N	4469	4469
Number of clusters	334	334
Control group mean - Far	0.486	0.629
Control group mean - Near	0.489	0.576

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 13: Effects of Agent Rollout on Poverty

Panel A: ITT for all clusters	Dependent variable: Poverty status
Agent	-0.003
	(0.021)
R-squared	.
N	4469
Number of clusters	334
Control group mean	0.428
Panel B: ITT by distance from bank branch	
Agent*Far	0.008
	(0.030)
Agent*Near	0
	(0.026)
R-squared	.
N	4469
Number of clusters	334
Control group mean - Far	0.421
Control group mean - Near	0.432

Note: Panel A shows results from OLS regressions of the dependent variables on a dummy variable that is equal to 1 if the cluster was randomly selected for the agent rollout and equal to zero otherwise. Panel B shows results from similar regressions, where the agent rollout dummy is interacted with two dummy variables indicating the distance to the nearest Airtel partner bank branch, where far is more than 25.2km away from a branch and near is less than or equal to 25.2km away from a branch. All regressions include randomization strata dummies and a dummy for whether the household head is male. When data on the outcome was collected at baseline, we also control for the baseline value of the outcome variable. For observations where the baseline value of the outcome is missing, we replace this value with zero and include a dummy variable indicating that the value is missing. Control group means are means of the dependent variables. Standard errors clustered at the cluster level in parenthesis. Statistical significance levels: * p<0.10, ** p<0.05, *** p<0.01.