Mobile Money, Remittances and Rural Household Welfare: Panel Evidence from Uganda

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Abstract

Mobile money service in Uganda has expanded rapidly, penetrating as much as over 30 percent of the adult population in just four years since its inception. We investigate the impact of this financial innovation on household welfare, using household survey panel data from rural Uganda. Results from our preferred specification reveal that adopting mobile money services increases household per capita consumption by 72 percent. The mechanism of this impact is the facilitation of remittances; user households are more likely to receive remittances, receive remittances more frequently and the total value received is significantly higher than that of non-user households. Our results are robust to a number of robustness checks.

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1 Introduction

Financial inclusion plays an integral role in reducing rural poverty as it facilitates saving and borrowing as well as empowering the poor to smooth consumption and insure themselves against a number of vulnerabilities in their lives (World Bank, 2012). [1] However, a large fraction of the population in developing countries lacks access to the basic financial services (Asli and Klapper, 2012). Lack of access to basic financial services restricts the ability of the rural poor to make savings and investments and engage in both formal and informal insurance mechanisms aimed at smoothing consumption and curbing poverty (Dupas and Robinson, 2008).

The prevailing low rate of financial inclusion has attracted the attention of scholars to investigate its driving factors (Asli and Klapper, 2012; Kumar, 2006; Collins et al., 2009; Susan and Zarazua, 2011). Among the commonly cited limiting factors is the relative concentration of formal financial institutions in urban centers with limited penetration among rural communities. This urban concentration poses high monetary and opportunity costs involved in accessing and using financial services, especially by the rural poor in remote locations. In their analysis of financial access and exclusion in Kenya and Uganda, Susan and Zarazua(2011) re-defined financial inclusion to include semi-formal and informal financial services like Rotating Saving and Credit Associations (ROSCA) and Savings and Credit Cooperative Organizations (SACCO). They found that exclusion is

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[1] Financial inclusion or financial access will be used interchangeably to refer to a situation where an individual has access to the services of a formal financial institution like a commercial bank, Micro-finance institutions and insurance companies. Financial exclusion is used in this paper to refer to the involuntary lack of access to formal financial services.

associated with agro-ecological and socio-cultural characteristics of the region, rather than the mere urban-rural status.

Mobile banking, a recent innovation in the financial sector, is expected to bridge the financial service access gap, thus allowing for socio-economic improvements especially among the financially excluded rural communities in many developing countries. Mobile banking allows users to make, deposits and transfers of funds as well as purchase of some limited range of goods and services using their mobile phone. This provides a relatively cheap and convenient means through which family members and friends exchange financial assistance in the form of remittances especially in remote areas with limited or no access to formal financial institutions like banks. Empirical studies have illustrated the developmental role of mobile banking. One such popular channel of this impact is the change in the pattern of remittances (Mbiti and Weil, 2011). The benefit of mobile money extends beyond the individual and household levels to businesses and organizations. Aker et al. (2011) demonstrated that the welfare program that distributed financial assistance for people to cope with the adverse effects of a severe drought in 2008 was implemented cheaply through mobile money, relative to conventional transfer mechanisms. This, they argue, owes to the relative inexpensiveness and convenience of mobile banking.

Jack and Suri (2011) provided evidence that access to mobile money services facilitates risk sharing by significantly reducing the transaction costs of remittances among family member and friends in Kenya. They found that households which subscribe to M-Pesa - Kenya's most popular mobile money service - were able to cushion themselves

against consumption volatilities when struck by income shocks, by receiving remittances from a wide pool of members in their social networks.

Despite the relative importance of mobile banking in the lives of the rural poor, less is known about its impact on their welfare. Specifically, there is scanty empirical evidence on how financial access affects the lives of the rural poor in developing countries. To the best of our knowledge, there is no empirical study that analyses the socio-economic impact of mobile banking in the Ugandan context, most of the recent works are based on the Kenyan experience (Mbiti and Weil, 2011; Jack and Suri, 2011). Besides, the analysis samples of these studies are inclusive of the urban mobile money users with less focus on the rural communities which tend to be more financially excluded. Moreover, recent studies on mobile money in Uganda are centered on analyzing adoption and use patterns (Susan and Zarazua, 2011; Ndiwalana, 2010) while other studies rely anecdotal evidence. Following the rapid adoption of mobile money services in Uganda, there is need to assess whether there is any direct welfare improvement that accrues to its users.

This paper seeks to fill the literature gap by investigating the impact of mobile money access on the welfare of rural households in Uganda. This study is unique in a way that it targets particularly households in rural locations which often tend to have less access to formal banking services coupled with relatively high poverty rates. We use a two-year panel of 907 households from 94 Local Council 1s in Uganda[2], collected in 2009 and 2012. In less than four years since its inception in March 2009, the number of active mobile

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[2] An LC1 is the second smallest unit of administration in Uganda.

money subscribers has expanded to over nine million users.[3] Between December 2011 and December 2012, the number of mobile money users increased from 2.9 million users to 9 million users. This is expected to facilitate inter-household transfer of funds especially and thereby increase household welfare. The number of LC1s with at least one mobile money booth increased from 26 to 90 out of 94 LC1s in our sample between the two survey rounds. At the same time, household adoption of mobile money services expanded from less than one percent to 38 percent.

From our preferred specification, results indicate that using mobile money is associated with a 69 percent increase in household per capita consumption. This is made possible through the facilitation of remittances among family members and friends. In particular, we find that households with at least one mobile money subscriber are 20 percentage points more likely to receive remittances from their members in towns and that the total annual value of remittances received is 33 percent higher compared with their non-user counterparts.

The rest of the paper is organized as follows. In section II, we provide background information about mobile money in Uganda. Section III discusses the data and summary statistics, followed by empirical strategy in section IV. Empirical results are discussed in section V while section VI concludes.

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[3] Bank of Uganda estimate as of December 2012.

2 Background on mobile money in Uganda.

In March 2009, Mobile Telephone Network (MTN) -Uganda established *MTN Mobile Money,* the first of its kind in the country, following the massive success of Safaricom's M-PESA in Kenya. Airtel Uganda, formerly known as Zain, joined the service when it rolled out its *Airtel Money* in June the same year. This new financial innovation proved to be an efficient way for telecom companies to increase their market shares by widening the range of services available to their clients. This attracted Uganda Telecom's *M-Sente* in March 2010, followed by *Warid Pesa* from Warid Telecom in December 2011 and *Orange Money* from Orange Telecom in the first half of 2012 (Uganda Communications Commission-UCC 2012).

Since mobile money was established in Uganda, the number of subscribers has been steadily increasing. By the end of 2012, Uganda had over 9 million mobile money users all over the country. This represents a three-fold expansion from 3 million users in 2011. The number of mobile money transactions increased from 180 million to 242 million between 2011 and 2012 while the total value exchanged through the platform increased from $1.5 billion to $4.5 billion in the same period (BoU, 2012).MTN Mobile Money alone has over 15,000 agents as compared with 455commercial bank branches with 660 Automated Teller Machines (ATMs). This rapid expansion partly owes to the high rates of both the roll-out of mobile phone network and adoption of mobile phones. In our sample, the proportion of households owning a mobile phone increased from 52 percent to 73 percent between the two survey rounds while all LC1s were covered by mobile phone network in both surveys.

Mobile money allows users to deposit money as e-float on a SIM card-based account, called an *m-wallet*, which can be converted into cash at any mobile money agent location all over the country. In the initial stages of its establishment, the range of services offered was largely limited to person-to-person transfer but with the growing interest from stake-holders, coupled with competition among the mobile network operators (MNOs), this platform has expanded the range of services to include more complex uses like payment of utility bills, school fees, airtime purchase and direct purchase of goods and services.

Recent developments in the mobile banking arena have made it possible for users to access their bank accounts using their mobile phones without having to physically visit their bank branches, thanks to the partnership between MNOs and banks.[4] This is expected to raise financial inclusion especially at the lower end of the social spectrum while reducing the cost of access and use of basic financial services. With the rapid urbanization in Uganda over the past years, the number of people migrating to towns has been steadily increasing. Those who migrate to cities often render financial support to their rural households in the form of remittances. The efficiency of this remittance system heavily relies on the quality of physical infrastructure as most of these transactions involve physical transfer of cash by the receiver, sender, and agents like bus and taxi drivers among others informal channels. Besides, the massive geographical dispersion between senders and receivers implies high transaction costs in terms of transport fares and travel time involved in sending and receiving money among household members especially across geographically distant and remote locations.

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[4] Major partnerships exist between *MTN Mobile Money* and Stanbic Bank, *M-Sente* and Standard Chartered Bank and *WaridPesa* and DFCU Bank.

3 Data and Summary Statistics

We use data from household and community surveys collected in Uganda in 2009 and 2012 as a part of the Research on Poverty, Environment and Agricultural Technology (RePEAT) project. This is part of the four survey rounds administered jointly by Makerere University, the Foundation for Studies on International Development (FASID) and the National Graduate Institute for Policy Studies (GRIPS) in 2003, 2005, 2009 and 2012. In the baseline survey of 2003, 94 LC1s were sampled and 10 households were randomly selected from each of the LC1s, making a total of 940 households. The follow-up surveys of 2005, 2009 and 2012 successfully captured 856, 816 and 866 of the original households, respectively. The high attrition rate in the third round was partially offset by the inclusion of neighboring households to replace those that could not be traced

The major household-level information that was captured in the surveys included demography, income and consumption expenditure, wealth indicators, use of telecommunication and financial services like mobile phones and mobile banking and farming practices. Community characteristics like distance and travel time to the market and district towns, availability of mobile phone network and quality of roads were captured in the community-level surveys.

Analysis in this paper is based on a balanced panel of 838 households generated from the third and fourth rounds in 2009 and 2012. We stratify our sample by mobile money adoption status before and after the introduction of mobile money and report the summary

statistics in Table 1[5]. In 2009, less than 0ne percent of the households reported having used mobile money services and this proportion rose to 38 percent by 2012. Among the households that adopted mobile money, 54 percent reported having at least one mobile phone in the initial year of our survey in 2009 compared to 50 percent reported among non-adopters. By 2012, the proportion of households with at least one mobile phone had increased to 93 percent and 61 percent among adopters and non-adopters, respectively. Although bank account information was not captured in 2009, we do not expect a substantial change between the two rounds. It is not surprising that only 38 percent and 12 percent of adopters and non-adopters reported owning a bank account in 2012, respectively because our sample households are predominantly from rural-based. This throws light on the relative exclusion of majority of rural households and individuals from the formal financial sector services.

At baseline, there was no notable difference between mobile money adopters and non-adopters in the flow of remittances, with an average proportion of 50 percent receiving remittances among both groups. By 2012, however, 78 percent of adopters received remittances at least once a year compared to 65 percent among non-adopters. Similarly, the number of remittances received was averagely 2.4 for both groups in 2009 while adopters received 5.5 remittances in 2012 compared to 3.0 remittances received by non-adopters. The total value of remittances received was statistically similar among users and non-users in 2009 while adopters received a significantly larger value of remittances in 2012. There

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[5] Although Mobile Money was introduced in the country in 2009, less than one percent of our sample households had adopted the service by the time of the 2009 survey. It is therefore reasonable to refer to 2009 as a year before mobile money and the household characteristics reported for 2009 represent the baseline characteristics of the households.

was no notable change in the average land size among users and non-users between the two survey rounds, with adopters (non-adopters) owning 7.2 acres (5.7 acres) in 2009 and 6.9 acres (5.6 acres) in 2012. On average, a household head was 53 years old for both mobile money adopters and non-adopters in both survey rounds while heads of adopting households had two more years of education compared to their non-adopting counterparts. On average, household were similar in terms of major household characteristics in 2009 with the exception of education of the household head, land and asset holdings. We later show how we deal with potential household heterogeneity in our empirical strategy.

4 Empirical Strategy

In this section, we estimate three major equations; (i) the determinants of mobile money adoption at the household level, (ii) the effect of mobile money adoption on household per capita consumption and (iii) the impact of mobile money use on measures of household remittances; probability of receiving remittances, frequency and total value of remittances received.

4.1 Determinants of mobile money adoption.

The decision to adopt mobile money services depends on observed characteristics of the household and village in the form

$$Mmoney_{ijdt} = 1\{\beta X_{it} + \eta_{dt} + \varepsilon_{ijdt} > 0\}, \quad (1)$$

where $Mmoney_{ijdt}$ is a dummy variable which takes 1 if household i living in village j in district d uses mobile money services at time period t and 0 otherwise; η_{dt} is expected to capture the district-year specific unobservable characteristics which would affect mobile money usage; X_{it} is a vector of household characteristics including household size, log of value of assets and land endowments, age, gender and education level of the household head and a dummy for household mobile phone possession. The Probit regression is employed for the estimation. Moreover, we also try another specification in which household-level fixed effects are introduced in order to rule out the effect of unobservable time-invariant household and village characteristics. A linear probability model is used for this estimation instead of Probit estimation. As we shall show in the results section, the change of estimation method does not qualitatively change our results.

4.2 Mobile money and household per capita consumption

We first examine the effect of mobile money adoption on household welfare using a simple difference-in-differences strategy that compares the monthly per capita consumption of mobile money users against that of non-users.

$$c_{ijdt} = \alpha_i + \mu Mmoney_{ijdt} + \psi X_{it} + \eta_{dt} + v_{ijdt}, \quad (2)$$

where c_{ijdt} is the monthly per capita consumption of household i in village j in district d in period t and α_i is a household fixed effect, The coefficient of $Mmoney$, μ represents the parameter of our interest or the welfare impact of mobile money use, which is expected to be positive. We use household per capita consumption as a proxy for household welfare. As an alternative, we could use total household income as it is also directly linked to the ability

of a household to improve the wellbeing of its members. However, this measure is more vulnerable to short-term economic effects compared to the consumption measure (Gilligan and Hoddinott, 2009).

4.3 Mechanisms: Mobile Money and Remittances

To assess whether remittance patterns differ across users and non-users of mobile money, we estimate the following equation, which is a slight modification of equation (2).

$$r_{ijdt} = \kappa_i + \pi\, Mmoney_{ijdt} + \phi X_{it} + \sigma_{jt} + \epsilon_{ijdt}, \qquad (3)$$

where r is a measure of remittances received by household i in year t. This measure takes three variants; the probability that a household receives a remittance, the number of remittances received in the past 12 months of the respective survey round and the total value received within the same period. As one of the household-level independent variable, X_{it}, we include a dummy variable taking one if the household reported having at least one member who moved out to search for a job outside the home village, hereafter used interchangeably as job-seeking behavior and having a migrant worker. In equation (3) we include a full set of controls as in (2) above.

4.4 Falsification Test

In order to confirm that the observed difference in consumption and remittances between users and non-users of mobile money is genuinely due to this financial platform, we replicate the estimation strategy as described above, using RePEAT data for the period prior to mobile money. We thus estimate equations (3) and (4) using 2003 and 2005 data.

This constitutes the first and second rounds of the RePEAT series, as described in the Data section of this paper. Using this data, we examine whether there existed differences in consumption and remittance patterns between households that later adopted mobile money against non-adopters. Since mobile money was not available in this period, we use a placebo binary treatment variable equal to one for households that adopted mobile money in/after 2009. We also examine whether having a migrant worker in a household had an influence over remittance patterns. This strategy enables us to assess whether the differences in outcome variables (consumption and remittance measures) between users and non-users are indeed a result of mobile money adoption status. We expect no significant difference between households that later adopted mobile money services and those that did not. If this is true, then the emergence of a significant relationship between mobile money and the outcome variables could be attributed to mobile money.

4.5 Instrumental Variable and Tobit Regressions

So far, we have assumed that mobile money adoption by the household is conditionally mean-independent, given the other control variables included in the regressions. This implies that the estimated coefficients are only valid if mobile money adoption is not correlated with the error term conditional on the other controls. Although we are able to rule out the effect of unobserved time-invariant household heterogeneity using fixed effects estimation, the decision to adopt mobile money services may be highly correlated with time-variant un-observables that also affect household consumption expenditure. Also, being a remittance recipient in the past might induce the household to adopt mobile money

as a cheaper and convenient platform to receive remittances from their members in towns. This endogeneity resulting from simultaneous effects might confound our OLS and fixed effects estimates. To address the issue, we resort to instrumental variable estimation of consumption using log of the distance to the nearest mobile money agent as an instrument for mobile money adoption at the household level.

The underlying assumption in this framework is that the distance to the nearest mobile money agent is not correlated with household and village characteristics that could affect household consumption. For example, agents might select into communities with larger population densities because of the size of the potential market. This however does not seem to be a threat because mobile money agents were previously existing local businessmen selling airtime cards, who took up the mobile money business as a diversification of their range of services. Besides, the procedure for licensing an agent is not restrictive and the all applications are reviewed by the mobile network operator against prescribed requirements without due consideration to the geographical and socio-economic characteristics of the agent's location. Besides, we do not find any significant correlation between these characteristics and mobile money agent placement (results available upon request).

We employ a Tobit model in combination with a control function method to deal with two critical challenges associated with our remittance variables. The first challenge concerns the corner solution nature of the remittance measures, owing to the fact that the number and total value of remittances received are only available for households which

received positive remittances. This implies that these variables have a skewed distribution given the many zeroes for non-recipients. The control function approach deals with the second challenge - potential endogeneity resulting from the correlation between remittance variables and time-variant unobserved household characteristics (Vella, 1993). In both variants of our Tobit models, we include time averages of household characteristics to rule out the effect of time-invariant household characteristics that could confound our results (Mason, 2013). Like in the standard IV method described above, we include the log of distance to the nearest mobile money agent in estimating the number and total value of remittances received.

4.6 Reduced form analysis

The effectiveness of mobile money services heavily relies on the availability and ease of access to mobile money agents as these facilitate cash-in and cash-out transactions. In this section, we examine whether access to a mobile money agent influences household welfare, supposedly through mobile money-based remittances. In the spirit of Jack and Suri (2011), we use the log of distance to the nearest mobile money booth as a measure of access to mobile money services and use the specification below to assess this relation.[6]

$$c_{ijt} = \gamma + \alpha_i + \pi \ln Dist_{jt} + \psi X_{it} + \sigma_{jt} + \varepsilon_{ijdt}, \qquad (4)$$

where $\ln Dist_{jt}$ is the log of distance in kilometers from village j to the nearest mobile money booth. We expect π to have a negative sign because the further the mobile money agent, the harder it may be for a household to access mobile banking services and this

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[6] Distance to the nearest mobile money location is captured at the community level.

might translate into reduced ability of a household to receive financial assistance in form of remittances from its members. This would, in turn, reduce the power of a household to smooth consumption as described in earlier sections.

5 Results

5.1 Determinants of household mobile money adoption.

Table 2 presents the determinants of household mobile money adoption. The Probit results in Column 1 reveal that households with mobile phones are nine percentage points more likely to use mobile money services. This is not surprising because mobile money services are offered through a cell phone handset. Education of the household head has a positive and significant impact on the decision to adopt mobile money services; an additional year of education of the household head leads to one percentage point increase in the probability of adopting mobile banking. This could partly capture the literacy effect of educated household heads who could be more able to operate mobile handsets. Alternatively, it could be true that educated household heads are more able to send their children to school who, upon graduation, find jobs in towns and extend financial assistance in form of remittances through mobile money platforms. This claim is partly supported by the significantly positive impact of the job-seeking dummy on mobile money use by the household.

These results remain qualitatively unchanged with the fixed effects estimation in Column 2. The significantly negative coefficient on the distance to the nearest mobile

money agent implies that households choose to subscribe to mobile money services if the distance from the nearest booth is relatively shorter. This further supports the notion that the relative urban concentration of banks is partially responsible for the slow adoption of formal financial services. It should be noted that mobile money booths and agents are instrumental in facilitating mobile money transactions in a way that they act as cash-in and cash-out agents.

[Insert Table 2 here]

5.2 Mobile money and household per capita consumption

Table 3A reports the results from the estimation of (2) as OLS and fixed effects models with a full set of household and community characteristics. In column 1 we include district-by-time controls among the covariates in our OLS model. The results suggest a 13 percent increase in household per capita consumption given the adoption of mobile money services. To address the possibility of bias in our OLS results that could potentially result from unobserved and time-invariant household heterogeneity, we estimate a fixed effects model with and without district-by-time effects in columns 2 and 3, respectively. Across all specifications, the estimates remain qualitatively similar, suggesting a significantly higher level of per capita consumption for mobile money users. The district-by-time effects in Column 3 capture district-level trends that might be correlated with both mobile money adoption and per capita consumption.

[Insert Table 3A here]

We further disaggregate our consumption expenditure measure into three categories – expenditure on food items, non-food household basics and social contributions.[7] Table 3B gives a report of these three measures using both OLS and fixed effects estimations. Column 1 shows that mobile money adoption has a positive impact on per capita food expenditure, although the relationship disappears after controlling for unobserved time-invariant household characteristics in Column 2. The average impact for basic expenditure ranges between 15% and 20% for OLS and fixed effects models, respectively (Columns 3 and 4). Columns 5 and 6 reveal that a household that uses mobile money services experiences between 47 and 56 percent higher value of social contributions. These results should, however, be interpreted carefully, as they are likely to be capturing reverse causality effects.[8] Nonetheless, they suggest that social contributions and basic expenditures respond more strongly to mobile money adoption as compared to food expenditure. This result is not rather surprising, owing to the rural nature of households in our sample which implies that a large fraction of consumed food comes from own farms. Chetty and Looney (2006) argue that when consumption is close to subsistence level, any shocks to income might not necessarily translate into reduced household consumption because its level is already too low such that it cannot be reduced any further.

5.3 Mechanisms

5.3.1 Mobile money and household remittances.

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[7] Expenditure on household basics includes expenditure on school, medical, transport, clothing, cooking and lighting materials. Social contributions cover expenses on ROSCAs, mutual support organizations – both funeral and non-funeral, churches and mosques, other local organizations and credit repayments.

[8] Household that make numerous social contributions may be convinced by members of their social networks to join mobile money services for easier transmission of contributions.

As we predicted in earlier sections, the impact of mobile money on household welfare is achieved through the facilitation of remittances. We explore into this claim by examining whether households that have access to mobile money services have differential access to remittances. These results are reported in table 4A. Being a mobile money user is associated with a significantly higher probability of receiving remittances and the remittances received are larger in number and total value compared with non-users. In estimating the probability of a household receiving remittance, we estimate equation (4) as a Probit model, since the dependent variable is binary. The results in Column1 show that mobile money adoption increases the probability of receiving remittances by seven percentage points. These results remain qualitatively unchanged when using OLS regression in Column 2. In columns 3 through 6, we present the results from the other two measures of remittances – number of remittances and total value received in the past 12 months. From Columns 3 and 4, mobile money users receive approximately one more remittance at a given time, compared to non-users. The OLS estimates of total value of remittances in Column 5 reveal that adopting mobile money services increases the total value of remittance received by 36%. This translates into approximately 116,706 Uganda Shillings (USD 61), as evaluated at the mean value of non-users. The fixed effects estimation of remittance value in Column 6 yields similar results even after controlling for unobserved time-invariant heterogeneity between users and non-users. In all specifications, we include controls for household characteristics (mobile phone possession, household size, asset value, land size, as well as age, education and gender of household head). The

inclusion of district-by-time effects in our regressions captures local macro trends that may have differential influence on household access to remittances.

[Insert Table 4A here]

5.3.2 The influence of migration (job-seeking behavior)

We now account for the source of remittances and examine the possibility of differential remittance structure between households that send their members to find jobs outside the village in towns and those that do not. These results are reported in Table 4B. Column 1 reveals that, conditional on mobile money status and other covariates, households that send their members to find town jobs are 11 percentage points more likely to receive remittances. Columns 2 and 3 report results for the number and total value of remittances received, respectively. Having a member working outside the village increases the number and total value of remittances by 1.4 times and 42%, respectively. We believe that the introduction of mobile money reduced the monetary and opportunity costs that hitherto hindered these workers from transferring money to villages. Our presumption is that, even when members were working in towns prior to the introduction of mobile money, the idiosyncratic lack of a cheap and convenient money transfer mechanism rendered it hard for the members to remit financial assistance back to their rural households. To check this claim, we perform similar analysis on a sub-sample covering the period before mobile money inception in 2009 – survey rounds of 2003 and 2005. The results in Table 8 suggest no significant relationship between working outside the village and all measures of remittances and

consumption. The fact that this relationship emerged after mobile money establishment provides partial evidence in support of impact of mobile money on remittances.

[Insert Table 4B here]

5.4 Results from Reduced Form Analysis

Table 5 reports the results from our reduced form analysis using log of distance to the nearest mobile money booth as a measure of access to mobile money services at the community level. The dependent variable in column 1 is the log of monthly household per capita consumption. As earlier predicted, being located away from the mobile money booth is associated with a significant reduction in household per capita consumption. The probability, number and total value of remittances received, as measures of remittances, are reported in columns 2, 3 and 4, respectively. Results are consistent with those reported in our previous estimations. Households in located one kilometer away from the mobile money booth have two percentage point lower probability of receiving remittances (Column 2). Similarly, the frequency and total value of remittances received reduces significantly with an increase in the distance to the mobile money agent. Note that the treatment variable in this case is a community-level variable and the inclusion of district and time dummies implies that our estimate is a conservative estimate of the true effect of mobile money access as these controls absorb much of the variations in mobile money access. Most importantly, controlling for district and time effects rules out the potentially confounding effect of local access to services that tend to be concentrated in district towns.

[Insert Table 5 here]

5.5 IV and Tobit Results

Results reported so far rely on the assumption that mobile money is not correlated with the error term conditional on the other controls included in the regressions. However, where this assumption does not hold, both OLS and fixed effects estimates may be biased. As earlier noted, mobile money is potentially endogenous given reverse causality concerns – households may adopt mobile money when they expect to receive remittances. In this section, we account for this endogeneity using standard fixed effects IV method for consumption and Tobit models with a control function approach for remittances. Apart from capturing potential endogeneity, the latter technique takes into account the corner solution problem resulting from the censored nature of our remittance variables, that is, households that never received remittances have no observations for the number and total value of remittances. In the control function version of our Tobit model, we include residuals from the first stage estimation of the determinants of mobile money in the main model. In both methods, we use log of distance to the nearest mobile money agent as an excluded instrument for the potentially endogenous mobile money variable.

The results of these estimation methods are reported in Table 6. Column 1 reports results of the consumption measure using standard fixed effects IV method. Columns 2 through 5 report the Tobit estimates of the number and total value of remittances received. In columns 3 and 5, we combine Tobit with control function methods to control for corner solution and endogeneity problems. Estimates in Column 1 reveal that per capita

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consumption increases by 72 percent upon adoption of mobile money. Although we do not show the first stage results for the IV regression because of space limitation, we report the F-statistic on the instrument which shows that the instrument if valid. Columns 2 and 3 show that mobile money adoption approximately doubles the total value of remittances received while Columns 4 and 5 show that users receive more than one additional remittance relative to non-users. The number of remittances is positively associated with mobile money usage, although the coefficient is not statistically distinguishable from zero at conventional levels of significance. In line with Mason 2013, the significance of the residual in Columns 3 and 5 not only implies potential endogeneity of the treatment variable but also deals with the problem. We therefore focus on the results in Columns 3 and 5 for our measures of remittances.

[Insert Table 6 here]

5.6 Alternative Explanations

Local economic conditions at the village level could account for changes in mobile money penetration and household per capita consumption. For example, mobile money agents could locate in trading centers where economic activities are concentrated, while at the same time business and employment opportunities near trading centers and towns could provide alternative income sources that potentially increase consumption. Instrumenting mobile money possession with distance to the nearest mobile money booth would potentially capture the spurious positive relationship between mobile money and

consumption. We take two measures to address this concern. First, in all our regressions, we control for the distance between the village center and the nearest district town where major economic activities are concentrated to capture the local economic potential of the corresponding villages. Secondly, since we use fixed effect IV (FE-IV) method withy time and village dummies rather than the conventional IV framework, we smooth out unobserved fixed attributes of the household as well as local time and village effects that could potentially confound our results.

One might argue that the changes in remittance patterns could have resulted from mobile phone possession which could have enabled rural households to contact their members in towns in times of hardship. If this were the case, then mobile phone possession would be expected to have a positive and significant effect on the flow of remittances among the household members even in the absence of mobile money. In order to explore into this possibility and thus disentangle any impact of mobile phone from that of mobile money, we examined the relationship between mobile phone possession and household per capita consumption and remittances prior to the introduction of mobile money. We therefore run regressions of the outcome variables on a dummy variable of mobile phone possession using 2003 and 2005 data, including a full set of controls as in previous sections. As reflected in Table 7, there is no significant relationship between mobile phone possession on one hand and consumption (Column 1) and remittances on the other (Columns 2 through 5). At best, the remittance impact of mobile phone possession is positive and statistically indistinguishable from zero. This partially rules out the possibility

that the observed consumption and remittance changes resulted majorly from mobile phone possession.

[Insert Table 7 here]

6 Conclusion

Lack of access to financial services is a typical challenge to rural livelihood in many developing countries. Apart from the direct hindrance on the ability to borrow and save, the associated high costs of remitting funds to financially inaccessible areas impose a limit on the effectiveness of informal sharing mechanisms among friends and relatives. Mobile money - a new financial service that allows direct transaction via a mobile phone –serves to bridge this gap given its relatively lower cost and convenience. In Uganda, mobile money adoption has expanded tremendously over the past three years since its inception in 2009. In this paper, we examine the welfare impact associated with this service by estimating its impact on monthly household per capita consumption. Specifically, we provide evidence that households using this financial innovation experience a significant increase in per capita consumption. The result is robust to sensitivity checks, mainly the change in empirical specification.

Disaggregating consumption into food, basic and social expenditures, we find stronger impacts of mobile money for the social expenditure measure, partially suggesting investment in informal social and insurance networks and saving mechanisms. There are a

number of potential pathways through which this result might be realized as cited in the literature including the facilitation of savings (Jack and Suri, 2011) and self-insurance through remittances. We provide evidence that the estimated impact is achieved through the facilitation of remittances; households with access to mobile money services are more likely to receive remittances, receive remittances more frequently and receive higher value of remittances relative to non-users. Although we do not explicitly demonstrate due to data limitations, we are convinced, based on anecdotal evidence that the average cost of remitting funds across households reduced greatly with the event of mobile money technology. We further venture into the role of family dynamics by comparing remittance patterns across households with and without members working outside the village. We provide a falsification test that the relationship between this migration measure and remittances did not exist prior to mobile money, suggesting that its emergency after 2009 partially reflects reduction in transaction costs that made it possible for workers to remit funds to their rural households.

The results presented in this paper suggest significant welfare benefits of access to financial services which might go afield in reducing rural poverty through reduction in vulnerability by the rural poor. Dercon (2006) suggests stronger welfare benefits of informal insurance mechanisms if random reductions in consumption affect poverty dynamics through persistent income reduction in incomes. One concern however is that, although we plausibly assume reduction in remittance cost as the major pathway of the welfare and remittance impact of mobile money, we do not test this premise within the

limitation of the data. This and the analysis of risk-sharing behavior will form the foundation for further research.

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Table 1: Summary Statistics by Year and Mobile Money Adoption Status

| | 2009 | | | | 2012 | | | |
| | Non-Adopters | | Adopters | | Non-Adopters | | Adopters | |
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ICT Use								
1 if mobile phone owned	0.5099	0.5003	0.5462	0.4985	0.6133	0.4874	0.9320	0.2520
1 if holds bank account	-		-		0.1269	0.3332	0.3815	0.4865
Wealth								
Total value of assets (Ush)	266,466	564,907	411,356	568,729	390,208	555,563	831,826	1,189,717
Land holding size (acre)	5.7931	7.1484	7.1633	10.0797	5.5852	6.1938	6.9291	9.1896
Remittances								
1 if received remittance	0.5036	0.5004	0.5098	0.5006	0.6558	0.4755	0.7892	0.4084
No. of Remittances	2.4116	4.7165	2.3838	4.6326	3.0394	5.0995	5.5496	7.3803
Total remittance (Ush)	566,222	1,002,502	558,571	914,789	621,833	1,116,481	1,088,673	1,595,953
Welfare								
Per capita consumption (Ush)	27,484	28,121	31,488	25,073	43,524	35,182	54,636	41,080
HH Characteristics								
Age of household head	53.1414	14.5252	53.3301	14.1900	52.6536	14.6563	52.7336	13.1949
1 if head is female	0.1170	0.3218	0.1481	0.3557	0.1554	0.3627	0.1569	0.3642
Head education	5.1611	3.6416	7.2138	4.1048	4.9328	3.5509	7.2215	3.9826
Household size	6.8675	3.2063	7.1512	3.6603	6.9068	3.4249	7.3549	3.6206
Village Characteristics								
Distance to district town (km)	13.4557	10.9761	11.8712	9.5719	10.3639	8.4176	8.7333	7.5988
Number of households	521		325		521		325	

Notes: Authors' computation based on RePEAT 2009 and 2012. According to the annual Bank of Uganda Report 2012, 1 USD was equivalent to Ush 2028 and 2557 in financial years 2008/2009 and 2011/2012, respectively.

Table 2: Determinants of Household Mobile Money Adoption

Variable	(1) Probit	(2) FE
1 if mobile phone owned	0.0806***	0.117***
	(0.0142)	(0.0273)
1 if HH has migrant worker	0.0349***	0.0908***
	(0.0131)	(0.0268)
Log of distance to nearest MM agent in km	-0.0137***	-0.0442***
	(0.00383)	(0.0106)
HH head's years of schooling	0.00543***	0.0115***
	(0.00152)	(0.00332)
Head age	0.00192	0.00471
	(0.00234)	(0.00472)
Head age squared	-1.50e-05	-4.16e-05
	(2.17e-05)	(4.32e-05)
Log of land size in acre	0.00207	0.00132
	(0.00710)	(0.0185)
Household size	0.000151	0.000378
	(0.00135)	(0.00365)
1 if head is female	0.0289	-0.0141
	(0.0185)	(0.0357)
Log value of total assets (UGX)	0.0195***	0.0248**
	(0.00485)	(0.0114)
District*Time dummies	Included	Included
Number of observations	1,745	1,745
R-squared		0.448
Number of households		906

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.

Table 3A: Mobile money and Household Consumption
Dependent Variable: Household Per capita Consumption

Variable	(1) OLS	(2) FE	(3) FE
1 if mobile money used	0.135***	0.110*	0.0947*
	(0.0394)	(0.0565)	(0.0565)
Constant	9.144***	8.611***	9.359***
	(0.288)	(0.377)	(0.383)
District*Time dummies	Included		Included
Number of observations	1,753	1,753	1,753
R-squared	0.300	0.272	0.379
Number of households		914	914

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.

Table 3B: Mobile money and disaggregated consumption expenditure
Dependent Variable: Components of Household Per capita Consumption

Variable	Food Expenditure		Non-food Basics		Social Contributions	
	OLS (1)	FE (2)	OLS (3)	FE (4)	OLS (5)	FE (6)
1 if mobile money used	0.0977**	-0.0129	0.154***	0.207**	0.563***	0.474**
	(0.0483)	(0.0683)	(0.0594)	(0.0832)	(0.117)	(0.187)
Constant	10.82***	11.75***	7.255***	8.193***	6.854***	7.213***
	(0.231)	(0.295)	(0.236)	(0.358)	(0.668)	(0.893)
District*Time dummies	Included	Included	Included	Included	Included	Included
Number of observations	1,725	1,753	1,753	1,753	1,725	1,753
R-squared	0.302	0.354	0.303	0.470	0.380	0.373
Number of households		914		914		914

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.

Table 4A: Mobile money and Household Remittances
Dependent Variable: Measures of Remittances

Dependent Variable:	1 if Remittances Received		No. of Remittances		Total Remittances	
			(3)	(4)	(5)	(6)
	(1)	(2)				
Variable	Probit	OLS	OLS	FE	OLS	FE
1 if mobile money used	0.0706*	0.0581*	0.843**	0.940*	0.360***	0.381*
	(0.0399)	(0.0324)	(0.421)	(0.525)	(0.133)	(0.220)
Constant		0.0273	-5.028**	-1.772	5.066***	5.080***
		(0.190)	(2.441)	(3.354)	(0.872)	(1.253)
District*Time dummies		Included	Included	Included	Included	Included
Number of observations	1,702	1,729	1,736	1,736	1,736	1,736
R-squared		0.228	0.188	0.261	0.278	0.286
Number of households				905		905

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.

Table 4B: Mobile Money, Job-seeking and Remittances. Dependent Variable: Measures of Remittances

Variable	(1) 1 if Remittances Received	(2) Number of Remittances	(3) Total Remittances
1 if mobile money used	0.0952**	1.385**	0.428***
	(0.0456)	(0.629)	(0.163)
1 if HH has migrant worker	0.114***	1.384***	0.415***
	(0.0327)	(0.482)	(0.138)
Constant		2.831	9.607***
		(2.315)	(0.605)
District*Time dummies	Included	Included	Included
Number of observations	1,709	1,736	1,736
R-squared		0.265	
Number of households		905	905

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.

Table 5: Reduced Form Results

VARIABLES	(1) Consumption	(2) 1 if Remittances Received	(3) No. of Remittances	(4) Total Remittances
Log (distance to booth)	-0.0481**	-0.0211*	-0.517***	-0.259**
	(0.0238)	(0.0127)	(0.182)	(0.123)
Constant	11.48***	0.622***	1.733	9.642***
	(0.257)	(0.141)	(1.687)	(1.104)
District*Time dummies	Included	Included	Included	Included
Number of observations	1,762	1,750	1,757	1,757
R-squared	0.345	0.216		
Number of households	915		914	914

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.

Table 6: IV and Tobit Results. Dependent Variables: Measures of Consumption and Remittances

Variable	Consumption	No. of Remittances		Total Remittances	
	FE-IV	Tobit	Tobit-CF	Tobit	Tobit-CF
	(1)	(2)	(3)	(4)	(5)
1 if mobile money used	0.727*	1.449*	1.253	1.160***	1.002***
	(0.382)	(0.777)	(0.782)	(0.369)	(0.372)
Residual			20.84***		6.357***
			(7.052)		(2.244)
Constant		-11.58***	0.883	2.139	6.220**
		(4.439)	(6.281)	(1.902)	(2.490)
F-statistic on instrument	16.38				
District*Time dummies	Included	Included	Included	Included	Included
Number of observations	1,664	1,746	1,746	1,746	1,746
R-squared	0.194				
Number of households	832				

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
The excluded instrument is the log of distance (in kilometers) from the LC1 to the nearest mobile money agent. Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head. The first stage results are not displayed due to limited space.

Table 7: Effect of Mobile Phone Possession on Household Consumption and Remittances (2003-2005)

Variable	(1) Consumption	(2) 1 if Remittances Received	(2) No. of Remittances	(3) Total Remittances
1 if mobile phone owned	-0.101	-0.0201	0.0150	-0.250
	(0.106)	(0.0561)	(0.117)	(0.475)
Constant	8.113***		-0.0561	6.932***
	(0.528)		(0.431)	(1.868)
District*Time dummies	Included	Included	Included	Included
Number of observations	1,748	1,735	1,735	1,735
R-squared	0.258		0.429	0.152
Number of households	934		931	931

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Additional controls include household size, log of asset value, log of land size owned as well as gender, age and education level of household head. Sample of 2003-2005 used.

Table 8: Falsification Test-Consumption, Job-seeking behavior and Remittances (2003-2005 sub-sample)

Variable	(1) Consumption	(2) 1 if Remittances Received	(3) No. of Remittances	(4) Total Remittances
1 if mobile money used	-0.0650	0.0113	-0.108	-0.0788
	(0.0675)	(0.0418)	(0.238)	(0.0708)
1 if HH has migrant worker		0.0245	0.105	-0.0589
		(0.0350)	(0.243)	(0.0697)
Constant	8.222***		6.967***	-0.0446
	(0.533)		(1.870)	(0.431)
District*Time dummies	Included	Included	Included	Included
Number of observations	1,735	1,735	1,735	1,735
R-squared	0.261		0.153	0.431
Number of households	931		931	931

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Additional controls include household size, a dummy for household mobile phone possession, log of asset value, log of land size owned as well as gender, age and education level of household head.