ESSAYS ON THE IMPACT OF MOBILE MONEY ON HUMAN CAPITAL AND AGRICULTURAL INVESTMENT: EVIDENCE FROM RURAL UGANDA

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Abstract

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It is widely accepted that a viable financial sector is essential for economic development and poverty reduction since it enhances resource mobilization and allocation into productive investments. It enables households to respond in a timely and effective manner to both opportunities and shocks and thereby attenuates the negative impact of erratic shocks on human capital and agricultural investment. Access to formal financial services has remained conspicuously low in most parts of Africa notably in rural communities. Rural households often have to rely on their own limited resources and thereby limiting their ability to take advantage of promising investment opportunities inherent in their environment. The advent of mobile phone based banking and money transfer services dubbed *Mobile money* has significantly improved access to financial services especially in rural communities in Uganda. Over 20 million Ugandans have adopted the service ever since its inception in 2009. However the impact of mobile money adoption on human capital and agricultural investment remains to be elucidated. This dissertation attempts to relate mobile money to rural households' educational and agricultural investment behavior using longitudinal data collected in rural Uganda in 2003, 2005, 2009, 2012 and 2015. The study finds that the adoption of mobile money induces a 32 per cent increase

in per school-age child educational expenditure and 4 percentage point increase in the likelihood of school enrollment of school age children. It also finds that small scale farmers who have adopted mobile money are 5 percentage points more likely to have adopt high yielding variety seeds thereby leading to productivity gains and consequently higher income. The study identifies increase in remittance receipt as the main channel through which mobile money adoption induces investment. These results imply that attempts at boosting investments in education and intensifying farming systems will require governments and other stakeholders to design affordable financial services.

Dedication

To my late father Mr Scott Obenson and my indifatigueable mother Mrs Mary Beyang

Obenson

Summary

It is widely accepted that a viable financial sector is indispensable for economic development and poverty reduction. An enabling financial environment is essential for the optimal allocation of resources which are conspicuously scarce in rural settings. Promising ventures are easily identified and supported. Small holder farmers can access affordable credits and thereby facilitate the adoption and optimal application of modern inputs. Access to credit enable households to investment more in health and education, thereby attenuating the impact of erratic shocks. Effective rural financial sector fosters productive investments hence poverty reduction through economic development.

Access to formal financial services is conspicuously low in most African countries especially in rural communities. Financial exclusion of rural communities attenuates their ability to respond in a timely and efficient manner to opportunities and shocks inherent in their environment. Rural households mostly have to rely on their own savings which is often insufficient to finance promising income-earning activities. In the absence of a formal financial sector, several informal institutions have emerged to fill the void such as Savings and Cooperative organizations (SACCO). In addition to the risk inherent in such informal institutions, they are also known to charge exorbitant fees for their services especially to non-members.

Many researchers have shown an interest in exploring drivers of financial exclusion notably in rural Africa. The direct and indirect cost associated with formal financial services is often too high for rural communities to afford them. Fees charged to open and maintain a bank account is often out of the reach of most rural households. The relative concentration of financial service providers in urban and peri-urban areas imposes non-negligible transportation cost for rural households seeking formal financial services.

Of recent, the financial environment in most rural communities has been changing considerably owing to the rapid dissemination of mobile phones as well as considerable expansion and improvement in telecommunication infrastructure. Mobile phones have become ubiquitous in most rural communities and thereby provides a platform through which affordable financial services can be delivered to rural communities. Mobile money has emerged as an affordable and convenient mobile phone based financial service which enables individuals to open bank accounts, send and receive money via their mobile phone. Mobile money has been disseminating very fast in rural Africa due to the fact that it is faster, affordable and less procedural compared to traditional banking services.

This dissertation explores the impact of mobile money adoption on rural households' investment behavior. First it examines the determinants of households' decision to adopt the mobile money service and the resultant impact on agricultural and educational investment. This study uses household and community level panel data collected in 2003, 2005, 2009, 2012 and 2015 by Makerere University, Foundation for Advanced Studies on International Development (FASID) and the National Graduate Institute for Policy Studies (GRIPS). The data collection was done under the Research on Poverty, Environment and Agricultural Technology (RePEAT) project. The household level component of the RePEAT captures information on demography, agriculture, soil quality, income, health, education, financial service usage, land tenure and migration amongst others. The community survey covers information on community characteristics, distance to market and district towns, state of roads and availability of public services such as schools, hospitals and telephone network.

This dissertation addresses two main hypothesis; (1) mobile money adoption induces small-scale farmers to adopt modern farming practices notably high yielding variety seeds as well as fertilizer. The adoption of these modern inputs leads to productivity gains (higher yields), larger market participation and consequently higher income (2) Mobile money adoption induces larger investments in education measured in per school age child educational expenditure. It also

increases the likelihood of school enrollment and conditional on enrollment, it increases the demand for private schools relative to public schools despite the latter is tuition free. To the best of our knowledge there have been no rigorous empirical studies on the impact of mobile money on rural development especially human capital and agricultural investments. This thesis contributes to the literature to fill the research gap

In terms of findings, the study reveals that the dissemination of mobile money has remained very high in rural Uganda. The adoption rate has jumped from less than 1 percent in 2009 to 28.8 percent in 2012 and to 66.5 percent in 2015. This rapid expansion in mobile money adoption is supported by improvements in access to mobile money agents. The average distance from the community to the nearest mobile money agent has dropped from 13km in 2009 to 4km in 2012 and 3km in 2015.This decrease in distance indicates significant reductions of transaction cost for rural households. This reduction in transaction costs is an advantage of mobile money over traditional banking services.

The study also finds that mobile money adopters are more likely to adopt modern agricultural inputs such as high yielding maize seeds and fertilizer. The adoption of these modern inputs leads to productivity gains and ultimately higher income for mobile money adopter households. Crop level analysis indicates that mobile money adoption induces modern input adoption for crops that are relatively intensively grown such as maize compared to crops that are grown with low modern input intensity such as banana. Regarding market participation, mobile phone ownership rather than mobile money is associated with greater market participation notably for perishable crops such as banana compared to maize

Regarding educational investment, mobile money adoption is associated with larger investments in education measured in per school-age child educational expenditure. Mobile money adoption increases the likelihood of school enrollment. Conditional on enrollment, it induces demand for private school education relative to public school education.

In examining the mechanism through which mobile money triggers agricultural and educational investment, the dissertation reveals that mobile money adopters are more likely to receive remittances and receive larger amount of remittances. This result indicates that mobile money adoption facilitates intra-household resource allocation across distances. Increases in remittances induced by mobile money adoption enables rural households' to increase investment in agriculture and education.

The above findings have resounding policy implications. First, the above results indicates that rural households' are willing to adopt modern financial services conditional on such services being affordable. Hence, the drive for greater financial inclusion will require existing traditional banking services to be stream lined in view of rendering them affordable and less procedural. There is an urgent need for governments and other financial stakeholders to expand the range of financial services available via mobile money accounts. The impact of mobile money on agriculture and education is essentially driven by remittances thereby tying mobile money to migration. There is need to promote mobile money as a platform for savings and loans thereby enabling rural communities to mobilize financial resources in addition to remittances needed for investments. Promoting access to credit via mobile money will enable rural households to respond in a timely and efficient manner to opportunities and shocks independent of remittances.

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CHAPTER 1

Introduction

The idea that households are rational welfare maximizers is fundamental in development economics since Theodore Schultz (1964). Empirical studies have shown that even when returns to investments in health, education or agriculture is high, households in developing countries still invest sub-optimally in them(Akerlof, 1978; Besley et al., 1992; Dupas, 2010;Alatas et al., 2013; Cohen et al., 2010). Credit constraint has been regularly cited as a major reason for households inability to invest optimally (Guyatt et al., 2002; Kremer and Miguel, 2004; Cohen and Dupas, 2010). Some studies have also identified behavioral inconsistencies (O'Donoghue et al., 1999; Duflo et al., 2008; Duflo et al., 2009) and limited access to information (Jalan and Somanathan, 2008; Cohen et al., 2011; Dupas, 2011) as other drivers of sub-optimal investment by households in developing countries.

The development of a well-functioning rural financial market is indispensable if rural households are to take advantage of the myriads of opportunities available within their environment (Levine, 1997; World bank, 2008; IFAD, 2009). An enabling financial sector is essential for the optimal allocation of resources which are conspicuously scarce in rural settings. In a viable financial environment, promising entrepreneurs are easily identified and supported and small-holder farmers can access affordable credits thereby facilitating the adoption of modern farming technologies. Investments in health and education are less prone to erratic shocks. An effective rural financial sector incentivizes productive investment which is fundamental for poverty reduction (Dupas and Robinson, 2013; Bernajee et al., 2015; Jalilian and Kirkpatrick, 2005).

Irrespective of the aforementioned gains associated with financial markets, the rural financial sector in developing countries remains notoriously small and ineffective, thereby precluding the rural poor from accessing vital formal financial services (Asli and Klapper, 2012). The drivers of financial exclusion especially of the rural poor in Africa have attracted recent scholarly attention (Asli and Klapper, 2012; Johnson and Zarazua, 2011; Collins et al.,2009). The cost associated with the adoption of formal financial services stands out as a major obstacle for the rural poor to have access to the services. The cost of maintaining a bank account in some African countries has been reported to be over 20 per cent of GDP per capita (Beck et al., 2008). In addition to relatively high bank service fees, the strong concentration of bank branches in urban locations implies additional transaction and significant opportunity costs (Dupas et al., 2012). Mistrust for banks exacerbated by limited access to education as well as gender discrimination in rural communities are further obstacles to the adoption of formal financial services (Johnson and Zarazua, 2011; Bachas et al., 2016).

From the supply side, several factors inhibit bankers from expanding their services to rural communities. Rural economic activities mostly dominated by agriculture present several challenges to bankers due to the seasonal and irregular nature of agricultural earnings coupled with serious weather and price risk (Global Partnership for Financial Inclusion, 2012; IFC, 2012). Consequently, the risk of default is considerably higher in rural communities thereby justifying the costly nature of financial services in rural communities.

Mobile technologies, however, have started changing the financial environment in developing countries recently. Rapid expansions in telecommunication networks and improved access to mobile phones even for the most deprived in developing countries

have provided a new and cheap platform that enables the rural poor to access formal financial services. Mobile banking is appealing to the poor as it overcomes many of the challenges associated with traditional banking services. Access to mobile banking services is faster, cheaper and less procedural. The range of services offered via mobile banking has grown steadily from money transfer (remittances) to savings and deposit accounts as well as access to loans and payment of bills. Among these, money transfer has by far been the most popular service as it enables users to respond to shocks and economic opportunities in a timely and cost effective manner by tapping from their personal networks.

There is growing empirical evidence of the development potentials inherent in mobile banking services. Jack and Suri (2011) provide evidence of consumption smoothing associated with mobile money adoption in Kenya. In the context of rural Uganda, Munyegera and Matsumoto (2016) provide evidence of greater per capita consumption and remittance receipts associated with mobile money adoption. Mobile money adopters enjoy greater welfare as they receive remittances more frequently and in larger amounts relative to non-adopters. Apart from consumption, mobile money has been linked to agricultural investment (Kirui et al., 2013; Kikulwe et al., 2014). Both studies reveal that mobile money adoption among small holder farmers in Kenya leads to greater input use and the commercialization of produce, thereby increasing market access and household income. It however appears that no attempt has been made to link mobile money adoption to households' educational investment behavior. Furthermore, there is limited rigorous evidence relating mobile money adoption to the adoption of modern farming technologies, market participation and the resultant impact on different components of household income.

This dissertation attempts to fill the aforementioned gaps in the literature by: firstly, examining the impact of mobile money adoption on households' educational investment behavior; secondly, investigating the impact of mobile money adoption on households' decision to adopt modern farming inputs and the resultant effect on different components of rural household income. There seems to be a growing consensus that mobile money adoption is welfare enhancing and thus its adoption provides a viable route to escape from poverty for the rural poor. We posit that the impact of mobile money adoption on welfare and consequently poverty alleviation will only be sustainable if mobile money adoption induces larger investments in agriculture and human capital formation (education). Specifically we analyze the impact of mobile money adoption on-: (i) household's educational expenditure per school-age child and the share of education budget in the household budget; (ii) at the child level, the likelihood of school enrollment as well as public-private school choice; (iii) the likelihood of remittance receipt in exploring the pathways through which mobile money affects educational expenditure. In pursuing our second objective, we examine the impact of mobile money adoption on-: (i) rural household's decision to adopt fertilizer and improved seed; (ii) households' decision to participation in maize and banana markets; (iii) the resultant impact on farm and nonfarm income as well as disaggregated farm income comprising crop income, livestock income and farm wage income

The dissertation uses longitudinal household data collected in rural Uganda in 2003, 2005, 2009, 2012 and 2015. The data covers the period prior to the introduction of mobile money and the period of rapid expansion in mobile money adoption. This enables us to compare households' educational and agricultural investment behavior before and

after the introduction of mobile money while controlling for a wide range of household and community level characteristics.

In terms of results, we find evidence of mobile money adoption inducing larger per school-age child educational expenditure. Mobile money adoption also increases the share of education in total household budget. We also find evidence that mobile money adoption increases the likelihood of a child being enrolled in school. Conditional on enrollment, mobile money adoption increases the demand for private school education relative to public school education. With regard to agricultural investments, our study reveals that mobile money adoption increases the likelihood of small-holder farmers adopting modern inputs such as fertilizer and high yielding maize seeds thereby leading to higher productivity and consequently higher income. Mobile phone rather than mobile money adoption induces market participation especially for perishable crops such as banana compared to maize. These results carry important policy implications. Firstly, investments in education remains sub-optimal even for relatively wealthy rural households. Secondly rural households' are aware of the significant difference in education quality between public and private schools and will opt for private school whenever they can afford despite public school is tuition free. There is an urgent need to step up the quality of public schools. With regards to agriculture, mobile money adoption has the potential to induce greater modern input adoption. There is need to promote mobile money as a platform through which small-holder farmers can save and access credit.

The rest of the dissertation is organized as follows. Chapter 2 provides an overview of the existing literature on mobile money in view of highlighting gaps which this dissertation intents to compliment. The first section of chapter 2 covers the concept

and evolution of mobile money. The last two sections explores relevant literature relating mobile money to household welfare and investment. Chapter 3 uses panel household and community level data (RePEAT) collected in 2009, 2012 and 2015 from rural Uganda to estimate the impact of mobile money adoption on per school-age child educational expenditure, share of education in household budget, the likelihood of school enrollment and public-private school choice decision. The impact of mobile money adoption on the amount and likelihood of remittance receipts is also estimated. Chapter 4 estimates the impact of mobile money adoption on farm and nonfarm income as well as disaggregated farm income comprising of crop, livestock and farm wage income. Chapter 4 further explores the pathways through which mobile money adoption affects farm income by examining the impact of mobile money on decision to adopt fertilizer and High yielding maize seeds at the household and the maize and banana plot level. The impact of mobile money adoption on households' decision to participation in maize and banana markets is also examined. Chapter 5 culminates the dissertation by recapping the main findings and policy implications.

CHAPTER 2

Background and Literature Review

2.1 Introduction

There is considerable empirical evidence linking financial inclusiveness to growth in productivity and economic development. (Dupas and Robinson, 2013; Bernajee et al., 2015; Jalilian and Kirkpatrick, 2005). A viable financial sector is essential for the optimal allocation of resources which are conspicuously scarce in rural settings. Promising entrepreneurs are easily identified and supported. Small holder farmers can access affordable credits thereby inducing the adoption of modern farming technologies. Investments in health and education are less prone to erratic shocks. (Guyatt et al., 2002; Kremer and Miguel, 2004; Cohen and Dupas, 2010)

This chapter explores the relevant literature on financial inclusiveness and socio-economic development with focus on developing countries. The first section provides back ground information on the financial sector in Uganda with emphasis on the evolution of mobile money ever since its inception. The next section highlights the literature on financial access and human capital investment with focus on how access to credit affects educational investment. The last section focuses on the interplay between financial access, agricultural investment and the resultant impact on rural welfare. The last section also highlights the impact of financial access on non-farm sector participation

2.2 Background of Mobile money services in Uganda

Following the success of Safaricom's *M-PESA* in Kenya, Mobile Telephone Network (MTN)-Uganda launched the MTN *Mobile Money* service in March 2009. It was the first mobile banking service in Uganda and proved to be a viable strategy in expanding MTN's

market share. Airtel Uganda established a similar mobile banking service dubbed *Airtel Money* in June of the same year. 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).

Unlike traditional banking, mobile money functions exclusively through a virtual sim card based account dubbed *m-wallet*. Users can load cash into their *m-wallet* account which then enables them to transfer money, pay bills, buy goods and services. Cash in and cash out transactions can be done at any mobile money agent. Mobile money adoption has expanded rapidly ever since its introduction in 2009. From Figure 3.1, the number of subscribers has jumped from less than a million in 2009 to 12.1 million in 2013 and finally 21.1 million in 2015. The proportion of Ugandans using mobile money service increased from 4.76 percent in 2011 to 25 percent in 2013 and finally 51 percent in 2015. The number of transactions jumped from 87.5 million in 2011 to 693 million in 2015 while the balance on customers account increased from 43.8 billion Ugandan shillings to 124.4 billion by 2013. From Figure 3.2, the value of financial transactions on the mobile money platform grew from 133 billion Ugandan Shillings in 2009 to 32,506 billion Ugandan shillings in 2015. (Bank of Uganda, 2015)

Rapid expansions in telecommunication networks and access to mobile phones even for the most deprived in developing countries have provided a new and cheap platform enabling the rural poor to access formal financial services. Mobile banking is appealing to the poor as it overcomes many of the challenges associated with traditional banking services. Access to mobile banking services is faster, cheaper and less procedural.

Prior to the inception of mobile money, remittances and informal loans were channeled through bus drivers or physically conveyed by senders or receivers over long distances. This mode of transaction implied significant risk and consequently high transaction cost. It thus appear that mobile money considerably reduces risk and transaction cost thereby facilitating intra-household resource sharing across distances.

Though cash transfer remains the most widely used mobile money service, there are other services with a strong potential to induce investment. In addition to individual saving and deposit accounts, collective/group accounts for ROSCA and SACCO enabling group members to access credits is also offered. Payment of utility bills and school fees through mobile money is also rapidly growing.

The rapid dissemination of mobile money seems not to be a short term dynamics given that only 20 percent of adults Ugandans use formal banking services. Over 78.5 percent of rural dwellers live beyond 5 km to the nearest commercial bank as compared to 42.3 percent of urbanites. Apparently the 24 commercial banks alongside their 400 branches and 835 ATM's operating in Uganda leaves a sizeable proportion of the population excluded from formal financial services (Bank of Uganda, 2013)

2.3 Mobile money, financial access and Human capital Investment

Human capital formation such as investments in education and health is considered the most reliable escape route from poverty. Empirical studies have shown that even when returns to investments in health or education is high, households in developing countries still invest sub-optimally in them(Akerlof, 1978; Besley et al., 1992; Dupas, 2010; Alatas et al., 2013; Cohen et al., 2010). Financial constraint has been regularly cited as a major reason for sub-optimal investment (Guyatt et al., 2002; Kremer and Miguel, 2004; Cohen

and Dupas, 2010). Conceptually parent's willingness to invest in their children's education depends on a mental accounting of the present cost of schooling compared to the discounted expected returns from education (Becker, 1975). In addition to the direct cost of schooling such as the payment of tuition fees, the opportunity cost of schooling such as forgone child labor may be very high in rural settings. Also returns to education is conspicuously low in agriculture (Appleton and Balihuta, 1996; Canagarajah, Mazumdar, and Ye, 1998; Joliffe, 1998) thereby des-incentivizing investment in education.

Micro-finance has been widely viewed as a channel through which poor households can mobilize resources needed for human capital investment. By providing capital for agriculture and micro-enterprises, micro-finance can boost household income thereby inducing larger investment in schooling (Armendariz and Morduch, 2005; Khandker, 2000). There is also evidence of smoothing behavior associated with educational investment by households who have adopted micro-finance services (Duryea, 1998; Duryea and Arends-Kuenning, 2003; Jacoby and Skoufias, 1997).

However, some studies have shown evidence of lower investment in education induced by membership in micro-finance. By providing credit to finance agriculture and micro-enterprises, micro-finance can raise the marginal productivity of labor compared to future returns on schooling thereby inducing rural households to substitute schooling for labor needed for household chores, agriculture or business. (Wydick, 1999; Hazarika and Sarangi, 2008 ; Shimamura and Cornhiel, 2010)

Though some studies (Jack and Suri, 2014; Munyegera and Matsumoto, 2016) have documented larger amounts of remittances induced by mobile money adoption, no

evidence of larger investments in human capital has been shown. This study will attempt to link mobile money adoption to investments in education.

2.4 Mobile money, financial access, and agricultural productivity

Growth in the agricultural sector has considerable impact on poverty reduction given that most of the poor live in rural areas, however even when new technologies appear to be very profitable to crop scientists and economists, small-scale farmers may not adopt them (Feder et al., 1985; Munshi, 2008; Duflo et al., 2008). One major constraint for small-scale farmers to adopt modern agricultural technologies is access to affordable credit (Croppenstedt et al., 2003; Gine and Klonner, 2006; Zerfu and Larson, 2010). Cash resources are most often insufficient to cover high-yielding variety seeds and chemical fertilizer purchase for small-scale farmers at the planting season.

Rapid expansion in telecommunication network and access to mobile phones even for the most deprived in developing countries has significantly improved access to information, reduced transaction cost, induce greater market participation and ultimately higher income for small scale farmers(Muto and Yamano, 2009; Aker and Mbiti, 2010; Aker, 2011; Nakasone et al., 2013; Tadesse and Bahiigwa, 2015). Most importantly the advent of mobile phone based banking services such as mobile money has provided a new and cheap platform enabling small scale farmers to individually or collectively access formal financial services. Mobile money is appealing to the poor as it overcomes most of the challenges associated with traditional banking services. Access to mobile money services is faster, cheaper and less procedural. The range of services offered via mobile money has grown steadily from money transfer (remittances) to savings and deposit accounts as well as access to loans and payment of bills. The money transfer service has

by far been the most successful as it enables users to respond to shocks and economic opportunities in a timely and cost effective manner.

Though mobile money has the potential of significantly transforming small scale agriculture in Africa, empirical studies linking mobile money to small scale agriculture is still nascent. Kenyan studies (Kirui et al., 2013; Kikulwe et al., 2014) reveals that mobile money adoption among small holder farmers in Kenya leads to greater input use and commercialization of produce there by increasing market access and household income.

From the above literature review, it appears that the literature on mobile money is still nascent with important gaps which this study will endeavor to fill. Firstly there is a consensus in the literature on the positive impact of mobile money on different measures of welfare. Secondly most studies have identified increase in remittance receipt as the most viable channel through which mobile money adoption induces greater welfare. Another salient feature of the existing literature on mobile money is that it's largely dominated by the Kenyan experience given the pioneering role of Kenya's mobile money service dubbed *M-pesa*.

This paper contributes to the literature on mobile banking and human capital investment by examining the direct impact of mobile money adoption on the level and choice of educational investments undertaken by households in rural Uganda. We gauge the impact of mobile money adoption on the per school-age child educational expenditure, share of educational budget, school enrollment and choice of schooling in the context of tuition-free public education and rapid expansion in private education provision.

Furthermore, this paper contributes to the literature on mobile banking and agricultural productivity by examining the direct impact of mobile money adoption at the

household level on decisions to adopt fertilizer and high yielding variety seeds and the resultant impact on productivity, market participation and different components of household income. We examine variations in the impact of mobile money adoption on input use and market participation across Banana and Maize crops

CHAPTER 3

Mobile Money, Educational Investment and School Choice: Panel Evidence from Rural Uganda

3.1 Introduction

Education is fundamental to development and growth (Schultz, 1961; Becker, 1964; Bowles and Gintis, 1975; Lucas, 1988; World Bank, 1993; King, 2011). As such International organizations and governments have made tremendous efforts to realize universal education, whereby every school-age child has access to schools. As a consequence, access to educational services has improved dramatically in developing countries, especially in the last two decades (UNESCO, 2015; African Development Bank, 2011). However, there are still many children who cannot go to school or who drop out at early stages of education such as at the primary or secondary school level (UNDP, 2015; UNICEF, 2015). It is often the case that financial constraints that parents face are the biggest obstacle to keeping their children in schools (Flug et al., 1998; Chevalier and Lanot, 2011).

A large fraction of the population in developing countries, in particular, the rural poor has had very limited access to basic financial services, which restricts them from investing in business, health, and education, to smoothing consumption and to escaping from poverty. Fewer than 24 percent of adults in developing countries owned a bank account as compared to 89 percent in developed countries. In fact 2.5 billion persons worldwide are excluded from formal financial systems (Asli and Klapper, 2012). Recent studies (Asli and Klapper, 2012; Johnson and Zarazua, 2011;Collins et al., 2009) paid attention to the drivers of financial exclusion especially of the rural poor in Africa and

found that the cost associated with the adoption of formal financial services stands out as a major obstacle for the rural poor to have access to financial services. Mobile technologies, however, have been changing the financial environment of rural economies in developing countries. Rapid expansions in telecommunication networks and improved access to mobile phones even for the most deprived in developing countries have provided a new and cheap platform that enables the rural poor to access formal financial services. Mobile banking is appealing to the poor as it overcomes many of the challenges embedded in the traditional banking system. Access to mobile banking services is faster, cheaper and less procedural. The range of services offered via mobile banking has grown steadily from money transfer (remittances) to savings and deposit accounts as well as access to loans and payment of bills. Among these, the money transfer service has by far been the most popular as there has been a huge potential demand for secured and fast means of financial transactions between rural households and migrant rural household members.

There is growing empirical evidence of the development potentials inherent in mobile banking services, in particular, so called "mobile money"[1] .Jack and Suri (2014) provide evidence of consumption smoothing associated with mobile money adoption in Kenya. In the context of rural Uganda, Munyegera and Matsumoto (2016) provide evidence of greater per capita consumption and remittance receipts associated with mobile money adoption. Mobile money adopters enjoy greater welfare as they receive remittances more frequently and in larger amounts than non-adopters. Apart from consumption, mobile money has been linked to agricultural investment (Kirui et al., 2013;

[1] Mobile money is a financial service provided by mobile network operators, which allows its users to make peer-to-peer money transfers. The users can open a mobile SIM card-based mobile money account, deposit and withdraw cash on it at mobile money agents. Once the users open the account, they can make basic financial transactions such as depositing money, sending remittance, paying school fees and purchasing goods via their mobile phones

Kikulwe et al., 2014). Both studies reveal that mobile money adoption among small-holder farmers in Kenya leads to greater input use and the commercialization of produce thereby increasing market access and household income. Apart from money transfer, Blumentsock et al. (2016) show evidence of increased transfer of airtime in response to natural disaster in Rwanda. To the best of our knowledge there has not been a rigorous study directly linking mobile banking (mobile money) to educational investment decisions, notably in developing countries.

This paper contributes to the literature on mobile banking and human capital investment by examining the direct impact of mobile money adoption on the level and choice of educational investments undertaken by households in rural Uganda. We gauge the impact of mobile money adoption on the per school-age child educational expenditure[2], share of educational budget and choice of schooling in the context of tuition-free public education and rapid expansion in private education provision. We mainly use 3-year balanced panel data covering 711 households collected from 94 communities in rural Uganda in 2009, 2012, and 2015. The data covers the period prior to the introduction of mobile money and the period of rapid dissemination of mobile money in Uganda. This enables to compare households' educational investment behavior before and after the inception of mobile money while controlling for a wide range of household and community level characteristics

The main findings indicates that mobile money adoption increases educational expenditure per school-age child by 32 percent. It also induces a 13 percentage point increase in the budget share of education. It induces a 4 percentage point increase in the

[2] Throughout this study per capita educational expenditure refers to educational expenditure per school age (5 to 18 year old) child

likelihood of a child being enrolled in school. In terms of school choice, mobile money adopters are 7 percentage points more likely to enroll their child in a private school relative to a public school. In line with other studies, pathway analysis reveals that mobile money adopters are 12 percentage points more likely to receive remittances compared to non-adopters. These findings suggest that dissemination of the mobile money in rural Uganda improves access to financial services of the rural households, increases their income through remittances via mobile money and enhances human capital investment for their younger generation

The rest of the paper is organized as follows. In section 2, we provide background information about mobile money in Uganda. Section 3 discusses the data and descriptive evidence, followed by the empirical strategy in section 4. The Estimation results are discussed in section 5 while section 6 concludes.

3.2 Evolution of Mobile money services in Uganda

Given the success of Safaricom's *M-PESA* in Kenya, Mobile Telephone Network (MTN)-Uganda launched the MTN Mobile Money[3] service in March 2009. It was the first mobile banking service in Uganda and proved to be a viable strategy in expanding MTN's market share. Airtel Uganda established a similar mobile banking service, dubbed *Airtel Money*, in June of the same year. 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).

[3] Given its pioneering role and dominant market share, the term mobile money is commonly used to refer to all mobile banking services in Uganda. In this paper we use the term Mobile Money and mobile banking interchangeably.

As afore-mentioned, mobile money adoption has expanded rapidly ever since its introduction in 2009. The number of subscribers has jumped from 3 million in 2011 to 12.1 million in 2013, representing a fourfold increase within 3 three years. The proportion of Ugandans using mobile money services increased from 4.76 percent in 2011 to 25 percent by 2013, the number of transactions jumped from 87.5 million in 2011 to 192.4 million in 2013 and the deposit balance on customers' accounts rose from 43.8 billion Ugandan shillings to 124.4 billion by 2013 (UCC, 2013).

Although cash transfer remain the most widely used mobile money service, there are other services with a strong potential. People have started using mobile money accounts as individual savings and deposit accounts. In addition, collective/group accounts for rotating savings and credit associations (ROSCAs) or savings and credit cooperative organizations (SACCOs) are also offered. Payment of utility bills and school fees through mobile money has been growing rapidly

The rapid expansion of mobile banking services is partly due to high demand for financial services under condition of very limited access to formal banking services especially among rural residents. Over 78.5 percent of rural dwellers live beyond 5 km to the nearest commercial bank as compared to 42.3 percent of urbanites. Apparently the 24 commercial banks alongside their 400 branches and 835 ATM's operating in Uganda leaves a sizeable proportion of the population excluded from formal financial services (Bank of Uganda, 2013). In such a financial environment in Uganda, mobile money has been disseminated at a very rapid rate even among rural households and is expected to have enormous impact on rural economies. We focus on its effect on rural households' educational investment behavior.

3.3 Data and descriptive evidence

3.3.1 Data

This study principally uses household and community level data collected in 2003, 2005, 2009, 2012 and 2015. The data collection was done as part of the longitudinal rural household panel survey project, so-called the Research on Poverty, Environment and Agricultural Technology (RePEAT) project led by a research team in the National Graduate Institute for Policy studies (GRIPS) and formerly Foundation for Advanced Studies on International Development (FASID) in collaboration with Makerere University in Uganda as a regional collaborator. The baseline survey conducted in 2003 covered 94 local council 1 (LC1s) each of which 10 households were randomly sampled. The 2005, 2009, 2012 and 2015 rounds of the survey successfully captured 936, 754, 699 and 658 of the original households respectively.

The survey collects information at household and community levels. The household level component captures information on demography, income, health, education, financial service usage, land tenure and migration, among others. The community survey covers information on basic community characteristics such as population, area size, road distance to the market and the district towns, the state of roads and the availability of public utilities, and the access and availability of public facilities such as schools, hospitals, and telephone networks.

3.3.2 Descriptive statistics

This paper mainly uses a balanced panel of 711 households obtained from the 2009, 2012 and 2015 rounds of the RePEAT survey. Table 3.1 presents the summary statistics of major households characteristics used in this study by survey year and by adoption status

of mobile money. The adoption status is defined based on whether households have at least one member who uses mobile money at the survey time.

The proportion of households which have at least one member who uses mobile money jumped from less than 1 percent in 2009 to 28.8 percent in 2012 and to 66 percent in 2015. Comparison between adopters and non-adopters of mobile money may be more meaningful in the 2012 and 2015 survey rounds since less than 1 percent of the 2009 sample households adopted mobile money. We will focus on the comparison of major household characteristics using the latest two survey rounds.

In terms of the value of asset holdings, the adopters in both survey years seem better off than the non-adopters. It thus appears that mobile money adoption may be driven by wealth, although there are no significant differences in land holdings and remittance receipts[4]. There appear to be no significant differences in the per capita food consumption among the adopters and the non-adopters. With regards to mobile phone possession, there are significant differences between the adopters and the non-adopters in both survey years as expected. Given that mobile money is a mobile phone base service, almost all adopters possess a mobile phone[5]. There are significant differences in the years of schooling of household heads between the adopters and the non-adopters. On average, the heads of the adopter households have acquired more education than those of the non-adopter households. In line with our expectation, adopter households are significantly closer to mobile money agents than non-adopter households

[4] In our survey remittances refers to cash transfers received from relatives and/or friends with no repayment obligation. It is distinct from loans and credits.

[5] There are a few cases in which respondents have mobile money account but have no mobile phone. As long as users have their own SIM card, they could open their mobile money account. They can borrow a mobile phone to conduct mobile money transactions using their SIM card.

In Table 3.2 we present school related summary statistics from the 2012 and 2015 data. There seems to be significant differences in the average number of children attending school between the adopters and non-adopter households. The mobile money adopters have more children in school than the non-adopters. There are also significant differences in the number of school age children. On average adopters have more school age children than non-adopters. It thus appear that enrollment rates may not be significantly different across mobile money adoption status. With regards to the choice of school, it appears that there are no significant differences in the number of children attending public schools between the adopters and the non-adopters. However, there are significant differences between the two groups regarding children attending private school. On average, the adopters have higher private school enrollment rates compared to the non-adopters. The significant difference in the number of children enrolled in private school between the mobile money adopters and non-adopters is accompanied by the significant difference in per capita educational expenditure between them. In 2012, the adopters spent 62 percent more on education compared to the non-adopters. This difference in educational spending further widens in 2015.

Further descriptive evidence of the potential link between remittance receipt[6], mobile money and educational investment is depicted in Figure 3.3 to Figure 3.6. Figures 3.3 and 3.4 shows monthly receipt of remittances in million Ugandan shilling for total remittances and remittances via mobile phone respectively. It appears that remittance flow is particularly higher in the months of August, September, November and December.

[6] Our survey covers mainly rural households, these households are predominantly receivers of remittances. The average amount of remittance receipt in the 2015 survey is 177,000 UGX while the average amount of remittances sent by households is 14,260 UGX. See appendix for additional figures on the nexus remittances, mobile money and educational investment

Given that the academic year in Uganda begins in February, Fig 3.3 and 3.4 do not depict any specific pattern related to schooling. The nexus remittances, mobile money and educational investment is further depicted in Figures 3.5 and 3.6. From the last wave of our survey, we disaggregate remittances by the purpose for which the remittances were received. We disaggregate total remittances and remittances made only through the mobile money platform. Both charts reveal that remittances are most often meant to respond to schooling investment. This is conspicuous for remittances received via mobile phone.

In our sample for 2009, 194 households had received remittances with 85 of them receiving remittances for at least school related reasons. 374 households reported remittances in our 2012 sample out of which 102 had received remittances specifically for school related purposes. In 2015, 437 households reported remittances, out of which 96 had received remittances for schooling purposes.

Unfortunately, in our data we do not observe detailed expenses for each child. Consequently, in constructing the per capita education expenditure we had to exclude households with no child aged 5-16 years.[7] Households with no reported educational expenditure for a particular year but with at least one child aged 5-16 are assigned zero educational expenditure. This is possible if the child is sponsored by a non-household member. Similarly, in constructing the budget share of education, we exclude households with no child aged 5-16. We assign zero educational expenditure to households who do not report any educational expenses for reasons analogous to those above. The household annual total expenditure comprises educational expenditure, medical expenditure, food

[7] Though the statutory age for enrollment into grade 1 is 6 years, it is however common for children to be enrolled earlier at the age of 5 or later at the age of 7.

expenditure and miscellaneous expenses such as contribution to ROSCA and gifts. Education budget share is obtained by dividing educational expenditure by the household total expenditure; consequently, it ranges between 0 and 1.

In sum, the descriptive statistics indicate a positive correlation between mobile money adoption and educational expenditure as well as private school choice probability. However, descriptive statistics does not suffice for us to establish a causal relation of the mobile money adoption. Mobile money adoption is potentially endogenous given that households decides whether to adopt or not to adopt the service. Consequently the adopter households of mobile money are likely to be significantly different from non-adopter households. In the following section, we further examine their causal relationship by conducting regression analyses utilizing the panel structure of the data as well as the instrumental variable method in consideration of the possible endogeneity of mobile money adoption.

3.4 Empirical strategy

In this section we are going to estimate-: (i) determinants of mobile money adoption in rural Uganda; (ii) impact of mobile money on education investment per school-age child, expenditure share of education, public-private school choice and several measures of remittance receipts.

3.4.1 Determinants of mobile money adoption

Firstly, we examine the determinants of the adoption of mobile money, which could be used to mitigate a possible bias due to the endogeneity of the adoption or self-selection

for the later analysis of the effect of the adoption on educational investment.[8] The decision to adopt mobile money services depends on observed characteristics of the household and the community in the form:

$$MM_{hjdt} = 1\{\alpha_h + \beta_X X_{ht} + \beta_C C_{jdt} + \gamma_{dt} + \varepsilon_{hjdt} > 0\}, \qquad \ldots (1)$$

where MM_{hjdt} is a binary indicator of mobile money adoption which takes 1 if household h in community j of district d has adopted mobile money at time t and 0 otherwise.; α is a household fixed effect which is expected to control for time-invariant household level factors including unobserved factors. ; X is a vector of household level time-variant controls including household size, household head's age, gender, education, natural logarithm of value of household assets holding[9], land holding and natural logarithm of distance to the nearest mobile money agent.; C is a vector of community level time-variant controls. It includes the average land holding size of households as well as the average years of schooling of household heads in the same community. It enables us to control for time-varying community-level attributes which may enhance or delay mobile money adoption. In addition, we include as other covariates the interactions between district and time dummies which are expected to control for district specific time effects, denoted by γ_{dt}. They capture the influence of district-time specific factors including unobservable factors. We employ a linear probability model with the full control variables mentioned above and also a non-linear (Probit) model without the household level fixed effects. We report the results from both of the estimations.

[8] Endogeneity of mobile money adoption will be discussed in the next section. The exclusion variable in Eq 1 is the log of distance to the nearest mobile money agent. The validity of this exclusion variable will be discussed in section IV

[9] Given the potential contemporaneous relationship between Asset holding and remittance receipt, asset holdings are lagged to pre-mobile money level i.e 2003, 2005 and 2009. Land holding is less responsive to remittance receipt

3.4.2. Mobile money and educational investment

As shown in the summary statistics given in Table 3.2, mobile money adopters seem to exhibit relatively larger educational expenditure per school-age child compared to non-adopters. Per school-age child educational expenditure is preferred to annual educational expenditure at the household level because it enables us to compare the education resources committed per school-age child.

There are several challenges in estimating the impact of mobile money adoption on educational investment. Mobile money adopters are likely to be systematically different from non-adopters.[10] From Table 3.1, mobile money adopter households on average exhibit higher per capita consumption, larger land holdings and have more years of schooling relative to non-adopter households. Mobile money adoption may equally be correlated with time-varying unobservable[11] which have an impact on household educational expenditure decision such as risk and time preferences, evolution in the quality of governance as well as selective expansion and improvement in telecommunication network may all confound our estimates of the treatment effect. Selective placement of mobile money agents into larger, richer and more educated communities will as well confound our estimates of treatment effect. Reverse causality between remittance receipt and mobile money adoption may equally bias our estimates of treatment effect. Remittance receipts or prospects for remittance receipts may be driving mobile money adoption. This reverse causality may cause an overestimation of the average impact of mobile money on remittance and educational investment. There

[10] A formal test of endogeneity is reported in Table 3.7

[11] The basic specification in Equation 2 is essentially a difference in difference estimation strategy. It does not control for household level time varying unobserved confounders. We will later resort to identification strategies appropriate for this type of confounders.

could be alternative scenarios which will cause a down ward bias of the average effect of mobile money. For instance, unobserved shocks such as illness, death, poor harvest at the household level may induce mobile money adoption in a bid to receive assistance from distant relatives. This scenario of the negative shocks will lead to an under estimation of the true effect of mobile money adoption on our outcome variables.

3.4.2.1 Basic specification

Mindful of the above challenges we first implement a household level fixed effects estimation method, which is essentially the same as the difference in differences method with other control variables, which compares the change in educational investment between adopters and non-adopters while controlling for several observable characteristics. The specification is given as follows:

$$Y_{hjdt} = \lambda_h + \delta_{MM} MM_{hjdt} + \delta_X X_{hjdt} + \delta_S S_{jdt} + \delta_C C_{jdt} + \gamma_{dt} + \varepsilon_{hjdt}, \qquad (2)$$

where Y is the per school-age child educational expenditure or the budget share of education of household h in community j of district d at time t; λ_h is household fixed effects. Household fixed effects are expected to control for unobserved time invariant household characteristics which may be correlated with mobile money adoption and educational investment such as innate ability; S is a vector of school related variables, notably the number of public and private primary schools in community j. The number of school in each community controls for the availability of schools as well as the possibility that agents may self-select into communities having schools. C is a vector of community-level controls comprising of the population size of each community, average of household head's years of schooling, average land holding in the community. These community

level controls are expected to capture the possibility of selective placement of mobile money agents into more attractive communities such as larger and richer communities. γ is district specific time trend which is expected to capture district level changes such as changes in economic conditions that may enhance or delay mobile money adoption. All other controls are as defined earlier. δ_{MM} is the parameter of our interest, capturing the impact of mobile money adoption on educational investment. Given the censored nature of our outcome variables, we resort to both linear and non-linear (Tobit) estimation.

3.4.3 Mechanism: Mobile Money and Remittances

In order to assess whether there exist any significant differences in the flow of remittances between mobile money adopters and non-adopters, we also estimate the following model;

$$R_{hjdt} = \lambda_h + \psi_{MM} MM_{hjdt} + \psi_X X_{hjdt} + \psi_C C_{jdt} + \kappa_{dt} + \omega_{hjdt}, \qquad (3)$$

The above equation is a variant of Eq.[2] where *R* is a measure of the remittance receipts[12] of household *h* in community *j* of district *d* at time *t*. The vector *X* is augmented to include a binary indicator of whether a member of household *h* has migrated for job seeking purposes and also control the composition of household members categorized into age groups. All other controls are as defined earlier. ψ_{MM} is our parameter of interest, capturing the impact of mobile money adoption on the measures of remittance receipts conditional on all other covariates.

3.4.4 Robustness test

3.4.4.1 Pre-mobile money estimation

[12] In line with the unitary household model, migrant household members are expected to contribute to the pool of household resources through remittances. Such transfers are essentially non-refundable and are distinct from loans and credits. We expect mobile money to facilitate the flow of remittances. See figures 3.1-3.4 for the nexus remittances-mobile money-educational expenditure.

The main assumption for the household fixed effect estimation to identify the causal effect of the mobile money adoption is the so-called trend assumption, that is , adopters of mobile money would have the same time trend in the outcome variable as non-adopters (after controlling for the influence of other observable factors) if the adopters had not adopted mobile money. Although it is impossible to observe the counterfactual outcomes of the mobile money adopters, we are able to see the outcome variables and their time trends in the period before the emergence of mobile money services and compare them between the two groups by utilizing the data from our longitudinal panel study started from the year 2003.

We re-estimate Eq.[2] and [3] using the pre-mobile money period RePEAT survey data. We use the 2003 and 2005 survey data to re-estimate the equations with a placebo mobile money adoption status assigned to households that adopted mobile money in 2012 or 2015 survey rounds[13]. If there are no systematic differences in the trend of the outcome variables in the pre-mobile money period between the adopters and non-adopters, then we would expect the coefficient of the dummy corresponding to the mobile money adoption status in 2012 or 2015 to be closed to zero and statistically insignificant.

3.4.4.2 Propensity score based Difference in differences estimation

As an additional robustness check, we re-estimate Eq.[2] using a restricted sample of only observations with similar probability of adopting mobile money in 2015 given pre-mobile money(2009) characteristics.[14] The likelihood of adopting mobile money in 2015 is

[13] The baseline survey in 2003 did not elicit school choice information; consequently, we can only implement robustness checks for educational investment and remittances.

[14] Given the distribution of the probability of adopting mobile money for adopters and non-adopters, we restrict our sample to observations with a probability of adoption ranging between 0.2 and 0.9

predicted from a linear probability model by regressing a binary indicator of mobile money adoption in 2015 on 2009 household and community characteristics. We re-estimate Eq.[2] using a restricted sample of only observations (494 households) within the common support region[15].

3.4.5 Instrumental variable and Tobit estimations

Though the basic specification controls for a wide range of potential confounders, the exogeneity of mobile money still remains questionable. There are several channels through which mobile money adoption may still be endogenous. Firstly our estimates of the treatment impact may be confounded by time-varying unobservable that are correlated with mobile money adoption such as household level shocks, risk and time preferences of household head's, may all confound our estimates of the treatment effect. Reverse causality between remittance receipt and mobile money adoption may also confound our estimates.

Given the above challenges, we resort to the instrumental variable and Tobit control function identification strategies. We use the log of distance to the nearest mobile money agent as an instrument for mobile money adoption.[16] The rationale for such an instrument is that the decision to adopt mobile money heavily depends on the proximity to mobile money agent. Jack and Suri (2014) in a similar study in Kenya show that distance to M-*pesa* agent is an effective instrument for mobile money adoption. However unlike Jack and Suri (2014) we observe the distance to mobile money agent only at the community level. The validity of this instrument hinges on the fact that agent placement

[15] Result of this estimation is reported in the appendix

[16] We use the log of distance because distance in Km to mobile money agent is a continuous variable. Estimates using the level form of distance are close to identical with estimates presented

does not have any direct effect on households' educational investment and remittance receipt decisions. In other words, the placement of mobile money agents is expected to be independent from and uncorrelated with both supply and demand side factors which determine households' educational investment behavior conditioning on other observed characteristics. We argue that the placement of mobile money agents has no direct impact on our outcome variables. Firstly the requirements[17] to be a licensed agent are neither cumbersome nor rigorously implemented by the different mobile phone operators. This laxity is driven by the quest for market share. Consequently, the number of agents has increased astronomically in virtually all communities without any indication of selective placement. This rapid expansion of mobile money agents is captured in our data by the sharp decline in average distance from a reference point in each community to the nearest mobile money agent from 13 km in 2009 to 4 km in 2012 and finally to 3 km in 2015. Given that the licensing of agents is exclusively the preserve of mobile phone companies, political influence and lobbying as well as strategic planning for placement in specific locations, which may be correlated with schools location is ruled out. Following Munyegera and Matsumoto (2016), we argue that most mobile money agents are traditional small shop owners who have expanded their business by providing mobile money services. Consequently a good number of the agents had already chosen their locations prior to the inception of mobile money. This is particularly true in rural Uganda. Most importantly the fact that we control for district specific time trend enables us to capture any unobserved time varying factors which may be correlated with both agent location and household's educational investment decisions

[17] Requirements to be a licensed mobile money agent include a completed agent agreement, a deposit of at least 384 USD per outlet in a specified bank account, a certificate of registration and a memorandum of association.

3.4.5.1 Reduced form estimation

As explained earlier, we use the log of distance to the nearest mobile money agent as a source of exogenous variation in mobile money adoption. We expect a negative relationship between the distances to a mobile money agent on the one hand and the per capita educational expenditure, budget share of education and remittance receipts on the other. Households having less access to mobile money agents are less likely to adopt the service and consequently are less likely to receive remittances, thereby attenuating their ability to invest in education. The average distance to the nearest mobile money agent has dropped sharply from 13 Km in 2009 to 4 Km in 2012 and 3 Km in 2015. Comparatively the average distance from each community to the district head quarter[18] has reduced from 14km in 2009 to 11 km in 2012 and 10 km in 2015. The reduction in distance to mobile money agent thus represent significant reductions in transaction cost which should induce greater access to financial services and consequently investment.

$$Y_{hjdt} = \gamma_h + \pi_{DMM} DMM_{jdt} + \pi_X X_{hjdt} + \pi_S S_{jdt} + \pi_C C_{jdt} + \eta_{dt} + \upsilon_{hjdt} \quad (4)$$

The above equation is identical to Eq.[2] except for the introduction of DMM_{jdt} , which represents the log of distance in km to the nearest mobile money agent of community *j* in district *d*- at time *t*. π_{DMM} is our parameter of interest and is expected to enter the regression with a negative sign. All other variables are as defined in Eq.[2]

3.4.6 Mobile money, enrollment and school choice

From Table 3.2, it appears that mobile money adopters have a higher likelihood of enrolling their children in private school compared to public schools, despite the latter is tuition free. It is likely that the relatively higher level of per capita educational expenditure

[18] Districts are the second administrative level while communities (LC1) are the last administrative level. There are four administrative layers separating LC1's from districts.

exhibited by mobile money adopters is driven by higher expenses associated with private schooling. It is worth noting that ever since the inception of Universal Primary Education (UPE) in 1997, the quality of public schools has declined sharply relative to private schools (MOES, 2013; UNEB, 2012; NAPE, 2012). The advent of UPE has not stemmed out of pocket payment from parents whose children are attending public schools. Several significant financial and material contributions are still imposed on parents (Black et al., 1999; Kitaev, 2001; Nishimura et al., 2008; Suzuki, 2002; MOES, 2003). On the other hand there has been a considerable expansion in private education provision even in rural areas. The proportion of private primary school enrollees in the RePEAT 2009 survey was 32 percent, but by 2012, it had increased to 37 percent and further to 45 percent in 2015.Uganda just like many other African countries has seen a rapid expansion in affordable private school (Tooley and Dixon, 2005; Oketch et al., 2010; Nishimura and Yamano, 2013).

In estimating the impact of mobile money adoption at the household level on the likelihood of enrollment and public-private school choice at the child level, we implement child-level regressions using a sample of children aged 5 to 18 years appearing in at least 1 of the 3 survey years.

$$P_{ihjdt} = \chi_i + \phi_{MM} MM_{hjdt} + \phi_X X_{hjdt} + \phi S_{ijdt} + \phi_C C_{jdt} + \phi_{Ch} Child_{ihjdt} + \gamma_{dt} + B_i + \varepsilon_{ihjdt}, \quad (5)$$

where the outcome variable P_{ihjdt} is a binary indicator of either enrollment status or the public-private school choice[19] of child *i* in household *h* in community *j* of district *d* and

[19] Ideally we would have implemented a nested model were households first decide on whether to enroll a child in school or not and then subsequently decide on the choice of school. However in

time *t*. It takes the value 1 if child *i* is enrolled in school and 0 otherwise. For the school choice equation, it takes the value 1 if child *i* is enrolled in a private school or 0 if enrolled in a public school. *Child* is a vector of child level controls such as age, gender, binary indicators of first child and orphan. *B* is birth year fixed effects, while χ_i is child fixed effects.[20] Child fixed effects enables us to control for unobserved time invariant child level characteristics such as children ability which may be correlated with households' decision to adopt mobile money. All other controls are as defined earlier. ϕ_{MM} is our parameter of interest capturing the impact of mobile money adoption on enrollment and school choice conditional on all other covariates. We estimate Eq.[5] using linear (Child fixed effects) and nonlinear (Probit) models without child fixed effects.

3.5 Results

3.5.1 Determinants of mobile money adoption

Table 3.3 presents the regression results examining the determinants of the mobile money adoption. It appears that the decision to adopt mobile money heavily depends on the distance to the nearest mobile money agent. [21]Asset holdings, head's years of schooling and household size are all significant determinants of mobile money adoption. Just like most other services, the adoption of mobile money depends on the accessibility to mobile money agents. It is thus rational that households located closer to mobile money agents should have a higher probability of adopting the service relative to far off households. Households with larger asset holdings are richer and consequently are less constrained in

Uganda enrollment is nearly guaranteed as enrollment rates are above 90%.We thus estimate school choice conditional on enrollment.

[20] We do not include the birth year fixed effects in the child fixed effects estimation.

[21] The significant coefficient on the log of distance to mobile money agent is indicative of the relevance of the instrument. Thus the instrument passes the test of strong instrument.

adopting mobile money. Such households may equally be involved in economic activities that necessitate the adoption of such a service. As with any innovation, education is a key determinant of adoption especially at the initial stages. Consequently, we expect educated household heads to adopt the service more rapidly than those with less education. In addition, larger households are more likely to have migrant workers and consequently more apt to adopt mobile money.

[Table 3.3 about here]

3.5.2 Mobile money and educational investment

The estimation results of Eq.[2] are presented in Table 3.4. The first three columns report the OLS estimates while the last three columns report the household-level fixed effect estimates. The outcome variable for columns 1-3 and 4-6 are per capita educational expenditure, log of per capita educational expenditure and budget share of education respectively. The Estimates from both specifications are qualitatively similar. The impact of mobile money on per capita educational expenditure shown in columns 1 and 4 is around 49000 UGX (approximately 15 USD). This constitutes an approximately 31 per cent increase in the mean per capita educational expenditure for our entire sample. This estimate is similar to those presented in columns 2 and 5 indicating that mobile money adoption leads to at least a 24 percent increase in educational expenditure. Considering the mean per capita educational expenditure for the whole sample, a 24 percent increase entails an increase of approximately 43608 UGX (approximately 13 USD). This effect is qualitatively similar to the estimates reported in columns 1 and 4. The impact of mobile money on the budget share of education is presented in columns 3 and 6. Again, the OLS and fixed effect estimates are qualitatively similar and significant. Mobile money

adoption induces between 7 to 8 percentage point increases in the budget share of education. In addition, household head's years of schooling and asset holdings both have significant impact on per capita educational investment.

[Table 3.4 about here]

A potential channel through which mobile money affects the budget share of education is through an increase in remittance receipts meant for educational investment. Also, mobile money adoption induces greater investment in agriculture leading to higher farm income (Kirui et al., 2013; Kikulwe et al., 2014). The above reported estimates are qualitatively similar to those obtained from the Tobit estimation.[22] As a whole, mobile money adoption seems to enhance educational investment.

3.5.3 Mobile money and remittances

The impact of mobile money adoption on remittances is presented in Table 3.5. Columns 1 and 2 are the OLS estimates with a binary and continuous measure of remittance receipts respectively as the dependent variable, while column 3 is a probit estimation of the probability of remittance receipts. Columns 4, 5 and 6 have as the dependent variable a binary indicator of remittance receipts, log of remittance receipts and the absolute amount of remittances received, respectively. In line with previous studies, columns 1, 3 and 4 indicates that mobile money increases the probability of households receiving remittances by at least 7 percentage points. Columns 2 reveals an insignificant impact of mobile money on the amount of remittances received. From column 5, mobile money adoption increases the amount of remittances received by over 60 percent. Households with migrant workers have a higher probability of receiving remittances as well as of receiving

[22]The results of the Tobit estimations are provided by the authors upon request

larger amounts. The household head's years of schooling, asset holdings, female-headed households, household head's age and household size all have a positive and significant impact on measures of remittance receipts. In sum, the results indicate a positive relationship between mobile money adoption and remittance receipts.

[Table 3.5 about here]

3.5.4 Instrumental variable and Tobit-control function results

We first present and discuss the reduced form results from estimating Eq.[4] presented in Table 3.6.[23] Columns 1-3 are the OLS estimates. The dependent variables are per capita educational expenditure, log of per capita educational expenditure and the budget share of education, respectively. Columns 4-6 are the fixed effect estimates. As before the dependent variables are per capita educational expenditure, log of per capita educational expenditure and the budget share of education respectively. As expected, the log of distance to the nearest mobile money agent as a measure of access to mobile money services has a negative and significant impact on all the measures of educational investment.

[Table 3.6 about here]

So far, we have relied on the assumption that the household fixed effects and time trends by district alongside a vector of controls can effectively control for the endogeneity of the mobile money adoption in order to estimate its impact on educational investment and remittances. As discussed earlier, the exogeneity of mobile money adoption may still remain questionable. Unobserved shocks at the household level, reverse causality

[23]The reduced form results for remittances are not reported due to limited space. They are available upon request

between mobile money adoption and remittance receipts as well as time-varying confounders at the community level such as the quality of regional governance are all potential confounders of the impact of mobile money adoption on our different outcome variables. In addressing these concerns, we resort to instrumental variables and Tobit models combined with a control function approach to the issue of endogeneity. We use the log of distance to the nearest mobile money agent measured in kilometers at the community level as an instrument for mobile money adoption. Combining instrumental variables with fixed effects enables us to address the potential endogenous nature of mobile money adoption in a more rigorous way. Our Tobit model combined with the control function takes into account the censored nature of most of our outcome variables as well as remedy for any possibility of weak instruments (Woodridge, 2007; Tadesse and Bahiigwa, 2014; Munyegera and Matsumoto, 2016). We follow Rivers and Vuong (1988) in predicting the generalized residuals from the determinants of mobile money adoption Eq.[1] and subsequently introduce these residuals alongside actual mobile money adoption status in our main estimations.

Columns 1-3 of Table 3.7 are the fixed effect-IV (FE-IV) estimates. The dependent variables are per capita educational expenditure, log of per capita educational expenditure and the budget share of education respectively. Columns 4-6 are the Tobit-control function (Tobit-CF) estimates. Again, the dependent variables are per capita educational expenditure, log of per capita educational expenditure and the budget share of education respectively. As a whole FE-IV and Tobit-CF estimates are qualitatively similar. The impact of mobile money on per capita educational expenditure shown in columns 1 and 4 is around 88,000 UGX (approximately 24 USD). This constitutes approximately 53 per cent increase in the mean per capita educational expenditure for our

entire sample. Columns 2 and 5 reveal that mobile money adoption induces approximately a 32 percent increase in per capita educational expenditure. Mobile money adoption is equally positively associated with the budget share of education. From columns 3 and 6, mobile money adoption increases the budget share of education by at least 13 percentage points.

[Table 3.7 about here]

The FE-IV and Tobit-CF estimates are consistently bigger than the estimates obtained from the OLS, FE or Tobit estimations reported in Table 3.4. Several factors may account for this difference. A potential explanation for OLS under-estimating the true impact of mobile money adoption is that mobile money adoption is partly driven by unobserved household level shocks. It is plausible that adopters of mobile money might have suffered some negative shock such as a poor harvest, death of a household member, which necessitates assistance from distant relatives and friends. A closer look at the purpose of remittance receipts reported in the 2015 survey reveals that close to 5 percent of the remittances were received in response to shock-related events such as to pay for medical bills and organize funerals for deceased household members. Interestingly, the purpose of remittance receipts via mobile money for the same year reveals that close to 11 percent of remittances received were in response to shock related events. It thus appears that mobile money provides a cost effective platform through which vulnerable households receive assistance from distant relatives (Jack and Suri, 2014). Such a scenario will lead to the OLS and FE under estimating the true impact of mobile money if such shocks are not observed. Also, if the compliers sub-population has a higher willingness to invest in education but is constrained due to limited access to mobile money, we would expect

expansion in mobile money adoption to induce large positive changes in educational investment for this category of households.

3.5.5 Mobile money and enrollment

In estimating the impact of mobile money adoption on enrollment, we restrict our sample to children aged 5 to 18. We report the results from estimating Eq.[5] with a binary indicator of enrollment as the dependent variable in Table 3.8A. The results indicates that mobile money adoption increases the likelihood of enrollment by 5 percentage points for children aged 5 to 10 years old. For children aged 11 to 18 years old, mobile money adoption increases the likelihood of enrollment by approximately 4 percentage points. Though primary education is tuition free in public schools, parents are still required to make important financial contributions which may prevent them from sending their children to schools.

[Table 3.8A about here]

3.5.6 Mobile money and school choice

As shown in the descriptive evidence, mobile money adopters are more likely to send their child to a private school compared to non-adopters. In estimating the impact of mobile money on school choice we restrict our sample to children aged 5 to 18 who are enrolled in school. We estimate Eq.[5] with a binary indicator of school choice as the dependent variable. It takes the value 1 if child *i* is enrolled in a private school and 0 if enrolled in a public school. Results from estimating Eq.[5] are presented in Table 3.8B.

[Table 3.8B about here]

On the whole, mobile money adoption seems to increase the likelihood of private school enrollment relative to public school. Mobile money adoption increases the likelihood of

private school enrollment by at least 7 percentage points for primary school children. With regards to secondary school choice, mobile money adoption is associated to a 10 percentage point increase in the likelihood of private school choice relative to public school.

There are alternative mechanisms through which children can attend private schools. The Public-Private partnership scheme under the USE policy enables poor children with good PLE scores to attend private schools. Also, rich children who did not score highly at the PLE might switch to private schools due to increase competition in public schools. Unfortunately in our data we cannot identify which children attended private schools due to Public-Private partnership scheme. Given that Public-Private school partnership is relatively new and considering that it is limited to secondary school age children, we belief that it does not affect our results.

3.5.7 Robustness Check

In this study, we have combined fixed effect methods and instrumental variables as well as a control function version of the Tobit model to estimate the impact of mobile money adoption at the household level on per capita educational expenditure, the budget share of education and remittances received. In estimating the impact of mobile money adoption on school enrollment and the public-private school choice, we have limited our estimations to fixed effect methods due to acute weak instrument. Fixed effects estimations enables us to capture time invariant potential confounders at the household and child level. Using district by time dummies enabled us to disentangle any possible correlation between mobile money adoption and socio-economic and technological changes at the district level. The inclusion of community controls in our estimations such

as the size of each community captures the community level attributes that may account for any endogenous placement of mobile money agents.

Notwithstanding we re-estimate Eq.[2] and Eq.[3] using pre-mobile money RePEAT survey rounds. We use the 2003 and 2005 survey data to re-estimate the equations with a placebo mobile money adoption status assigned to households that adopted mobile money in 2012 or 2015 survey rounds. If the effects obtained are indeed induced by mobile money adoption and not by unobserved household time-variant attributes, then we would expect to find no effect of mobile money in our Robustness check estimations. As can be seen from Tables 3.9A and 3.9B, placebo mobile money adoption has no significant impact on any measure of educational investment or remittances.

Estimation results of Eq.[2] using a restricted sample of observations with similar probability of adopting mobile money in 2015 given their 2009 characteristics is presented in table A1 in the appendix. The results are very similar in both sign and magnitude to those reported in Table 3.7. In a whole, mobile money adoption has a positive and significant impact on different measures of educational investment

Another concern in this study is related to the possibility of direct payment of school fee by distant household members or through non-household mobile money adopters. In either cases, the household may not report any remittances receipt or educational expenditure though they might have school age children within the household. However such household may subsequently adopt mobile money, receive remittances and pay school fee via mobile money thereby reporting positive educational expenditure after mobile money adoption. This scenario is plausible and will lead to an over-estimation of

the impact of mobile money adoption on educational investment. However given that the payment of school fee using mobile money is a recent phenomenon that is still gaining ground in rural Uganda, we would not expect this mechanism to fundamentally influence our results. The significant impact of mobile money adoption on school choice is equally indicative of the robustness of our results to such a scenario.

Another concern in this study may be the selective attrition of households. Out of the 912 households sampled in the 2009 survey, we were able to track 784 households in the 2015 survey implying an attrition rate of 19.5 percent. It has been argued that even a 50 percent attrition rate in a large survey in developing countries has little impact on estimates (Fritzgerald, Gottschalk, and Moffitt, 1998; Falaris, 2003). We, however, conducted sensitivity checks using a pooled sample of our data. We re-estimated Eq.[1], [2] and [4] with and without weights.[24] Results of the Hausman tests indicate that there are no systematic differences between the weighted and non-weighted estimations.

3.6 Conclusion and Policy Implication

Human capital investment can be costly and impedible especially for the rural poor who face severe credit constraints and have considerably limited access to the traditional banking system, thereby limiting their ability to mobilize resources needed for human capital investment, which in itself remains the most reliable escape route from poverty. A new and fast growing mobile phone based banking service dubbed "mobile money" has considerably improved access to conventional financial systems for the rural poor. In this study we have shown evidence of a human-capital enhancing effect of mobile money adoption among rural households. We however caution that the results from this study

[24] The inverse probability of attrition are used as weights. These probabilities are generated from regressing a binary indicator of attrition on the pre-determined baseline(2009) characteristics

may not necessarily imply causation. In line with other studies (Jack and Suri, 2014; Munyegera and Matsumoto, 2016), we have shown that mobile money adoption is strongly associated with human capital investment through a higher frequency and larger amount of remittances received. Given data limitations, we could not provide evidence of additional pathways through which mobile money adoption affects human capital investment other than through remittances. However considering the introduction of additional mobile money services such as group/collective saving enabling greater access to commercial bank loans and mindful of numerous anecdotal stories, we are convinced that mobile money adoption affects human capital investment in ways other than through remittances.

Our analysis also suggest that mobile money adoption induces a stronger demand for private schools relative to public schools though the latter is tuition free but however of lower quality. It thus appears that public schools in Uganda are the second best option when private school becomes affordable. Mobile money adoption through remittances considerably relaxes credit constraints for rural households, thereby enabling them to afford enrolling their children in private schools. This flight to private school has been reported in other African countries as an urban-rich phenomenon following the institution of free primary education (Mbiti and Lucas, 2012; Bold, Kimenyi, and Sandafur, 2013; Nishimura and Yamano, 2013). However, our analysis suggest that rural households are aware of the marked difference in quality between public and private schools and will prefer private school whenever they can afford.

While the impact of mobile money adoption on school choice may be short term pending improvements in public school quality, its association with human capital investment, notably educational investment, is durable. Though the mobile money

adoption rate is very high in rural Uganda, there are still several obstacles associated with its full utilization notably by rural households. Firstly, due to limited information mobile money usage has been limited to money transfers though from an investment point of view it provides more attractive but still unpopular services such as individual and group saving account. Promoting these new services will require increased legal recognition of financial statements issued on mobile money savings and deposit accounts

The impact of mobile money adoption on educational investment may constitute one of several other ways in which mobile money enhances human capital investment. Exploring the link between mobile money adoption and health seeking behavior will further strengthen the human capital enhancing impact of mobile money adoption considering the virtual absence or inefficient health insurance system thereby necessitating out of pocket payments. As mobile money evolves to include new services, it will be important to examine other pathways other than remittances.

CHAPTER 4

Credit Constraint, Mobile Money and Agricultural Intensification
Panel Evidence from Rural Uganda

4.1 Introduction

Agricultural development is one of the most effective tools to end extreme poverty, boost shared prosperity and feed 9 billion people by 2050. Growth in the agriculture sector is two to four times more effective in raising incomes among the poorest compared to other sectors(Ravallion and Chen, 2007; Christiaensen et al., 2011). This has important implications particularly for the poor who live in rural areas and depend largely on farming to make a living (World development report, 2008; FAO, 2004). However even when new technologies appear to be very profitable to crop scientists and economists, small-scale farmers may not adopt them (Feder et al., 1985; Munshi, 2008; Duflo et al., 2008). One major constraint for small-scale farmers to adopt agricultural technologies is limited access to credit (Croppenstedt et al., 2003; Gine and Klonner, 2006; Zerfu and Larson, 2010) .Cash resources are generally insufficient to cover high-yielding variety seeds and fertilizer[25] purchase by small-scale farmers at the planting season (Awotide et al., 2016; Gine and Klonner, 2006)

Financial inclusion of small scale farmers in developing countries induces significant productivity gains through greater input use and adoption of modern agricultural technologies (Ali, Deininger and Duponchel, 2014; Yamano and Nyoro , 2004; Narayanan, 2016; Deb and Suri, 2013). Banking sectors in developing countries

[25] In this study the term fertilizer refers to mineral(inorganic) fertilizer

lend a much smaller share of their loan portfolios to agriculture compared to the agriculture's share of GDP. This limits investment in agriculture by both farmers and agro-enterprises. It also reveals that the barrier to lending is not due to a lack of liquidity in the banking sector, but rather due to a lack of willingness to expand lending to the agricultural sector due to the seasonal and irregular nature of agricultural earnings coupled with serious weather and price risk (Global Partnership for Financial Inclusion, 2012; IFC, 2012).

Mobile technologies, however, have started changing the financial environment in developing countries recently. Rapid expansion in telecommunication network and improved access to mobile phones even for the most deprived in developing countries has significantly increased access to information, reduced transaction cost, induced greater market participation and ultimately enhanced income for small scale farmers(Muto and Yamano, 2009; Aker and Mbiti, 2010; Aker, 2010; Nakasone et al., 2013; Tadesse and Bahiigwa, 2015). Most importantly the advent of mobile phone based banking services has provided a new and cheap platform which enables small scale farmers to individually or collectively access formal financial services. Mobile banking is appealing to the poor as it overcomes many of the challenges associated to traditional banking services. Access to mobile banking services is faster, cheaper and less procedural. The range of services offered via mobile banking has grown steadily from money transfer (remittances) to savings and deposit accounts as well as access to loans and payment of bills. The money transfer service has by far been the most successful as it enables users to respond to shocks and economic opportunities in a timely and cost effective manner.

Though mobile money[26] has the potential of significantly transforming small scale agriculture in Africa, empirical studies linking mobile money to small scale agriculture is still nascent. Kenyan studies (Kirui et al.,2013; Kikulwe et al.,2014) reveals that mobile money adoption among small holder farmers in Kenya leads to greater input use and commercialization of produce there by increasing market access and household income.

We hypothesis that mobile money adoption increases the likelihood of farmers adopting high yielding variety (HYV) seeds[27] and chemical fertilizers. Consequently small-holder farmers who have adopted mobile money exhibit higher productivity leading to higher income. On average we expect mobile money adopters to exhibit relatively larger amounts of farm income notably crop income[28] compared to non-adopters.

We argue that small-holder farmers who have adopted mobile money receive remittances more frequently and in larger amounts thereby enabling them to finance short term investments such as the adoption and application of modern agricultural inputs. The productivity of modern inputs may vary substantially across crops. Credit constrained farmers probably have to choose on which crops to apply modern inputs. We expect mobile money adoption to induce modern input adoption for relatively high value and

[26] Mobile money is a financial service provided by mobile network operators, which allow its users to make peer-to-peer money transfers. The users can open a mobile SIM card-based mobile money account, deposit and withdraw cash on it mobile money agents. Once the users open the account, they can make basic financial transactions such as depositing money, sending remittance, paying school fees and purchasing goods via their mobile phones.

[27] Maize farmers in Uganda cultivate local, high yielding hybrid and improved pollinated variety (OPV) variety of maize.On farm seed multiplication is commonly practiced. We categorize the improved new seeds comprising of newly purchased high yielding hybrid and OPV as High Yielding Variety (HYV) seeds.

[28] Crop income is computed as the value of crop produced per year minus the cost of all inputs except own labor.

intensively grown crops[29] such as maize and compared to banana which is less intensively grown. Previous studies have related mobile money adoption to greater welfare notably per capita consumption (Jack and Suri, 2011; Munyegera and Matsumoto, 2016) through significantly larger amounts of remittance receipt.

We argue that remittance receipt via mobile money is not only allocated to consumption, but most importantly allocated to short-term agricultural investment through modern input use. Apart from remittances, recent mobile money services such as availability of short-term loans for individual or group of farmers is another viable channel through which mobile money adoption may affect agricultural input use.

Mobile money adoption has expanded rapidly ever since its introduction in 2009. The number of subscribers has jumped from 3 million in 2011 to 12.1 million in 2013, representing a fourfold increase within three years. The proportion of Ugandans using mobile money services increased from 4.76 percent in 2011 to 25 percent by 2013(Ugandan Communications Commission-UCC, 2013). In our data mobile money adoption jumped from less than 1 percent to 27.4 percent between 2009 and 2012. The 2015 survey revealed a 66 percent adoption rate.

This paper contributes to the literature on mobile phone technologies and agricultural productivity by examining the direct impact of mobile money adoption at the household level on different components of farm and non-farm income[30], adoption of modern inputs, and the extent of market participation among small scale farmers in

[29] Table 4.2 indicates that modern inputs are relatively more intensively applied in maize plots compared to banana plots. Fig 4.2 further confirms the responsiveness of maize to modern input use. Maize income is highest in plots on which both fertilizer and HYV seeds were used.
[30] Farm income constitutes crop income, livestock income and farm wage income. Non-farm income constitutes profit from business and wages from off farm jobs.

Uganda. We examine variation in the impact of mobile money adoption on input use, yield, and crop income across banana and maize plots. We mainly use a 2-year balanced panel data covering 781 households collected from 94 communities in rural Uganda in 2012 and 2015.

The main findings indicates that mobile money adoption increases per capita farm and crop income by 13 and 16 percent respectively. Mobile money adoption is associated with a 14 percent increase in maize yields and 25 percent increase in maize income. It increases the likelihood of HYV maize seeds adoption in maize plots by 5 percentage points and expenditure on fertilizer use in maize plots by 39 percent. In line with other studies, pathway analysis reveals that mobile money adoption induces remittance receipt.

The rest of the paper is organized as follows. In Section 2, we provide background information about mobile money in Uganda. Section 3 discusses the data and descriptive evidence, followed by empirical strategy in Section 4. Estimation results are discussed in Section 5 while Section 6 concludes.

4.2 Development of Mobile money services in Uganda

Considering the success of Safaricom's *M-PESA* in Kenya, Mobile Telephone Network(MTN)-Uganda launched the MTN *Mobile money*[31] service in March 2009. It was the first mobile banking service in Uganda and proved to be a viable strategy in expanding MTN's market share. Airtel Uganda established a similar mobile banking service dubbed *Airtel Money* in June of the same year. 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 (UCC, 2012).

Mobile money adoption has expanded rapidly ever since its introduction in 2009. The number of subscribers has jumped from 3 million in 2011 to 12.1 million in 2013, representing a fourfold increase within three years. The proportion of Ugandans using mobile money service increased from 4.76 percent in 2011 to 25 percent by 2013. The number of transactions jumped from 87.5 million in 2011 to 192.4 million in 2013 while the balance on customers account hyped from 43.8 billion Ugandan shillings to 124.4 billion by 2013 .(UCC, 2013).

Though cash transfer remains the most widely used mobile money service, there are other services with a strong potential to induce investment. In addition to individual saving and deposit accounts, collective/group accounts for ROSCA and SACCO enabling group members to access credits is equally offered. Payment of utility bills and school fees through mobile money is equally rapidly growing.

[31] Given its pioneering role and dominant market share, the term mobile money is commonly used to refer to all mobile banking services in Uganda. In this paper we use the term Mobile Money and mobile banking interchangeably.

The rapid expansion of mobile banking services is partly due to high demand for financial services in a context of very limited access to formal banking services especially among rural residents. Over 78.5 percent of rural dwellers live beyond 5 km to the nearest commercial bank as compared to 42.3 percent of urbanites. Apparently the 24 commercial banks alongside their 400 branches and 835 ATM's operating in Uganda leaves a sizeable proportion of the population excluded from formal financial services (Bank of Uganda, 2013). Under such a financial environment in Uganda. Mobile money has been disseminated at a very rapid rate even among rural households and is expected to have enormous impact on rural economies. We focus on its effect on rural household's decision to adopt and apply modern agricultural inputs

4.3 Data and descriptive evidence

4.3.1 Data

This study uses household and community level data collected in 2003, 2005, 2012 and 2015 by Makerere university, Foundation for Advanced Studies on International Development (FASID) and the National Graduate Institute for Policy Studies (GRIPS). The data collection was done under the Research on Poverty, Environment and Agricultural Technology (RePEAT) project. The sample for the RePEAT survey builds upon a research project on policies for improved land management in Uganda, conducted by the International Food Policy Research Institute (IFPRI) and Makerere University from 1999 to 2001. The baseline survey conducted in 2003 covered 94 local communities (LC1) from which a random sample of 10 households was drawn from each community. The 2005, 2009, 2012 and 2015 rounds of the survey successfully captured 936, 754, 699 and 658 of the original households respectively.

The household level component of the RePEAT captures information on demography, agriculture, soil quality[32], income, health, education, financial service usage, land tenure and migration amongst others. The community survey covers information on community characteristics, distance to market and district towns, state of roads and availability of public services such as schools, hospitals and telephone network.

This paper uses a balanced panel sample of 781 households obtained from the 2012 and 2015 rounds of the RePEAT survey.

4.3.2 Descriptive statistics

Table 4.1 stratifies household's base on mobile money adoption status.[33] In both survey years, never adopters of mobile money seems worst off compared to early and late adopters. Early and late adopters have higher income except farm income.[34] They equally own more assets and larger land holdings compared to never adopters of mobile money. It thus appear that mobile money adoption may be driven by wealth. In terms of household head characteristics, heads of early and late adopter households are significantly younger, more educated but have larger households.

In terms of agricultural input use and expenditure, Table 4.1 reveals interesting differences between the three categories. In terms of fertilizer adoption, early and never adopters were most likely to have adopted fertilizer in 2012 and 2015 respectively. In both survey years, early and never adopters on average spend more on fertilizer and consequently apply more fertilizer compared to late adopters. With regards to HYV seeds,

[32] Data on soil quality was only collected in the 2003 and 2012 survey rounds. Most importantly soil samples were collected only from the largest maize or any other cereal plot.
[33] Households are categorized into early, late or never adopters if they had adopted mobile money in 2012, 2015 or never adopted mobile money respectively. Continuous adopters are included in early adopters.
[34] All monetary values have been deflated using CPI. USD values are PPP adjusted

early adopters on average have adopted HYV seeds more than late and never adopters. They equally spend more on hired labor than late and never adopters of mobile money.

In sum the above summary statistics reveal that early and late adopters of mobile money are better off compared to never adopters. We also note that HYV seeds adoption rate is considerably higher compared to fertilizer adoption. Expenditure on hired labor and seed largely exceeds expenditure on fertilizer. If rural households prioritize seeds and hired labor over fertilizer, this may be indicative of lower crop income associated to fertilizer adoption.

From Figure 4.2, maize yield and income is highest in plots on which both fertilizer and HYV seeds were adopted. However using only fertilizer is far less profitable compared to using only HYV seeds or no modern input. From Figure 4.2, it appear that in the event of binding financial constraint, farmers will likely adopt HYV seeds or no modern inputs compared to adopting fertilizer. In the context of Uganda, several studies (Yamano and Arai, 2010; Okoboi, 2010) have shown that maize farmers who have adopted fertilizer are likely to realize negative gross profit given the input-output price ratio.

Table 4.2 provides a more detail picture of agricultural input use in Maize and Banana plots. [35]From Table 4.2 it appears that maize production is more intensive in terms of modern inputs adoption compared to banana which is grown with very little modern inputs. Fertilizer and HYV seeds are more adopted and intensively applied in maize plots compared to banana plots. On average banana plots are larger than maize plots. Banana

[35] The above statistics are derived from a pooled sample of maize and banana plots reported in RePEAT 2009, 2012 or 2015 Maize plots are stand-alone plots. Plots are uniquely defined per season

income is considerably higher than maize income. Again maize and banana plots pertaining to mobile money adopter households exhibit higher productivity and income.

In sum, the descriptive statistics indicate the positive correlation of mobile money adoption with different components of household income and agricultural input use. However, it does not suffice for us to establish a causal relation of the mobile money adoption. In the following section, we further examine their causal relationship by conducting regression analyses utilizing the panel structure of the data as well as the instrumental variable method in consideration of possible endogeneity of the mobile money adoption.

4.4 Empirical strategy

In this section we are going to estimate-: (i) determinants of mobile money adoption in rural Uganda; (ii) impact of mobile money adoption on per capita farm and non-farm income, disaggregated components of farm income such as crop income, livestock income and farm wage income; (iii) impact of mobile money adoption on the decision to adopt modern inputs, crop yield and gross farm income as well as market participation.

4.4.1 Determinants of mobile money adoption:

The decision to adopt mobile money is not random as adopters may be systematically different from non-adopters. First we examine the determinants of mobile money adoption which could be used to address the endogeneity of mobile money in view of estimating the impact of mobile money on household income and modern input use.[36]

[36] Endogeneity of mobile money adoption will be discussed in the next section. The exclusion variable in Eq 1 is the log of distance to the nearest mobile money agent. The validity of this exclusion variable will be discussed in section 4.4

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

$$MM_{ijdt} = 1\{\alpha_i + \beta X_{it} + \delta C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt} > 0\}, \ldots . (1)$$

where MM_{ijdt} is a binary indicator of mobile money adoption which takes 1 if household *i* in community *j* of district *d* has adopted mobile money at time *t* and 0 otherwise; α is household fixed effects which are expected to capture time-invariant unobserved fixed factors; X is a vector of household level controls including household size, household head's age, gender, education, log of household assets holding, land holding and log of distance to the nearest mobile money agent; C is a vector of community level controls of community *j* in district *d* at time *t.* It includes population density, distance in Km from the community to the nearest district town and market. Community level covariates enables us to control for time varying community level attributes which may enhance or delay mobile money adoption; γ_{dt} is expected to capture the influence of district-time specific factors including unobservable factors. We employ both linear specification with household fixed effects and non-linear (Probit) specification without the household fixed effects. We report results from both estimations

4.4.2 Mobile money, farm and non-farm income

Estimating the impact of mobile money adoption on components of household income and agricultural intensification is not straight forward. Mobile money adopters are likely systematically different from non-adopters.[37] From Table 4.1, mobile money adopter households on average exhibit higher per capita income, larger land holdings and have

[37]A formal test of endogeneity is reported in Table 4.8.

more years of schooling relative to non-adopter households. Mobile money adoption may be correlated with time-varying unobservable which have an impact on household decision to adopt modern inputs such as risk and time preferences. Non-random placement of mobile money agents into larger, richer and more educated communities with well-developed agricultural input supply network will as well confound our estimates of treatment effect. Reverse causality between remittance receipt and mobile money adoption may also bias our estimates of the treatment effect. Remittance receipts or prospects for remittance receipts may be driving mobile money adoption. This reverse causality may cause an overestimation of the average impact of mobile money on nonfarm income and modern input use. There could be alternative scenarios which will cause a down-ward bias of the average effect of mobile money. For instance, unobserved aggregate and covariate shocks such as floods, droughts, illness, death, poor harvest at the household level may induce mobile money adoption in a bid to receive assistance from distant relatives. This scenario of the negative shocks will lead to an under estimation of the true effect of mobile money adoption on our outcome variables.

4.4.2.1 Basic specification

In view of the above challenges in estimating the impact of mobile money, we first estimate a basic specification which compares the outcome variables for adopters and non-adopters while controlling for household specific time invariant potential confounders. The impact of mobile money adoption on different components of household income is specified as:

$$Y_{ijdt} = \lambda_i + \delta_{MM} MM_{ijdt} + \delta_X X_{ijdt} + \delta_C C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt}, \ldots. \quad (2)$$

where Y is per capita income, per capita farm or non-farm income of household i in community j of district d at time t.-; λ_i is household fixed effects-; the vector X is

augmented to include binary indicators of mobile phone and improved cattle ownership-; C is a vector of community level controls of community *j* in district d at time *t*. Community level controls entails log of distance measured in Km from the community to the nearest market and district town and community population density. Community level covariates strengthens the claim concerning conditional independence of mobile money adoption from the error term. In other words, given the possibility of endogenous placement of mobile money agents into more attractive communities, it is important to control for time-varying community level attributes which may be correlated with mobile money adoption and components of household income. All other controls are as defined earlier. δ_{MM} is the parameter of our interest capturing the impact of mobile money adoption on components of household income conditional on other covariates. We implement a linear specification with household level fixed effects, however in consideration of the censored nature of some of our outcome variables we also resort to non-linear (Tobit) estimation without fixed effects.[38]

4.4.3 Mechanism: mobile money and input use:

As hypothesized earlier, mobile money adoption increases the likelihood of farm households adopting modern inputs notably improved seeds and fertilizer. We expect mobile money adoption to induce greater agricultural intensification via larger amounts of modern inputs application. In relating mobile money to input use, we estimate the following model

$$E_{ijdt} = \tau_i + \beta_{MM} MM_{ijdt} + \beta_X X_{ijdt} + \beta_C C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt}, \ldots. \quad (3)$$

[38]Approximately 50 per cent of our sample is not engage any non-farm activity

The above equation is a variant of eq. [2] where *E* is a measure of input use of household *i* in community *j* of district *d* at time *t. E* holds expenditure per hectare on seeds, fertilizers, hired labor and binary indicators of HYV seeds and fertilizer adoption; τ_i is household fixed effects. All other controls are as defined earlier. β_{MM} is our parameter of interest capturing the impact of mobile money adoption on measures of input use conditional on all other covariates. Given the censored nature of some of our outcome variables we resort to both linear with and non-linear without fixed effects (Tobit) estimation.[39]

4.4.4 Mobile money and input use: heterogeneity analysis

The impact of mobile money adoption on input use at the household level may conceal significant heterogeneity across crops and plots. This is of particular concern to our study given that small holder farmers in Uganda cultivate a variety of crops requiring different level of input application as well as face different input-output price ratios. Plot-parcel level characteristics such as distance from homestead, altitude, tenure and security likely determines the amount of input to be used. We focus on the most widely cultivated crops i.e Banana and Maize.[40] We pool maize and banana plots reported in our 2012 and 2015 survey rounds. We relate mobile money adoption at the household level to input use, yield and gross income for banana and maize as follows:

$$E_{psijdt} = a_i + \psi_{MM} MM_{ijdt} + \psi_X X_{ijdt} + \psi_P P_p + \psi_C C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt} \quad (4)$$

where *E* is one of our outcome variable of interest including modern input use, crop yield and income of plot *p* in season *s* of household *i* in community *j* of district *d* at time *t.*; α_i

[39] Less than 25 per cent of our sample has adopted fertilizer

[40] Maize and banana are non-traditional cash crops, however maize is grown with relatively high modern input intensity while banana is grown with minimal modern input. Banana, however seems to be profitable compared to maize.

is household fixed effects; the vector *P* holds plot-parcel specific attributes such as a binary indicator of ownership and stand-alone plots, time in minutes from homestead to plot *p* and altitude. The vector *X* is augmented to include a binary indicator of season. All other covariates are as defined earlier. ψ_{MM} is our parameter of interest and is expected to enter the regression positively. We estimate Eq.[4] separately for maize and banana plots using linear and non-linear without fixed effects (Tobit) techniques.

4.4.5 Mobile money and Market participation

One channel through which mobile money adoption can induce higher income is through greater market participation. Increase in productivity is expected to lead to greater market participation culminating in higher incomes. We relate mobile money adoption to participation in maize and banana markets as follows;

$$R_{ijdt} = \lambda_i + \phi_{MM} MM_{ijdt} + \phi_X X_{ijdt} + \phi_C C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt}, \ldots. \quad (5)$$

Eq.[5] is identical to Eq.[2] except for the outcome variable *R* which represents the ratio of sales out of harvest measured in Kg annually. We estimate Eq.[5] separately for maize and banana. ϕ_{MM} is the parameter of our interest capturing the impact of mobile money adoption on market participation conditional on other covariates. Given that some households do not participate in the market, we resort to both linear and non-linear (Tobit) estimation.

4.4.6 Instrumental variable and Tobit estimations:

So far, we have relied on household fixed effects alongside a vector of controls in estimating the impact of mobile money adoption on income and input use. However there are several channels through which mobile money adoption may still be endogenous. Firstly our estimates of treatment impact may be confounded by time varying unobservable that are correlated with mobile money adoption. Agricultural input

distribution policies such as fertilizer credits may be correlated with mobile money adoption. Reverse causality is equally a major concern given that increases in household income induced by either remittance receipt or larger crop income may increase the likelihood of mobile money adoption. Most importantly unobserved aggregate and covariate shocks such as floods, droughts, illness, death, bad harvest at the household level may attenuate the households' ability to purchase agricultural inputs as well as induce mobile money adoption in a bid to receive assistance from distant relatives. This scenario will lead to an under estimation of the true effect of mobile money adoption on our outcome variables.

Given the above challenges, we resort to instrumental variable identification strategy. We use the log of distance to the nearest mobile money agent as an instrument for mobile money adoption. The rational for such an instrument is that the decision to adopt mobile money heavily depends on proximity to mobile money agent. Consequently we would expect that households that are closer to a mobile money agent are more likely to adopt the service relative to distant households. We argue that agent placement does not have any direct impact on households' decision to adopt modern input such as HYV seeds and fertilizer. We argue that the placement of mobile money agent has no direct impact on our outcome variables. Firstly the requirements to be a licensed agent are neither cumbersome nor rigorously implemented by the different mobile phone operators.[41] This laxity is driven by the quest for market share, consequently the number of agents has increased astronomically in virtually all communities without any indication

[41] Requirements to be a licensed mobile money agent includes ;completed agent agreement, deposit of atleast 384 USD per outlet in a specified bank account, certificate of registration and memorandum of association.

of selective placement. This rapid expansion of mobile money agents is captured in our data as the average distance from a reference point in each community to the nearest mobile money agent has declined sharply from 14 km in 2009 to 4 km in 2012 and finally to 3 km in 2015. Given that the licensing of agents is exclusively the preserve of mobile phone companies, political influence and lobbying as well as strategic planning for placement in specific locations which may be correlated with other agricultural policies is unlikely. Following Munyegera and Matsumoto (2016) we argue that most mobile money agents are traditional small shop owners who have expanded their business by providing mobile money services consequently a good number of the agents had already chosen their locations prior to the inception of mobile money. This is particularly true in rural Uganda.

4.4.6.1 Reduced form estimation:

As explained earlier, we use the log of distance to the nearest mobile money agent as a source of exogenous variation in mobile money adoption. We expect a negative relationship between the distance to mobile money agent on the one hand and different measures of household income and agricultural input use. Households having less access to mobile money agents are less likely to adopt the service and consequently are less likely to either receive remittances or access credits available via mobile money there by attenuating their ability to adopt modern inputs.

$$Y_{ijdt} = \lambda_i + \delta_{MM} DMM_{jdt} + \delta_X X_{ijdt} + \delta_C C_{jdt} + \gamma_{dt} + \varepsilon_{ijdt}, \ldots. \quad (6)$$

The above equation is identical to Eq.[2] except for the introduction of DMM_{jdt} which represents the log of distance in Km to the nearest mobile money agent of community *j*

in district *d*- at time *t*. δ_{MM} is our parameter of interest and is expected to enter the regression with a negative sign. All other variables are as defined in Eq.[2].

4.5 Results

4.5.1 Determinants of Mobile money adoption

The estimation results of Eq. [1] are presented in Table 4.3. The results are qualitatively similar across columns. Distance in Km to the nearest mobile money agents is a significant determinant of mobile money adoption. Just like any other service, mobile money adoption strongly depends on proximity to a mobile money agent. A 1 Km increase in the distance to mobile money agent reduces the probability of mobile money adoption by at least 1 percentage point. Other important determinants of mobile money adoption are asset holding, age and years of schooling of household head and distance in Km to the nearest district town and population density.

4.5.2 Mobile money, farm and non-farm income

The estimation results of Eq.[2] are presented in Table 4.4. The first four columns report the OLS estimates while the last four columns report the household-level fixed effect estimates. The outcome variable for columns 1-4 are per capita income, per capita farm and nonfarm income without remittance and nonfarm income with remittance respectively. All continuous outcome variables are in logarithmic form. Estimates from both specifications are qualitatively similar.[42] From columns 1 and 5, mobile money adoption on average increases per capita income by at least 14 per cent. Considering mean per capita income of our entire sample, this estimate indicates an increase of approximately USD 47. From columns 2 and 6 mobile money adoption induces an

[42] Tobit estimates are qualitatively similar to OLS and FE estimates. They are available upon request

increase in farm income of 11 percent. It appears that mobile money adoption affects non-farm income solely through remittance receipt as revealed in columns 4 and 8.[43] Land and asset holdings as well as soil quality are other major determinants of farm income

[Table 4.4 about here]

On a whole the evidence presented in Table 4.4 supports our claim that mobile money adoption induces larger farm income leading to significant improvements in welfare. Previous studies (Munyegera and Matsumoto, 2016; Jack and Suri, 2011) have linked mobile money adoption to greater per capita consumption via remittance receipt. It however appears that remittance receipt via mobile money may not only be used to smooth consumption, but most importantly finance short term agricultural investment.

4.5.3. Mobile money and disaggregated farm income:

The impact of mobile money adoption on different components of farm income are presented in Table 4.5. Columns 1 to 3 and columns 4 to 6 represents crop income, livestock income and farm wage income respectively. All outcome variables are in logarithmic form with the first 3 columns presenting OLS estimations while the last 3 columns are household fixed effect estimates. Estimates from both specifications are qualitatively similar.[44] From columns 1 and 4, the mobile money adoption on average increases crop income by at least 10 per cent. This estimate is similar in magnitude to estimates of impact of mobile money on farm income. Mobile money adoption seems not to have any impact on livestock and farm wage income. It thus appear that mobile money

[43] This indicates that increase in remittance receipt is the primary mechanism through which Mobile money induces investment.

[44] Tobit estimates are qualitatively similar to OLS and FE estimates. They are available upon request

adoption affects farm income essentially through crop income. Land holdings are another important determinant of crop income. In a context of low agricultural intensification, land holdings remains the major determinant of crop income.

[Table 4.5 about here]

Given that mobile money adoption is significantly associated to crop income, we expect mobile money adoption to induce the adoption of modern input thereby increasing agricultural productivity.

4.5.4 Mobile Money and Input use:

Estimation results of Eq.[3] are presented in Tables 4.6. Mobile money adoption increases the likelihood of fertilizer and HYV seed adoption by at least 5 and 7 percentage points respectively. Most importantly columns 3 and 6 reveals that mobile money significantly increases the likelihood of households adopting both fertilizer and HYV seeds for households which have adopted at least one of these two modern inputs. Mobile money adoption increases the probability of adopting both modern inputs by at least 11 percentage point for households which have adopted at least one of the two modern inputs.

[Table 4.6 about here]

4.5.5. Distance to mobile money agent and Income: Reduced form analysis

Results from estimating Eq.[4] are presented in Table 4.7. Columns 1-4 have as outcome variables per capita income, per capita farm income and per capita nonfarm income respectively. Columns 5-7 have as outcome variables crop income, livestock income and farm labor income respectively. All variables are in logarithmic form.

As expected, distance to mobile money agent is negatively associated with all measures of income except non-farm income. An increase in the distance to mobile

money agent by 1km on average reduces per capita income and per capita farm income by 3 and 10 per cent respectively.

[Table 4.7 about here]

4.5.6. Instrumental variable and Tobit control function results:

So far, we have relied on fixed effect and district by time trends alongside a vector of controls to estimate the impact of mobile money adoption on components of household income, modern input adoption. As earlier argued, the exogeneity of mobile money adoption still remains questionable. Unobserved aggregate and covariate shocks, reverse causality between mobile money adoption and income as well as time varying unobservable such as risk and time preferences may influence decision to adopt mobile money as well as decision to adopt modern inputs.

In addressing these concerns we resort to instrumental variables and Tobit control function identification strategies. We use the log of distance to the nearest mobile money agent measured in kilometers at the community level as an instrument for mobile money adoption. Our Tobit model combined with control function takes into account the censored nature of most of our outcome variables as well as remedy for any possibility of weak instrument(Woodridge, 2007; Tadesse and Bahiigwa, 2014; Munyegera and Matsumoto, 2016). We follow Rivers and Vuong (1988) in predicting generalized residuals from the determinants of mobile money adoption Eq.[1] and subsequently introduce these residuals alongside actual mobile money adoption status in our main estimations. Combining instrumental variables with fixed effect addresses the potential endogenous nature of mobile money adoption in a more rigorous way.

4.5.6.1 Mobile money, farm and nonfarm income:

The dependent variables for columns 1-4 and columns 5-8 of Table 4.8 are per capita income, per capita farm income, per capita nonfarm income and per capita nonfarm income including remittances respectively. All variables are in logarithmic form. Mobile money adoption on average increases per capita income by at least 43 per cent as shown in column 5. This impact is however not significant in column 1. From columns 2 and 6, mobile money adoption on average increases farm income by at least 13 per cent. The impact of mobile money on non-farm income seems to be essentially driven by remittances as shown in columns 5 and 8.

[Table 4.8 about here]

On a whole the results presented in Table 4.8 are in line with those presented in Table 4.4. Mobile money adoption is welfare enhancing (Jack and Suri, 2011; Kikulwe et al.,2014; Munyegera and Matsumoto, 2016). The increase in welfare largely comes from increases in remittance receipt which is partly use to finance short term investment in agriculture.

4.5.6.2 Mobile money and disaggregated farm income:

The dependent variables for columns 1-3 and columns 4-6 of Table 4.9 are per capita crop income, per capita livestock and farm wage income respectively. All variables are in logarithmic form. On a whole estimates from both specifications are qualitatively similar. From columns 1 and 4, mobile money adoption on average increases crop income by at least 16 per cent. From columns 2 and 5 we do not find any significant relationship between mobile money adoption and livestock income. Contrary to our expectations, mobile money adoption increases farm wage income by 14 per cent. The mechanism

through which mobile money positively affects farm labor market participation remains unclear.

[Table 4.9 about here]

On a whole the results presented in Table 4.9 are in line with results presented in Tables 4.6. Mobile money adoption enhances crop income notably through productivity gains induced by adoption of modern inputs. Though not explored in this study, small scale farmers who adopt mobile money in particular and mobile phone related technologies in general are known to receive better market prices for their produce (Muto and Yamano, 2009; Kikulwe et al., 2014)

We note that the FE-IV and Tobit-CF estimates are significantly larger than estimates from OLS and FE estimations reported in Tables 4.4 and 4.5. This is plausible given that mobile money adoption is likely correlated with unobserved aggregate and covariate shocks at the household level. Since we do not observe such shocks in our data or specifications, it is likely that OLS and FE estimates are down ward bias. A closer look at the purpose of remittance receipt reported in our data reveals that approximately 6 per cent of remittances were received for shock related reasons such as to pay hospital bills, dead celebrations, and to bail out a family member from detention etc. However a similar decomposition for remittances received exclusively via mobile money indicates that approximately 11 per cent of remittances were received for the above mentioned shock related reasons. It thus appear that mobile money adoption is driven by exposure to shocks. Vulnerable households adopt mobile money as a fast and cheap platform to receive assistance in case they suffer from shocks.

4.5.7 Mobile money and input use: Heterogeneity analysis

The results from estimating Eq.[4] separately for maize and banana plots are presented in Tables 4.10, 4.11 and 4.12 respectively. From Table 4.10, mobile money increases the likelihood of fertilizer and HYV seed adoption in maize plots by at least 6 and 5 percentage points respectively. Most importantly it increases the likelihood of the joint adoption of fertilizer and HYV seeds by at least 3 percentage point conditional on the adoption of at least one of these modern inputs. From Table 4.11, mobile money increases expenditure on fertilizer by 39 per cent. There is limited evidence relating mobile money to expenditure on hired labor and seeds. Mobile money is associated with an increase in maize yield and maize income of at least 14 and 25 per cent respectively. It thus appear that the increase in maize yields is essentially driven by the joint adoption HYV seeds and fertilizer in maize plots. As shown in Figure 4.2, the joint adoption of HYV seeds and fertilizer in maize plots leads to significant gains in productivity and income. This optimal input mix is however costly and only 9 and 12 percent of households jointly adopted fertilizer and HYV seeds in 2015 and 2012 respectively. From Figure 4.1 fertilizer and HYV seeds are jointly applied on less than 20 percent of maize plots

[Table 4.11 about here]

With regards to banana, we do not find any evidence that mobile money adoption enhances modern input use in banana plots and consequently it seems to have no impact on banana yield and income.

[Table 4.12 about here]

On a whole the evidence presented in Tables 4.11 and 4.12 is in line with our expectation. Maize production is more responsive to modern inputs than banana

production. Credit constraint relaxation through remittance receipt via mobile money enables farmers to adopt and apply modern inputs on crops which are responsive such as maize. As depicted in Figure 4.2, fertilizer application is most profitable when combined with HYV seeds. The adoption of both HYV seeds and fertilizer is ideal but costly.

Several studies have shown that the relative price of fertilizer in Uganda is substantially high there by rendering its adoption and application potentially unprofitable for small scale farmers (Omamo SW, 2003; Moris et al., 2007; Matsumoto and Yamano, 2010; Arai and Yamano, 2010). Our results however suggest that combined adoption of HYV seeds and fertilizer is likely profitable notably for maize growers.

4.5.8 Mobile money and Market participation

The results from estimating Eq.[5] separately for maize and banana at the household level are presented in Table 4.13. We find no evidence that mobile money adoption increases participation in either maize or banana markets. Unlike maize, mobile phone ownership and distance to market significantly increases participation in banana markets.

Previous studies (Muto and Yamano, 2009; Tadesse and Bahiigwa, 2015) have shown that mobile phone ownership is more susceptible to increase market participation for perishable crops compared to non-perishable crops. Mobile phone adoption increases participation in banana market due to the perishability of banana as well as limited possibility for speculative marketing compared to maize.

4.6-Robustness Check

We have combined fixed effect methods and instrumental variables as well as a control function version of Tobit model to estimate the impact of mobile money adoption at the

household level on components of household income, fertilizer application and market participation. Fixed effects enables us to capture time invariant potential confounders at the household level. District by time dummies has enabled us to disentangle any possible correlation between mobile money adoption and socio-economic and technological changes at the district level. The inclusion of community controls in our estimations enables us to control for community level attributes that may account for any endogenous placement of mobile money agents.

4.6.1 Pre-mobile money trend verification

The trend in the outcome variables might have been different between mobile money adopters and non-adopters even before the inception of mobile money. To confirm the robustness of our results, we re-estimate Eq.[2] and Eq.[3] using pre-mobile money RePEAT survey rounds. We use the 2003 and 2005 survey data to re-estimate the equations with a placebo mobile money adoption status assigned to households that adopted mobile money in 2012 or 2015 survey rounds. If the effects obtained are indeed induced by mobile money adoption and not unobserved household time variant attributes then we would expect to find no effect of mobile money in our Robustness check estimations. As can be seen from Tables 4.14A and 4.14B, placebo mobile money adoption has no significant impact on any measure of household income.

4.6.2 Propensity score based fixed effect estimation:

As an additional robustness check, we re-estimate Eq.[2] using a restricted sample of only observations with similar probability of adopting mobile money in 2015 given pre-mobile money(2009) characteristics.[45] The likelihood of adopting mobile money in 2015 is

[45] Given the distribution of the probability of adopting mobile money for adopters and non-adopters, we restrict our sample to observations with a probability of adoption ranging between 0.2 and 0.9. The results of this estimation is reported in the appendix

predicted from a linear probability model by regressing a binary indicator of mobile money adoption in 2015 on 2009 household and community characteristics. We re-estimate Eq.[2] using a restricted sample of only observations (494 households) within the common support region. The results shown in Table 4.14C are qualitatively similar to those presented earlier in Tables 4.4 and 4.5. Mobile money has a significant impact on different components of household income.

4.7 Conclusions and policy implications

Even when agricultural technology is proven to be productivity enhancing, small scale farmers in developing countries still do not adopt them. (Feder et al., 1985; Munshi, 2008; Duflo et al., 2008). One major constraints for small-scale farmers to adopt agricultural technologies is limited access to credit (Croppenstedt et al., 2003; Gine and Klonner, 2006; Zerfu and Larson, 2010). Financial resources are generally insufficient to cover high-yielding variety seeds and fertilizer purchase for small-scale farmers at the beginning of the planting season. Though there is ample evidence (Ayalew, Deininger and Duponchel, 2014; Yamano and Nyoro, 2004; Narayanan, 2016; Deb and Suri, 2013) of significant productivity gains associated with greater financial inclusion of small scale farmers in developing countries, formal financial institutions are still reluctant to expand lending to small scale farmers due in part to the vagaries associated with agricultural income and weather risk inherent to agriculture

The advent of mobile phone banking and money transfer services in developing countries has considerably improved accessibility of small scale farmers to formal

financial services such as short term credits. Speedy cash transfers has equally enabled small scale farmers to be more responsive to market opportunities.

In this study we have shown evidence of increased farm income induced by mobile money adoption at the household level. On average small scale farmers in rural Uganda who have adopted mobile money exhibit higher per capita farm income. We note that less than 25 percent of households participated in any non-farm activities. This may explain why we do not find any impact of mobile money on non-farm income other than remittances. Path way analysis indicates that mobile money adoption induces the adoption of modern inputs such as high yielding seeds and fertilizer notably for crops that are relatively intensively grown such as maize and beans. Irrespective of the above empirical evidence of the impact of mobile money on the adoption and application of modern agricultural technologies such as fertilizer and HYV seeds, there are still myriads of constrains limiting its full potential in small scale agriculture. Firstly fertilizer adoption and application among small scale farmers in Uganda has remained conspicuously low compared to Kenya or Ethiopia. This is due to the inefficient fertilizer marketing system coupled with the land locked nature of Uganda. Consequently the fertilizer market structure in Uganda is marked by small scale trade, high prices and low net margins (Omamo, 2003; Arai and Yamano, 2011). In this context the impact of mobile money or any other similar technology in stepping up fertilizer adoption and application is limited. Supply side reforms are imperative for the impact of mobile money on small scale agriculture to be fully harnessed. Mobile money will only incentivize fertilizer adoption if the input-output price ratios are low enough to make fertilizer adoption profitable.

CHAPTER 5

Conclusions and Policy Implications

The notion that households are rational welfare maximizers is fundamental in development economics since Theodore Schultz (1964). Empirical studies have shown that even when returns to investments in health, education or agriculture is profitable, households in developing countries still invest sub-optimally in them(Akerlof, 1978; Besley et al., 1992; Dupas, 2010; Alatas et al., 2013; Cohen et al., 2010). Financial constraint has been regularly cited as a major reason for sub-optimal investment (Guyatt et al., 2002; Kremer and Miguel, 2004; Cohen and Dupas, 2010).

Several studies have highlighted the importance of an effective rural financial market if rural households are to take advantage of the myriads of opportunities available within their environment (Levine, 1997; World bank, 2008; IFAD, 2009). An enabling financial sector is essential for the optimal allocation of resources which are conspicuously scarce in rural settings. In an enabling financial environment promising entrepreneurs are easily identified and supported. Small-holder farmers can access affordable credits thereby facilitating the adoption and optimal application of modern inputs. Access to credit enable households to increase investments in health and education thereby attenuating the impact of erratic shocks. An effective rural financial sector fosters productive investment which is fundamental for poverty reduction (Dupas and Robinson, 2013; Bernajee et al., 2015; Jalilian and Kirkpatrick, 2005).

Irrespective of the gains associated with rural financial markets, the rural financial sector in developing countries has remained notoriously small and ineffective thereby

precluding the rural poor from accessing vital formal financial services (Asli and Klapper, 2012). Amongst others, the cost associated with the adoption of formal financial services stands out as a major obstacle to the rural poor having access to financial services. The cost of maintaining a bank account in some African countries has been reported to be over 20 per cent of GDP per capita (Beck et al., 2008). In addition to relatively high bank service fees, the strong concentration of bank branches in urban locations implies additional transaction costs for the rural poor as well as significant opportunity costs (Dupas et al., 2012).

Given this context of limited access to formal financial services, a new mobile phone base banking and money transfer service dubbed *Mobile money* has been spreading very rapidly in rural Uganda. Unlike traditional banking services, mobile money is less procedural and affordable. Existing studies on mobile money (Jack and Suri, 2011; Munyegera and Matsumoto, 2016) have focused on its impact on welfare (consumption). To the best of our knowledge there are no rigorous empirical studies on the impact of mobile money adoption on rural development notably human capital and agricultural investments

In this dissertation we relate mobile money adoption to investment behavior of rural households in Uganda. We estimate the impact of mobile money adoption on investments in agriculture and education. The dissertation analyzes the determinants of mobile money adoption. It explores the impact of mobile money adoption on rural households' decisions to adopt modern farming inputs notably high yielding maize variety seeds and fertilizer and the resultant impact on crop yield, market participation and different components of household income. The dissertation also relates mobile

money adoption to educational investment. It evaluates the impact of mobile money adoption on households' expenditure on education as well as enrollment and public-private school choice decisions.

The dissertation presents several findings; first, the dissemination of mobile money has remained very high in rural Uganda. The adoption rate has jumped from less than 1 percent in 2009 to 28.8 percent in 2012 and to 66 percent in 2015. This expansion in the adoption of mobile money is driven by expansion in the number of mobile money agents. The average distance to the nearest mobile money agent has dropped from 13km in 2009 to 4km in 2012 and 3km in 2015.This drop in distance represents significant reduction in transaction cost for rural households. Previous studies have also identified reduction in transaction cost as an advantage of mobile money over traditional banking services.

Another key finding is that mobile money adopters are more likely to adopt modern agricultural inputs such as high yielding maize seeds and chemical fertilizers. The adoption of these modern inputs leads to productivity gains which translates into higher income. Heterogeneity analysis reveals that mobile money adoption induces modern input adoption for crops that are relatively intensively grown such as maize compared to crops that are grown with low modern input intensity such as banana. In terms of market participation, mobile phone rather than mobile money induces greater market participation notably for perishable crops such as banana compared to maize. This finding is in line with earlier findings that access to credit and mobile phone technologies induces agricultural productivity, market participation and income.

Regarding educational investment, mobile money adoption is associated with larger investment in education measured in per school age child educational expenditure. It increases the budget share of education within the household budget. Mobile money adoption increases the likelihood of school enrollment. Conditional on enrollment, it induces demand for private school education relative to public school education.

In exploring the mechanism through which mobile money triggers agricultural and educational investment, the dissertation reveals that mobile money adopters are more likely to receive remittances as well as receive larger amount of remittances. This results is in line with previous findings indicating that mobile money adoption facilitates resource allocation across distances. Increases in remittances induced by mobile money adoption enables rural households' to increase investment in agriculture and education.

The above findings have resounding policy implications. First, the results indicates that rural households' are willing to adopt modern financial services conditional on such services been affordable. Hence the drive for greater financial inclusiveness will require existing traditional banking services to be stream lined in view of rendering them affordable and less procedural. There is an urgent need for governments and other financial stakeholders to expand the range of financial services available via mobile money accounts. The impact of mobile money on agricultural and educational investment is essentially driven by remittances thereby tying mobile money to migration. There is need to promote mobile money as a platform for savings and loans thereby enabling rural communities to mobilize financial resources in addition to remittances needed for investments. Promoting access to credit via mobile money will enable rural households

to respond to in a timely and efficient manner to opportunities and shocks independent of remittances.

On the educational front, the fact that mobile money is associated with higher demand for private school education is indicative of the fact that public schools are second best to private schools though they are tuition free. There is an urgent need for more investment in public education in view of closing the perceived gap in quality between public and private schools.

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Table 3.1 :Summary statistics by Year and Mobile money adoption status

	2009		2012		2015	
	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters
Variables	Mean	Mean	Mean	Mean	Mean	Mean
HH characteristics						
1 if head is female	0.1	0.286	0.163	0.149	0.31	0.211***
1 if head is married	0.91	0.857	0.831	0.856	0.99	0.97*
Head education	7.099	8.286	5.11	7.103***	5.766	5.55**
Head age	47.571	51.857	51.901	52.124	53.18	51.017
Household size	9.249	11.857	10.875	12.412***	11.75	12.37
Number of Migrants	0.353	0.286	0.639	1.052***	0.866	1.035
1 if own Mobile Phone	0.528	0.572	0.645	0.979***	0.887	1.00***
Log of distance to the mobile money agent	2.56	1.71***	2.11	1.01***	1.44*	0.69
Wealth						
Land size(acres)	5.59	7.154	5.884	7.099	5.66	6.104
Total value of assets(Ush)	747.791	2,220.00	841.232	1,980.07***	653.534	1,388.806***
Proportion of Household receiving remittances	28.57	42.85	32.05*	38.07	35.00**	71.45
Total remittance(Ush)	79	760.6*	110.293	246.502	93.232	159.358
Remittance for Education(Ush)	15.67	22.44	21.75	38.03*	29.62	56.11**
Welfare						
Per Capita food expenditure (Ush)	151.315	162.554	230.190	257.964***	239.588	341.77
No of Households	704	7	506	205	202	509

Note: Calculated by author from RePEAT 2009, 2012 and 2015. 1$=2028UGX, 1$=2557UGX and 1$=2857UGX in 2009, 2012 and 2015 respectively(Bank of Uganda)
2)* indicates significance in difference in means between adopters and non-adopters
3)*** p<0.01, ** p<0.05, * p<0.1
4)Monetary values are in 1000 UGX

Table 3.2: Mobile money, Enrollment and School Choice

	2012		2015	
	Non-Adopters	Adopters	Non-Adopters	Adopters
Variables	Mean	Mean	Mean	Mean
Enrollment				
No of school age children	4.01	4.7*	2.98	4.2
No of school age children enrolled	3.487	4.376***	2.498	3.926***
1 if schooling & Age Less than 10	0.93	0.9	0.88	0.89
1 if schooling & Age greater than 9	0.95	0.92	0.94	0.95
School choice				
No attending Private school	1.187	2.015***	0.828	1.983***
No attending Public school	2.266	2.247	1.649	1.854
School choice & Age Less than 10				
1 if attending Private school	0.34	0.58**	0.33	0.6*
1 if attending Public school	0.66	0.42	0.67	0.4
School choice & Age Greater than 9				
1 if attending Private school	0.35	0.41*	30	0.44*
1 if attending Public school	0.65	0.59	70	0.56
Per Capita Educ Exp(Ush)	215.37	365.568***	150.33	336.233***
Number of Households	506	205	202	509

Note: Calculated by author from RePEAT 2012 and 2015. 1$=2557UGX and 1$=2857UGX in 2012 and 2015 respectively(Bank of Uganda)

1) Sample consist of children aged 5-16 years

2)* indicates significance in difference in means between adopters and non-adopters

3)*** p<0.01, ** p<0.05, * p<0.1

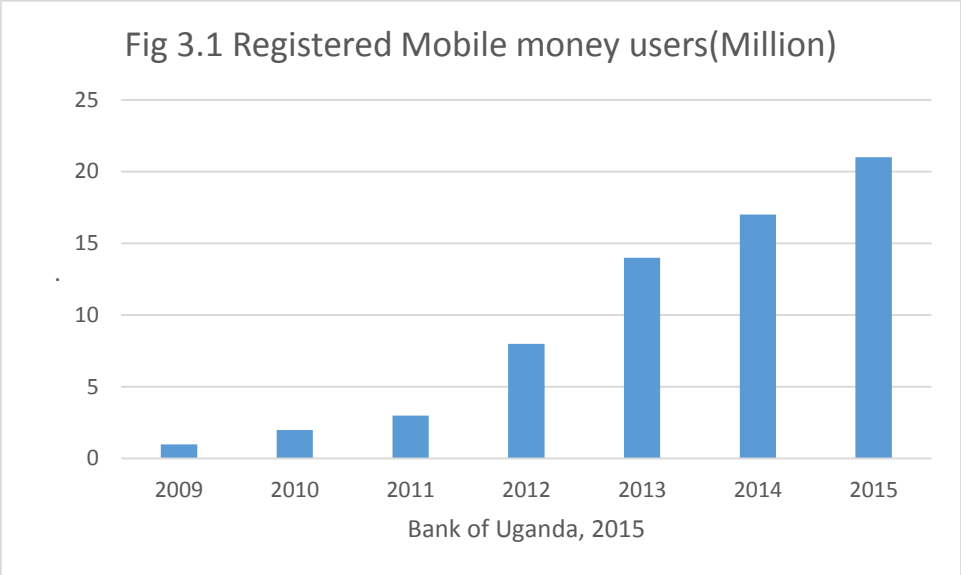


Fig 3.1 Registered Mobile money users(Million)
25
20
15
10
5
0
2009
2010
2011
2012
2013
2014
2015
Bank of Uganda, 2015

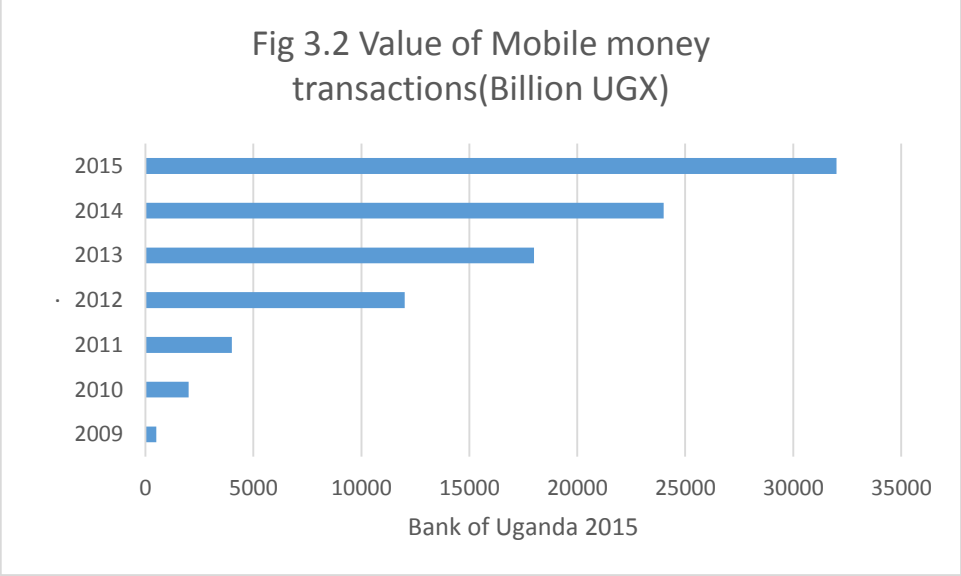
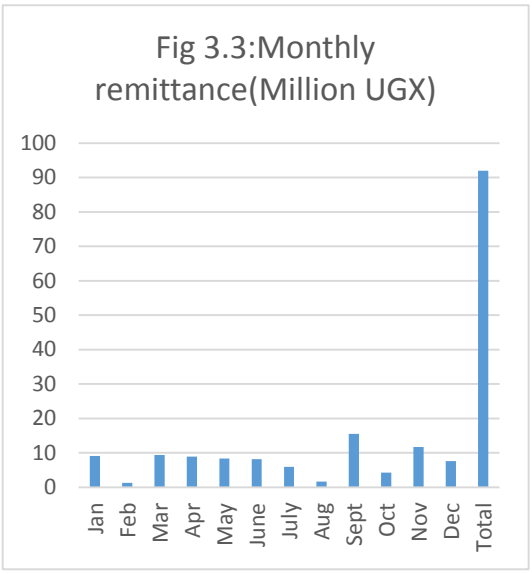
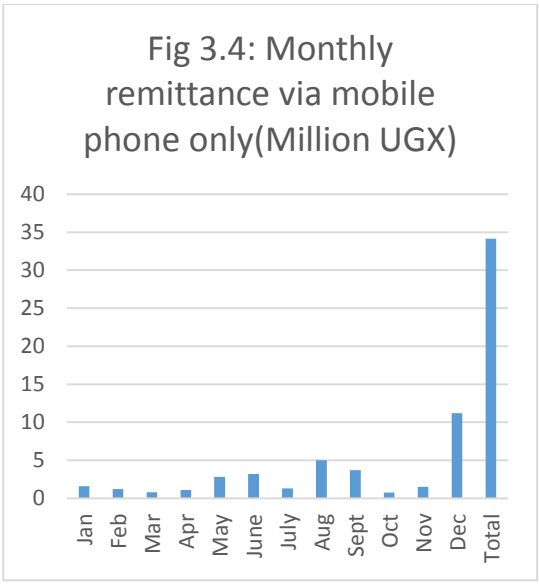
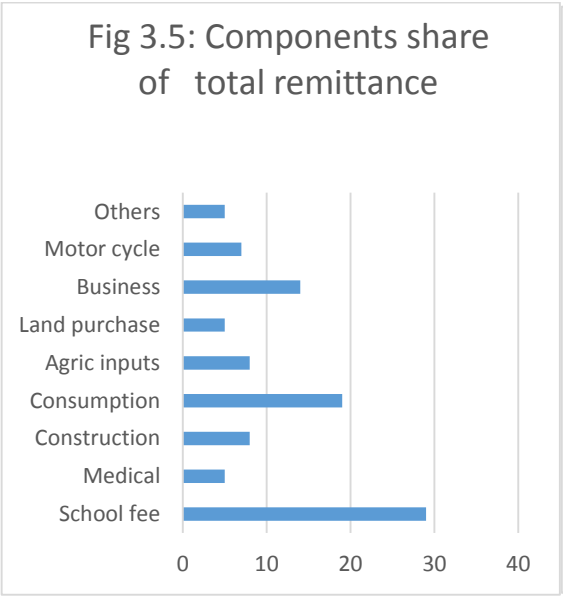


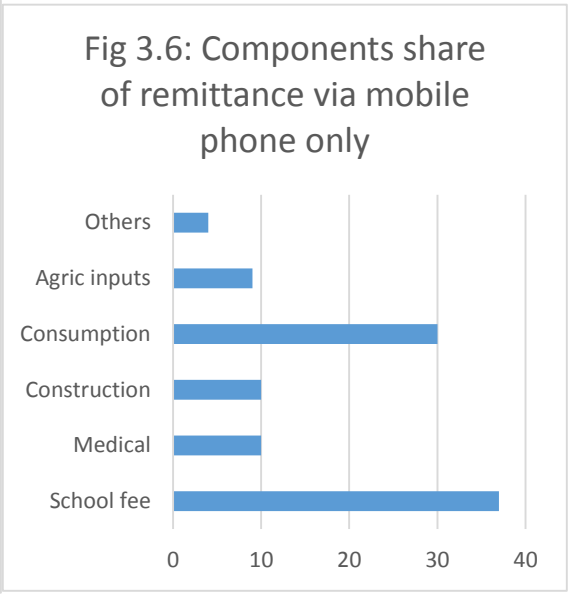
Fig 3.2 Value of Mobile money transactions(Billion UGX)
2015
2014
2013
2012
2011
2010
2009
0
5000
10000
15000
20000
25000
30000
35000
Bank of Uganda 2015





Source: Computed by author from RePEAT 2012 survey





Source: Computed by author from RePEAT 2015 survey

Table 3.3: Determinants of Mobile money adoption (Panel data)

	Dependent variable: Mobile money adoption=1	
Variables	Probit	Fixed effects
Log of distance to Mobile Money agent in Km	-0.154***	-0.140***
	(0.012)	(0.0244)
1 if household head is female	0.031	0.0342
	(0.025)	(0.053)
1 if household head is married	0.027	-0.00604
	(0.039)	(0.050)
Years of schooling of household head	0.016***	0.0310***
	(0.002)	(0.0056)
Age in years of household head	-0.0006	-0.000432
	(0.0005)	(0.0009)
log of household size	0.073**	0.240***
	(0.032)	(0.079)
log of size of landholding in acre	-0.010	0.00103
	(0.009)	(0.021)
log of value of assets	0.06	0.0659***
	(0.058)	(0.0123)
Constant		-0.756***
		(0.243)
Observations	2,133	2,133
R-squared		0.486
Number of Households	711	711
District by time	YES	YES
Household FE		YES

Notes

1)Additional regressors include ;Number of public and private schools in each community, population size of each community,community level average of heads schooling and land holdings

2) Standard errors in parenthesis are clustered at community level

3) Significance level *** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Mobile money and Educational expenditure(Panel data)

VARIABLES	OLS			FE		
	Educ.exp	log Educ exp	Educ Share	Educ.exp	log Educ exp	Educ Share
1 if Mobile money adopter	49.49***	0.302***	0.0852***	47.61***	0.243***	0.0767***
	(5.478)	(0.025)	(0.007)	(6.293)	(0.024)	(0.007)
1 if household owns mobile phone	-6.302	-0.00606	0.00305	-17.09**	-0.0364	-0.00796
	(5.556)	(0.023)	(0.005)	(6.758)	(0.027)	(0.007)
1 if household head is female	-3.361	0.00469	0.00141	-12.83	-0.00464	-0.0107
	(5.947)	(0.029)	(0.008)	(13.1)	(0.061)	(0.01)
Household head years of schooling	3.100***	0.0110***	0.00283***	0.00629	0.00796	0.00300**
	(0.78)	(0.002)	(0.0006)	(1.882)	(0.005)	(0.001)
log of household size	3.09	-0.049	-0.0231**	-5.108	-0.00794	-0.0128
	(13.93)	(0.045)	(0.010)	(19.41)	(0.087)	(0.021)
log of size of landholding in acres	6.068**	0.015	0.00277	0.325	0.0124	-0.0049
	(2.492)	(0.009)	(0.0029)	(3.24)	(0.012)	(0.004)
log of value asset	16.90***	0.0813***	0.00598**	7.975***	0.0647***	0.000714
	(3.162)	(0.009)	(0.002)	(2.654)	(0.01)	(0.003)
Constant	-168.8***	0.951***	0.00789	8.009	1.214***	0.107
	(59.26)	(0.175)	(0.036)	(54.54)	(0.281)	(0.072)
Observations	2133	2133	2133	2133	2133	2133
R-squared	0.237	0.328	0.287	0.215	0.284	0.321
District by time	YES	YES	YES	YES	YES	YES
Household FE				YES	YES	YES
Number of household				711	711	711

Notes

1)Additional regressors include :Number of public and private schools in each village, population size of each community, community level average of heads schooling and land holdings,# of boys and girls

2)Community clustered errors in parentheses

3)Significance level *** p<0.01, ** p<0.05, * p<0.1

4) Outcome variables are in 1000 UGX

Table 3.5: Mobile money and Remittance (Panel data)

	OLS		PROBIT	FE		TOBIT
Variables	1 if received remittance	Total remittance	1 if remittance received	1 if remittance received	Log of remittance	Total remittance
1 if mobile money adopter	0.0731**	-1.262	0.076***	0.124***	0.638***	173.0**
	(0.034)	(63.14)	(0.027)	(0.034)	(0.156)	(87.42)
Constant	-0.564***	-1,161***		-0.363	4.867***	-4,492***
	(0.154)	(282.7)		(0.326)	(1.5)	(528.8)
Observations	2,133	2,133	2,133	2,133	2,133	2,133
R-squared	0.154	0.085		0.135	0.144	
District by time	YES	YES	YES	YES	YES	YES
Household FE				YES	YES	
Number of household	711	711	711	711	711	711

Notes

1)Additional regressors include :An indicator of mobile phone possession, presence of migrant worker, Heads education, age, gender, marital status, household size, land and asset holding, composition of the household by age cohort**,** population of each community,, community level average of heads schooling and land holding,# of boys and girls

2) Mean remittance receipt is 233.61 UGX

3)community clustered standard errors in parentheses

4)Significance level *** p<0.01, ** p<0.05, * p<0.1

5) Outcome variables are in 1000 UGX

Table 3.6: Distance to Mobile money agent and Educational expenditure(Panel data)

VARIABLES	OLS			FE		
	Educ.exp	log Educ exp	Educ Share	Educ.exp	log Educ exp	Educ.Share
Log of distance in Km to nearest Mobile money agent	-16.07***	-0.0578***	-0.0199***	-10.87***	-0.0446***	-0.0184***
	(2.95)	(0.011)	(0.003)	(3.922)	(0.015)	(0.004)
1 if household owns mobile phone	0.0353	0.0382*	0.0150***	-14.14**	-0.02	-0.00331
	(5.707)	(0.022)	(0.005)	(6.904)	(0.026)	(0.007)
1 if household head is female	-2.935	0.00715	0.00212	-10.82	0.00575	-0.00745
	(5.415)	(0.029)	(0.008)	(12.51)	(0.047)	(0.0142)
Household head years of schooling	3.729***	0.0152***	0.00398***	1.427	0.0153***	0.00528***
	(0.716)	(0.002)	(0.00)	(1.227)	(0.004)	(0.001)
log of household size	-0.0823	-0.061	-0.0272**	-1.381	0.0162	-0.00721
	(11.06)	(0.041)	(0.011)	(18.86)	(0.072)	(0.021)
log of size of landholding in acres	5.370*	0.0107	0.00157	0.362	0.0129	-0.00486
	(2.82)	(0.010)	(0.002)	(3.393)	(0.013)	(0.003)
log of value asset	19.17***	0.0970***	0.0102***	10.57***	0.0785***	0.00486
	(2.402)	(0.009)	(0.002)	(2.828)	(0.010)	(0.003)
Constant	-153.5***	0.930***	0.0123	-0.242	1.135***	0.0968
	(36.82)	(0.146)	(0.036)	(63.29)	(0.242)	(0.071)
Observations	2,133	2,133	2,133	2,133	2,133	2,133
R-squared	0.216	0.264	0.226	0.184	0.229	0.265
District by time	YES	YES	YES	YES	YES	YES
Household FE				YES	YES	YES
Number of household				711	711	711

Notes

1)Additional regressors include :Number of public and private schools in each village,

population size of each community,community level average of heads schooling and land holdings,# of boys and girls

2)Community clustered errors in parentheses

3)Significance level *** p<0.01, ** p<0.05, * p<0.1

4) Outcome variables are in 1000 UGX

Table 3.7: Mobile Money and Educational Investment(Panel data Main estimation)

	FE-IV			Tobit-CF		
Variables	Educ.exp	log Educ exp	Educ.Share	Educ.exp	log Educ exp	Educ. Share
1 if mobile money adopter	88.43**	0.326**	0.136***	94.24***	0.380***	0.135***
	(34.95)	(0.13)	(0.039)	(22.02)	(0.079)	(0.024)
residual				-42.12*	-0.104	-0.0486*
				(22.72)	(0.081)	(0.024)
1 if mobile phone owned	-20.15***	-0.0458*	-0.0139*	-15.50***	-0.0109	-0.00387
	(6.96)	(0.027)	(0.0073)	(5.936)	(0.021)	(0.0064)
1 if household head is female	-14.41	-0.00893	-0.0135	-6.264	-0.0081	-0.00246
	(13.51)	(0.053)	(0.015)	(7.434)	(0.0267)	(0.008)
Years of schooling of hh head	-1.058	0.00465	0.00091	1.785*	0.00790**	0.00156
	(1.936)	(0.0054)	(0.0017)	(0.956)	(0.003)	(0.001)
log of household size	-10.82	-0.0284	-0.0254	-8.491	-0.0629	-0.0365***
	(18.65)	(0.085)	(0.022)	(11.92)	(0.0429)	(0.013)
log of size of landholding in acre	-0.242	0.0126	-0.00507	5.061*	0.0146	0.000914
	(3.254)	(0.0129)	(0.0039)	(2.634)	(0.0094)	(0.002)
log of value of assets	5.500*	0.0586***	-0.00338	15.83***	0.0731***	0.00439
	(3.213)	(0.013)	(0.004)	(2.646)	(0.009)	(0.002)
Constant				-136.4***	1.020***	0.053
				(44.08)	(0.156)	(0.047)
Observations	2,133	2,133	2,133	2,133	2,133	2,133
R-squared	0.19	0.278	0.283			
F-statistics	61.82	61.82	61.82			
Endogeneity test stat	3.52	3.52	3.53			
Number of Household	711	711	711	711	711	711
Household FE	YES	YES	YES			
District by time	YES	YES	YES	YES	YES	YES

Notes

1) First stage IV estimation are not reported due to limited space. All diagnostic test are satisfied. Results are available upon request

2)Additional regressors include ;Number of public and private schools in each community, population size of each community,community level average of heads schooling and land holdings

3)community clustered errors in parentheses

4)Significance level *** p<0.01, ** p<0.05, * p<0.1

5)Outcome variables are in 1000 UGX

Table 3.8A: Mobile money and Enrollment(Panel Data Estimation)

Dependent Variable: Enrollment=1				
	Age 5 to 10		Age 11 to 18	
VARIABLES	OLS	FE	OLS	FE
1 if Mobile money adopter	0.0504*	0.0252	0.0497***	0.0411*
	(0.025)	(0.044)	(0.018)	(0.024)
1 if owns Mobile phone	0.055***	0.0229	0.00999	-0.0459*
	(0.021)	(0.05)	(0.016)	(0.026)
Constant	0.194*	0.262	1.292***	0.866***
	-0.102	-0.462	-0.0841	-0.271
Observations	2,689	2,689	4,186	4,186
R-squared	0.192	0.231	0.162	0.308
Year of Birth FE	YES		YES	
District by time	YES	YES	YES	YES
Number of Children		1,823		2,671
Child FE		YES		YES

Notes: Samples are drawn from RePEAT 2009, 2012 and 2015. Additional regressors include; Household head's age, gender and years of schooling. Binary indicators of first child and orphanhood.Child's age and gender as well as demographic composition of the household, household asset and land holding.Community population size and average of head's years of schooling and number of schools are also included

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.8B: Mobile money and School Choice(Panel data estimation)

Dependent Variable: Private school=1				
	Grades 1 to 7		Grades 8 to 13	
VARIABLES	OLS	FE	OLS	FE
1 if Mobile money adopter	0.093***	0.069***	0.109**	0.0256
	(0.020)	(0.024)	(0.045)	(0.090)
1 if owns Mobile phone	0.0824***	-0.0515**	-0.00138	-0.0554
	(0.016)	(0.024)	(0.046)	(0.103)
Constant	0.712***	0.621**	1.075***	0.399
	(0.087)	(0.244)	(0.23)	(1.04)
Observations	5,165	5,165	1,243	1,243
R-squared	0.166	0.107	0.166	0.429
Year of Birth FE	YES		YES	
District by time	YES	YES	YES	YES
Number of Children		2,874		987
Child FE		YES		YES

Notes: Samples are drawn from RePEAT 2009, 2012 and 2015. Additional regressors include; Household head's age, gender and years of schooling. Binary indicators of first child and orphanhood.Child's age and gender as well as demographic composition of the household, household asset and land holding.Community population size and average of head's years of scholling are also included

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.9A:Mobile money and Educational Investment(Robustness check:2003/2005)

Variables	OLS			RE		TOBIT
	Log of educ exp	Educ exp	Educ.Share	Log educ exp	Educ share	Educ exp
1 if mobile money adopted	0.327***	51.01	0.028	0.333	0.029	75.03
	(0.105)	(54.77)	(0.039)	(0.322)	(0.019)	(46.72)
Constant	2.787***	138.643	-8.061	6.559***	12.39	-125.061
	(0.904)	(432.036)	(42.05)	(1.661)	(110.9)	(290.226)
Observations	1,398	1,398	1,398	1,398	1,398	1,398
R-squared	0.267	0.032	0.08	0.108	0.093	
District by time	YES	YES	YES	YES	YES	YES
Number of household				711	711	711

Notes

2)Additional regressors include ; household heads age, gender, education, marital status, age composition of the household, population of each community, community level average of heads schooling and land holdings,# of boys and girls, log of distance to the nearest school , asset and land holding, indicator of mobile phone possession and presence of migrant worker, number of schools in each community

2)Community clustered standard errors in parenthesis

Table 3.9B: Mobile money and Remittance(Robustness check:2003/2005)

Variables	OLS			RE		TOBIT
	Log of remit	Total remit	1 if received remit	Log of remit	1 if received remit	Total remit
1 if mobile money adopter	-0.244	-3.57	-0.029	-0.255	0.031	-35.65
	(0.226)	(11.29)	(0.023)	(0.299)	(0.023)	(37.02)
Constant	0.624	-271.29***	0.0818	5.131		-980.505***
	(1.418)	(72.75)	(0.145)	(3.545)		(219.471)
Observations	1,398	1,398	1,398	1,398	1,398	1,398
R-squared	0.095	0.096	0.081	0.133	0.124	
District by time	YES	YES	YES	YES	YES	YES
Number of household				711	711	711

Notes

1)Additional controls as listed in 3.9A

2) Community clustered standard errors in parenthesis

Table 4.1: Summary statistics by year and mobile money adoption status

	2012				2015			
	Adoption status				**Adoption status**			
Variables	**Early**	**Late**	**Never**	**All**	**Early**	**Late**	**Never**	**All**
Per capita income(1000 UGX)	1,053.91	1,246.80	985.21	1,124.88	1,040.86	980.85	707.19	926.04
	(1,130.2)	(8,882.1)	(3,887.7)	(6,372.7)	(3,674.6)	(2,081.5)	(3,099.8)	(2,872.6)
Per capita non farm income(1000 UGX)	345.32	195.10	181.11	233.19	342.11	195.69	203.68	238.46
	(529.1)	(373.2)	(283.3)	(409.1)	(1,151.2)	(290.2)	(337.3)	(662.99)
Per capita farm income(1000 UGX)	468.41	980.18	741.40	775.61	688.97	798.92	814.09	772.33
	(610.91)	(8,865.0)	(3,769.9)	(6,326.1)	(3,638.3)	(2,147.6)	(3,797.2)	(3,089.3)
Total remittance received (1000 UGX)	228.03	87.10	142.83	140.81	254.53	129.15	165.70	173.53
	(1,111.9)	(255.3)	(655.04)	(698.23)	(871.91)	(490.45)	(918.05)	(734.27)
Land holding in hectares	3.99	2.70	1.98	2.87	3.08	2.54	2.52	2.69
	(10.89)	(5.03)	(2.55)	(6.84)	(5.47)	(4.35)	(9.98)	(6.56)
Value of total assets (1000 UGX)	1,897.33	910.59	637.04	1,113.30	2,321.21	1,386.85	643.77	1,452.37
	(3,102.2)	(1,501.2)	(1,095.6)	(2,064.9)	(4,688.7)	(4,012.4)	(1,354.2)	(3,789.2)
Years of schooling of household head	7.17	5.22	4.53	5.58	6.66	5.39	4.32	5.46
	(4.19)	(3.75)	(3.42)	(3.93)	(4.49)	(4.13)	(4.15)	(4.32)
Age in years of household Head	52.65	52.15	54.72	52.96	55.56	53.82	57.77	55.33
	(13.16)	(13.65)	(15.08)	(13.93)	(16.45)	(12.45)	(17.66)	(15.17)
Household Size	12.35	11.40	9.88	11.27	13.06	11.88	10.23	12.11
	(4.72)	(4.73)	(4.50)	(4.75)	(7.16)	(7.28)	(5.97)	(6.99)
1 if adopted chemical fertilizer	0.25	0.11	0.13	0.16	0.15	0.13	0.22	0.16
	(0.44)	(0.32)	(0.34)	(0.36)	(0.36)	(0.34)	(0.42)	(0.37)
Chemical fertilizer application(Kg/hec)	2.76	1.65	2.57	2.20	2.96	2.49	2.93	2.73
	(20.72)	(10.12)	(12.08)	(14.31)	(18.41)	(12.32)	(13.39)	(14.52)
1 if adopted HYV seed	0.46	0.33	0.30	0.36	0.40	0.28	0.24	0.30
	(0.50)	(0.47)	(0.46)	(0.48)	(0.49)	(0.45)	(0.43)	(0.46)
Expenditure on seeds(1000 UGX/hec)	53.77	35.34	65.14	48.27	71.43	135.02	99.70	108.31
	(423.15)	(242.33)	(404.52)	(345.74)	(659.49)	(844.66)	(478.88)	(717.18)
Expenditure on chemical fertilizer (1000 UGX/hec)	6.30	5.81	7.85	6.48	6.34	16.33	5.72	10.88
	(39.80)	(40.53)	(45.62)	(41.68)	(31.85)	(142.83)	(28.03)	(100.36)
Expenditure on hired labor(1000 UGX/hec)	44.95	36.69	35.27	38.63	52.26	46.95	27.23	43.56
	(85.63)	(81.93)	(69.96)	(80.07)	(101.91)	(133.68)	(67.26)	(111.86)
Number of households	217.00	360.00	204.00	781.00	217.00	360.00	204.00	781.00

Note:Computed by author from RePEAT 2012 and 2015. 1$=2557UGX & 1$=2857UGX in 2012 & 2015 respectively(Bank of Uganda)
2) Standard errors are reported in parenthesis
3)Monetary values are in 1000 UGX

Table 4.2: Plot level summary statistics by crop type and Mobile money adoption status

	Maize			Banana		
	Non-adopters	**Adopters**	**All**	**Non-adopters**	**Adopters**	**All**
Yield per hectare	1,741.13	2,190.05	1,862.44	2,550.19	2,612.62	2,572.42
	(3,335.8)	(3,951.7)	(3,517.6)	(5,686.1)	(5,552.4)	(5,638.3)
Chemical fertilizer expenditure	66.45	21.56	54.32	0.9	1.82	1.42
	(145.3)	(109.3)	(138.0)	(0.119)	(1.81)	(1.50)
Chemical fertilizer application(Kg/hec)	7.40	3.30	6.32	0.23	1.02	0.51
	(48.46)	(36.46)	(46.01)	(3.47)	(14.31)	(8.99)
Plot size in hectares	0.30	0.42	0.33	0.38	0.38	0.38
	(0.33)	(0.39)	(0.35)	(0.50)	(0.65)	(0.56)
Expenditure on seed per hectare	25.206	46.586	30.984	2.830	2.505	2.729
	(73.925)	(158.452)	(104.184)	(3.176)	(4.052)	(3.558)
1 if used improved seed	0.32	0.34	0.33	0.00	0.00	0.00
	(0.47)	(0.45)	(0.46)	(0.00)	(0.07)	(0.04)
Gross income per hectare	605.130	1,107.324	740.840	1,732.054	2,048.645	1,845.106
	(967.997)	(1,922.970)	(1,315.877)	(1,004.936)	(1,046.732)	(1,030.822)
Number of plots	1,650.00	611.00	2,261.00	2,798.00	1,547.00	4,345.00

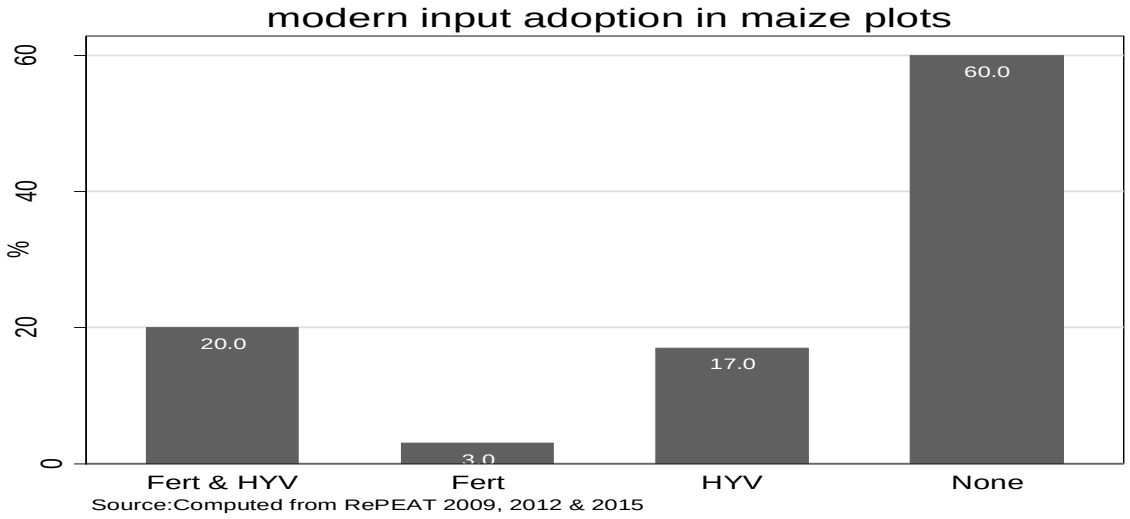
Notes

1)Summary statistics are computed from a pool sample of maize and banana plots reported in ReEAT 2009, 2012 & 2015

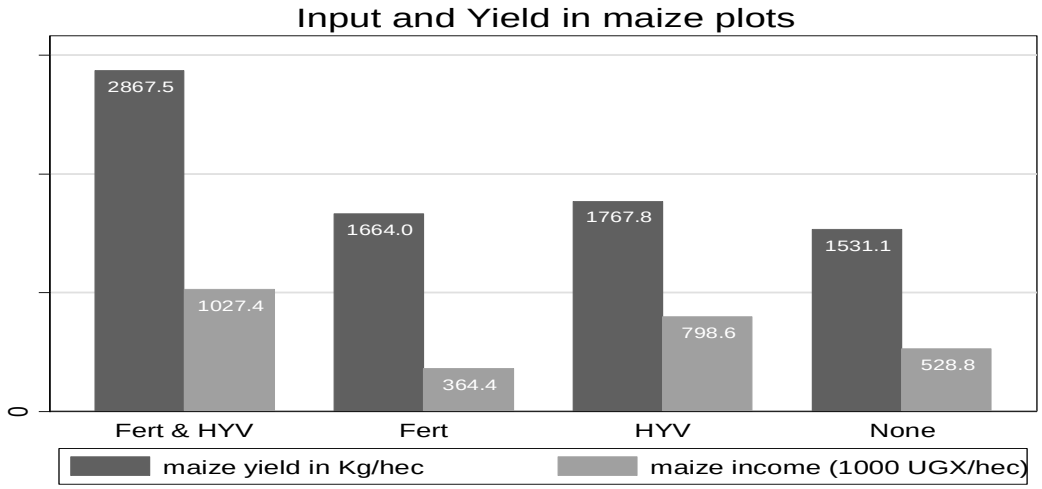
2) Gross income is computed as value of production less expenditure on seed, hired labor, chemical fertilizer and pesticide

3)Maize plots are stand alone plots while banana plots are intercropped

4)Standard errors are in parenthesis



Source:Computed from RePEAT 2009, 2012 & 2015



Source:Computed from RePEAT 2009, 2012 & 2015

Table 4.3: Determinants of Mobile money adoption(Panel data)

	OLS	Fixed effects
Variables	Dep variable: mobile money adoption=1	
log of distance to mm agent	-0.0238***	-0.0186***
	(0.0042)	(0.0046)
1 if head is female	-0.00509	0.00237
	(0.027)	(0.070)
Head's years of schooling	0.00895***	0.0178**
	(0.0028)	(0.0078)
Head's age in years	-0.00235***	-0.00257
	(0.0008)	(0.001)
Log of household size	0.105***	0.208**
	(0.030)	(0.095)
log of distance to district town	0.0279*	0.0392
	(0.014)	(0.056)
log of distance to market	-0.00912	0.0106
	(0.011)	(0.018)
log of population density	-0.0292**	-0.0283
	(0.014)	(0.020)
log value of asset holding	0.0722***	0.0653***
	(0.009)	(0.016)
log of land holding	-0.022	-0.0676**
	(0.015)	(0.033)
Constant	-0.436**	-0.613
	(0.166)	(0.415)
Observations	1,562	1,562
R-squared	0.368	0.402
District by time	YES	YES
Number of households	781	781
Household FE		YES

1) Community clustered errors in parenthesis

Table 4.4: Mobile money, farm and non-farm income (Panel data)

	OLS				Fixed effects			
VARIABLES	income	farm income	Nonfarm inc	Nonfarm inc+rem	income	farm income	Nonfarminc	Nonfarm inc+rem
1 if mobile money adopted	0.146**	0.110*	0.0344	0.188*	0.203***	0.229***	0.133	0.277*
	(0.068)	(0.058)	(0.082)	(0.1)	(0.072)	(0.060)	(0.12)	(0.149)
1 if own mobile phone	0.0153	-0.0219	0.0779	0.358**	0.193*	0.134	0.121	0.434**
	(0.089)	(0.087)	(0.09)	(0.143)	(0.107)	(0.101)	(0.123)	(0.191)
1 if Head is female	-0.0156	-0.104	-0.0318	-0.0631	-0.0981	-0.00476	-0.0849	0.266
	(0.068)	(0.077)	(0.061)	(0.109)	(0.186)	(0.165)	(0.155)	(0.22)
Head's years of schooling	0.0190***	0.0112	-0.00986	0.0222*	-0.0022	-0.00814	-0.0407**	0.00932
	(0.00624)	(0.00689)	(0.00821)	(0.0123)	(0.0131)	(0.0111)	(0.017)	(0.025)
Head's age in years	0.000301	0.00138	0.000547	-0.00689**	0.00467	0.00337	0.00285	-0.00008
	(0.0016)	(0.0018)	(0.0016)	(0.002)	(0.002)	(0.003)	(0.0066)	(0.004)
log value of total assets	0.192***	0.0590**	0.0126	0.0333	0.126***	0.053	-0.0757*	-0.0241
	(0.035)	(0.028)	(0.022)	(0.035)	(0.0436)	(0.0366)	(0.0388)	(0.0639)
Soil quality	1.812*	1.842*	0.294	0.738				
	(1.055)	(1.044)	(1.087)	(1.437)				
Land holding	0.348***	0.393***	0.0616	0.0956**	0.209*	0.422***	-0.0937	-0.0793
	(0.0382)	(0.0436)	(0.0429)	(0.0475)	(0.12)	(0.064)	(0.069)	(0.114)
1 if own improved cattle	0.173**	-0.059	0.257***	0.245*	0.227*	-0.0325	0.340**	0.424**
	(0.0749)	(0.090)	(0.0821)	(0.127)	(0.119)	(0.106)	(0.135)	(0.195)
log of distance to district town	0.000415	0.0697*	-0.171**	-0.246***	0.0558	-0.0175	0.163	0.0261
	(0.0299)	(0.0404)	(0.0721)	(0.08)	(0.0732)	(0.0932)	(0.212)	(0.175)
log of distance to market	0.0285	0.0291	0.0877	0.0621	-0.0307	0.00572	0.157*	0.0681
	(0.024)	(0.026)	(0.053)	(0.0493)	(0.0329)	(0.0347)	(0.092)	(0.097)
log of population density	0.0182	-0.0068	0.0487	0.167***	0.0265	0.00676	-0.00263	0.175***
	(0.025)	(0.024)	(0.040)	(0.042)	(0.018)	(0.019)	(0.060)	(0.064)
Constant	3.719***	5.008***	5.417***	4.022***	3.974***	4.835***	5.878***	3.092***
	(0.592)	(0.494)	(0.581)	(0.65)	(0.71)	(0.579)	(0.966)	(1.084)
Observations	1,549	1,549	1,549	1,535	1,549	1,549	1,549	1,535
R-squared	0.355	0.311	0.186	0.238	0.258	0.261	0.25	0.239
District by time	YES	YES	YES	YES	YES	YES	YES	YES
Number of Households					781	781	781	780
Household FE					YES	YES	YES	YES

1)Community clustered standard errors in parenthesis 2)Additional controls include; number of men, women and children in the household

Table 4.5: Mobile money and disaggregated farm income (Panel data)

	OLS			Fixed effects		
VARIABLES	Crop income	Livestock Income	Farm wage income	Crop income	Livestock income	Farm wage income
1 if mobile money adopted	0.100*	0.0482	-0.0169	0.230***	-0.0177	-0.0746
	(0.058)	(0.078)	(0.041)	(0.061)	(0.117)	(0.0505)
1 if own mobile phone	-0.0139	0.0981	0.0054	0.145	0.0887	-0.0348
	(0.088)	(0.125)	(0.028)	(0.103)	(0.162)	(0.036)
1 if Head is female	-0.106	0.0614	-0.00708	-0.00212	-0.161	-0.0602*
	(0.078)	(0.114)	(0.027)	(0.168)	(0.29)	(0.0313)
Head's years of schooling	0.0125*	-0.0133	0.00399	-0.00934	-0.0509*	0.0124
	(0.0069)	(0.010)	(0.002)	(0.0111)	(0.026)	(0.009)
Head's age in years	0.000678	-0.000215	0.000745	0.00311	0.000174	-0.00033
	(0.0010	(0.002)	(0.0006)	(0.003)	(0.0064)	(0.0014)
log value of total assets	0.0615**	0.133***	0.00637	0.0474	-0.0301	0.00977
	(0.027)	(0.036)	(0.009)	(0.037)	(0.054)	(0.009)
Soil quality	1.743*	1.175	0.964			
	(1.026)	(2.02)	(0.623)			
Land holding	0.376***	0.158**	-0.0628**	0.409***	0.147	-0.0302
	(0.043)	(0.061)	(0.030)	(0.064)	(0.156)	(0.036)
1 if own improved cattle	-0.0537	0.662***	-0.112**	-0.0141	0.493**	-0.0271
	(0.090)	(0.148)	(0.048)	(0.106)	(0.199)	(0.020)
log of distance to district town	0.0699*	-0.175**	0.0505	-0.0165	-0.348***	0.0703*
	(0.040)	(0.076)	(0.038)	(0.096)	(0.127)	(0.036)
log of distance to market	0.0314	-0.0364	-0.0214	0.00412	0.035	0.0198
	(0.026)	(0.05)	(0.013)	(0.0347)	(0.074)	(0.027)
log of population density	-0.00896	0.0665**	0.0146	0.0106	0.0635	-0.012
	(0.024)	(0.031)	(0.01)	(0.019)	(0.051)	(0.023)
Constant	5.093***	2.682***	3.447***	4.924***	4.665***	3.682***
	(0.479)	(0.7)	(0.267)	(0.584)	(0.969)	(0.197)
Observations	1,549	1,549	1,549	1,549	1,549	1,549
R-squared	0.314	0.268	0.227	0.268	0.171	0.485
District by time	YES	YES	YES	YES	YES	YES
Number of Households				781	781	781
Household FE				YES	YES	YES

1)Community clustered standard errors in parenthesis 2) Additional controls include the number of men, women and children in the household

Table 4.6: Mobile money and modern input adoption(Panel data)

	OLS			Fixed effects		
VARIABLES	1 if adopted fertilizer	1 if adopted HYV	1 if adopted HYV & fertilizer[46]	1 if adopted fertilizer	1 if adopted HYV	1 if adopted HYV & fertilizer
1 if mobile money adopted	0.0522***	0.0796***	0.115***	0.0563***	0.00145	0.181*
	(0.0187)	(0.0284)	(0.0404)	(0.020)	(0.034)	(0.096)
1 if own mobile phone	0.0594*	0.0143	0.0677	0.0922**	0.0012	0.0242
	(0.03)	(0.043)	(0.053)	(0.041)	(0.044)	(0.081)
MEN	-0.00486	-0.00576	-0.00993	0.0000935	0.0143	0.0683***
	(0.003)	(0.005)	(0.008)	(0.0102)	(0.0139)	(0.022)
WOMEN	0.00735*	0.0106**	0.0169**	0.000132	0.00639	-0.0279
	(0.0042)	(0.005)	(0.008)	(0.009)	(0.0087)	(0.0276)
CHILD	0.00642	0.00425	0.0212	-0.00105	0.0121	0.00438
	(0.0075)	(0.009)	(0.014)	(0.0143)	(0.018)	(0.044)
1 if Head is female	-0.0543**	-0.0188	-0.0226	-0.130**	0.0139	-0.161
	(0.023)	(0.036)	(0.054)	(0.053)	(0.072)	(0.154)
Head's years of schooling	0.00233	0.00914***	0.000663	-0.00618	0.00432	-0.00687
	(0.0023)	(0.0031)	(0.0050)	(0.0053)	(0.006)	(0.0097)
Head's age in years	0.0000849	-0.00222***	-0.00073	0.000617	-0.00353	-0.00233
	(0.0008)	(0.0007)	(0.001)	(0.0019)	(0.002)	(0.002)
log value of total assets	0.00354	0.0272**	0.00824	-0.01	0.00523	0.00855
	(0.009)	(0.0124)	(0.012)	(0.016)	(0.02)	(0.036)
Soil quality	0.557	0.0146	0.205			
	(0.576)	(0.492)	(0.984)			
Land holding	0.0208*	0.0505***	0.0211	0.014	0.0311	0.0114
	(0.011)	(0.014)	(0.024)	(0.029)	(0.039)	(0.061)
1 if own improved cattle	-0.000174	-0.00289	-0.00018	0.000203	-0.0012	0.0058
	(0.0009)	(0.002)	(0.0056)	(0.001)	(0.004)	(0.019)
log of distance to district town	-0.000924	0.000921	-0.00709*	-0.00047	-0.00349	-0.0191*
	(0.0013)	(0.0017)	(0.0037)	(0.0015)	(0.0025)	(0.0112)
log of distance to market	-0.0027	-0.00867*	0.0162	-0.00241	0.00511	-0.00445
	(0.0047)	(0.0045)	(0.0129)	(0.005)	(0.009)	(0.0217)
log of population density	-0.0086	-0.00283	-0.0114	-0.00926	-0.018	-0.043
	(0.009)	(0.01)	(0.020)	(0.007)	(0.011)	(0.030)
Constant	-0.192	-0.306	-0.112	0.235	0.478	0.461
	(0.189)	(0.219)	(0.323)	(0.234)	(0.304)	(0.53)
Observations	1,533	1,521	579	1,533	1,521	579
R-squared	0.245	0.256	0.298	0.083	0.109	0.179
District by time	YES	YES	YES	YES	YES	YES
Number of Households				781	781	419
Household FE				YES	YES	YES

1)Community clustered standard errors in parenthesis

[46] The estimation sample for columns (3) & (6) comprises of households which have adopted at least fertilizer or HYV seeds. It indicates that mobile money adoption increases the likelihood of a household adopting both modern inputs conditional on household adopting one of them.

Table 4.7: Distance to mobile money agent and disaggregated household income

VARIABLES	Income	farm income	non-farm income	non-farm income+rem	crop income	Livestock income	farm wage income
Log of distnace in Km to mobile money agen	-0.0322*	-0.101**	0.0296	-0.138**	-0.104**	0.0261	-0.0129
	(0.016)	(0.040)	(0.054)	(0.063)	(0.041)	(0.046)	(0.016)
1 if own mobile phone	0.221**	0.139	0.16	0.437**	0.15	0.0956	-0.055
	(0.106)	(0.099)	(0.126)	(0.185)	(0.102)	(0.158)	(0.046)
1 if Head is female	-0.102	-0.0228	-0.0775	0.242	-0.0207	-0.156	-0.0636**
	(0.185)	(0.165)	(0.153)	(0.22)	(0.167)	(0.293)	(0.030)
Head's years of schooling	0.000826	-0.00615	-0.0376**	0.0117	-0.00741	-0.0506*	0.0107
	(0.013)	(0.011)	(0.0179)	(0.025)	(0.011)	(0.025)	(0.008)
Head's age in years	0.00406	0.0023	0.00274	-0.00132	0.00202	0.000361	-0.000246
	(0.002)	(0.003)	(0.006)	(0.004)	(0.002)	(0.006)	(0.001)
log value of total assets	0.140***	0.0630*	-0.0632	-0.0129	0.0572	-0.0295	0.00304
	(0.04)	(0.03)	(0.041)	(0.06)	(0.03)	(0.053)	(0.008)
Land holding	0.194	0.399***	-0.0979	-0.113	0.385***	0.151	-0.0275
	(0.12)	(0.061)	(0.068)	(0.115)	(0.06)	(0.155)	(0.03)
1 if own improved cattle	0.242**	0.00803	0.331**	0.472**	0.0275	0.483**	-0.0234
	(0.12)	(0.106)	(0.137)	(0.183)	(0.106)	(0.197)	(0.02)
log of distance to district town	0.0763	0.0296	0.158	0.0902	0.0317	-0.358***	0.0719*
	(0.07)	(0.07)	(0.209)	(0.188)	(0.077)	(0.132)	(0.0374)
log of distance to market	-0.03	0.00949	0.155*	0.0749	0.00802	0.0338	0.0207
	(0.032)	(0.034)	(0.092)	(0.097)	(0.034)	(0.07)	(0.027)
log of population density	0.0208	-0.00917	0.00103	0.155**	-0.00569	0.0674	-0.0135
	(0.01)	(0.01)	(0.05)	(0.06)	(0.018)	(0.05)	(0.02)
Constant	3.870***	4.973***	5.699***	3.211***	5.069***	4.550***	3.779***
	(0.722)	(0.6)	(0.98)	(1.023)	(0.60)	(0.985)	(0.164)
Observations	1,549	1,549	1,549	1,535	1,549	1,549	1,549
R-squared	0.252	0.27	0.249	0.245	0.277	0.172	0.481
District by time	YES	YES	YES	YES	YES	YES	YES
Number of Households	781	781	781	780	781	781	781
Household FE	YES	YES	YES	YES	YES	YES	YES

1) Community clustered standard errors in parenthesis 2)Additional controls include number of men, women and children in the household

Table 4.8: Mobile money and disaggregated household income (Main estimation. Panel data)

	Fixed effect-IV				Tobit-CF			
VARIABLES	Income	farm income	non-farm income	non-farm income+ rem	income	farm income	non-farm income	non-farm income+ rem
1 if adopted mobile money	0.36	0.133***	-0.33	1.582***	0.439**	0.509**	0.0948	2.040***
	(0.292)	(0.33)	(0.369)	(0.563)	(0.214)	(0.21)	(0.238)	(0.339)
First stage residual					-0.308	-0.398*	-0.0501	-2.005***
					(0.224)	(0.219)	(0.25)	(0.355)
1 if own mobile phone	0.162	-0.0473	0.214	0.176	0.0601	0.0302	0.0687	0.364***
	(0.119)	(0.121)	(0.153)	(0.219)	(0.0795)	(0.077)	(0.088)	(0.124)
Constant					3.884***	5.178***	5.447***	4.805***
					(0.411)	(0.418)	(0.434)	(0.616)
Observations	1,536	1,536	1,536	1,510	1,549	1,549	1,549	1,535
R-squared	0.253	0.087	0.224	0.127				
F-statistics	56.33	56.33	56.33	56.33				
Endogeneity test statistics	8.829	8.62	1.79	6.63				
District by time	YES	YES	YES	YES	YES	YES	YES	YES
Number of Households	768	768	768	755	781	781	781	780
Household FE	YES	YES	YES	YES				

1)First stage results are not reporter due to limited space. 2)Community clustered standard errors are reported in parenthesis 3)Additional controls include; Number of men, women & children in the household, household head's gender, age & years of schooling. Distance in time from homestead to plot, plot altitude, & a binary indicator of plot ownership. Community population density, distance to district town and market. 3)*** p<0.01, ** p<0.05, * p<0.

Table 4.9: Mobile money and disaggregated Farm income (Main estimation. Panel data)

	Fixed effect-IV			Tobit-CF		
VARIABLES	Crop income	Livestock income	Farm wage income	Crop income	Livestock income	Farm wage
1 if mobile money adopter	0.164***	-0.292	0.144*	0.522**	-0.412	0.404***
	(0.339)	(0.441)	(0.0875)	(0.211)	(0.34)	(0.090)
First stage residual				-0.420*	0.493	-0.466***
				(0.221)	(0.356)	(0.094)
1 if own mobile phone	-0.0423	0.144	-0.0788*	0.0398	0.0919	0.00198
	(0.122)	(0.181)	(0.0405)	(0.078)	(0.125)	(0.033)
Head's years of schooling	-0.0266*	-0.0458*	0.00832	0.00133	-0.00385	-0.00408
	(0.015)	(0.025)	(0.006)	(0.007)	(0.0118)	(0.0033)
Head's age in years	0.0051	-0.000413	0.000137	0.0019	-0.00159	0.00194**
	(0.00378)	(0.0076)	(0.0016)	(0.002)	(0.0029)	(0.0008)
log value of total assets	-0.0246	-0.00894	-0.00711	0.0256	0.171***	-0.0268**
	(0.0517)	(0.063)	(0.0182)	(0.0269)	(0.041)	(0.011)
Land holding	0.460***	0.132	-0.0182	0.362***	0.424***	0.0598
	(0.074)	(0.144)	(0.0320	(0.0350	(0.0350)	(0.037)
log of distance to district town	-0.0562	-0.336**	0.0610***	0.0436	-0.160***	0.0601***
	(0.086)	(0.132)	(0.0139)	(0.035)	(0.0523)	(0.0156)
log of distance to market	0.00799	0.0338	0.0207**	0.0236	-0.0278	-0.0217*
	(0.0387)	(0.057)	(0.0095)	(0.0264)	(0.041)	(0.011)
log of population density	0.0153	0.0622	-0.0109	0.0000544	0.0606*	0.0181**
	(0.0316)	(0.0499)	(0.0086)	(0.020)	(0.0317)	(0.0086)
Constant				5.278***	2.443***	3.629***
				(0.422)	(0.616)	(0.177)
Observations	1,536	1,536	1,536	1,549	1,549	1,549
R-squared	0.084	0.166	0.436			
F-statistics	56.33	56.33	56.33			
Endogeneity test statistics	8.829	0.421	6.249			
District by time	YES	YES	YES	YES	YES	YES
Number of Households	768	768	768	781	781	781
Household FE	YES	YES	YES			

1)First stage results are not reporter due to limited space. 2)Community clustered standard errors are reported in parenthesis 3)Additional controls include; Number of men, women & children in the household, household head's age & years of schooling. Households' assets and land holding as well as a measure of soil quality. Community population density, distance to district town and market. 4)*** p<0.01, ** p<0.05, * p<0.

Table 4.10: Mobile money and modern input adoption(Maize plot level analysis)

	OLS			FE		
VARIABLES	1 if adopted fertilizer	1 if adopted HYV	1 if adopted fertilizer &HYV[47]	1 if adopted fertilizer	1 if adopted HYV	1 if adopted fertilizer &HYV
1 if mobile money adopter	0.0698**	0.0523**	0.0526***	0.0991***	0.0579***	0.0396***
	(0.027)	(0.021)	(0.014)	(0.014)	(0.0205)	(0.013)
1 if own mobile phone	0.0347	-0.021	0.0281*	0.0432**	0.0154	0.0359**
	(0.036)	(0.031)	(0.015)	(0.018)	(0.025)	(0.0164)
1 if maize plot	-0.00233	0.265***	0.0842***	-0.0105	0.261***	0.0848***
	(0.0123)	(0.0183)	(0.0115)	(0.007)	(0.0133)	(0.00794)
1 if first season	0.0109*	0.0536***	0.0181***	0.000825	0.0576***	0.0160***
	(0.006)	(0.009)	(0.006)	(0.005)	(0.009)	(0.0061)
1 if plot is intercropped	-0.000217	-0.0139	-0.0152*	-0.0112	-0.0359***	-0.0130*
	(0.01)	(0.014)	(0.007)	(0.008)	(0.012)	(0.007)
Time in minutes from homestead to plot	-0.000126	0.000186	-0.0001	0.000086	-0.000279	0.000133
	(0.0002)	(0.0002)	(0.0001)	(0.00013)	(0.0002)	(0.0001)
Soil quality	0.942*	0.882***	0.15	2.658**	2.454*	
	(0.531)	(0.285)	(0.262)	(1.095)	(1.297)	
Log of distance in Km to maket	-0.00281	-0.0076	-0.00292	-0.00989	-0.00349	-0.00743
	(0.011)	(0.008)	(0.005)	(0.006)	(0.009)	(0.006)
Log of distance in Km to district town	-0.0126	-0.00638	-0.00874	-0.0195	-0.00966	-0.000507
	(0.016)	(0.012)	(0.007)	(0.012)	(0.016)	(0.008)
Log of population density	-0.0104	-0.00656	-0.00535	-0.00769*	0.000682	-0.00892*
	(0.0103)	(0.006)	(0.004)	(0.004)	(0.007)	(0.004)
Constant	-0.671***	-0.527***	-0.199*	-0.112	-0.178	-0.141
	(0.247)	(0.162)	(0.107)	(0.107)	(0.176)	(0.105)
Observations	4920	4920	4523	4920	4,920	4,523
R-squared	0.288	0.251	0.144	0.763	0.502	0.431
District by time	YES	YES	YES	YES	YES	YES
Household FE				YES	YES	YES

Notes: Additional controls include household and plot level characteristics as listed under Table 4.11

[47] The estimation sample for columns 3 & 6 comprises of plots on which at least fertilizer or HYV seeds were used. It indicates that mobile money adoption increases the likelihood of a household adopting both modern inputs in maize and beans plots conditional on household adopting one of them.

Table 4.11: Mobile money, input use and gross income(Maize plot level analysis)

	OLS					FE				
VARIABLES	Exp hired lab	Exp seeds	Exp fertilizer	Yield	Gross income	Exp hired lab	Exp seeds	Exp fertilizer	Yield	Gross income
1 if mobile money adopter	0.0477	-0.344	0.520***	0.143**	0.251***	0.176	-0.219	0.396***	0.182**	0.272***
	(0.27)	(0.29)	(0.15)	(0.06)	(0.079)	(0.25)	(0.266)	(0.123)	(0.072)	(0.103)
1 if own mobile phone	0.554	0.0383	0.271*	0.0321	-0.134	0.276	0.565*	0.307**	0.066	-0.18
	(0.34)	(0.378)	(0.147)	(0.092)	90.113)	(0.323)	(0.34)	(0.143)	(0.102)	(0.157)
1 if maize plot	1.225***	0.996***	0.931***	0.644***	-0.0569	1.154***	0.905***	0.924***	0.624***	-0.054
	(0.178)	(0.20)	(0.124)	(0.047)	(0.066)	(0.152)	(0.156)	(0.085)	(0.046)	(0.06)
1 if first season	0.539***	0.702***	0.192***	-0.000547	-0.05	0.523***	0.698***	0.173***	-0.00078	-0.0325
	(0.119)	(0.12)	(0.066)	(0.03)	(0.046)	(0.124)	(0.126)	(0.062)	(0.036)	(0.05)
1 if plot is intercropped	-0.0366	0.3	-0.181**	-0.123***	0.0348	0.0596	0.441***	-0.135	-0.0822*	0.143*
	(0.177)	(0.191)	(0.084)	(0.047)	(0.062)	(0.158)	(0.168)	(0.082)	(0.048)	(0.074)
Soil quality	8.550*	7.147	1.57E+00	2.922***	2.321*					
	(5.076)	(4.812)	(2.336)	(1.108)	(1.33)					
Observations	4920	4920	4920	4,920	4,484	4,920	4,920	4,920	4920	4484
R-squared	0.108	0.141	0.151	0.111	0.056	0.425	0.452	0.441	0.344	0.293
District by time	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Household FE						YES	YES	YES	YES	YES

Notes

1)Estimation sample comprises of a pool sample of maize and beans plots reported in RePEAT 2012 & 2015

2) Gross income is computed as value of production less expenditure on seed, hired labor, chemical fertilizer and pesticide. Additional controls include; Number of men, women & children in the household, household head's gender, age & years of schooling. Distance in time from homestead to plot, plot altitude, & a binary indicator of plot ownership. 4) Community clustered errors are in parenthesis.

Table 4.12: Mobile money, input use and gross income(banana plots)

	OLS				FE			
VARIABLES	Exp hired labor	Exp fertilizer	Yield	Gross income	Exp hired labor	Exp fertilizer	Yield	Gross income
1 if mobile money adopter	-0.253	0.943***	-0.0401	0.14	-0.789**	0.329	0.209	0.435
	(0.369)	(0.328)	(0.127)	(0.218)	(0.351)	(0.264)	(0.162)	(0.33)
1 if own mobile phone	-0.179	0.157	-0.0718	-0.0659	0.0757	-0.516	0.17	1.306**
	(0.389)	(0.758)	(0.185)	(0.432)	(0.474)	(0.352)	(0.212)	(0.535)
1 if first season	0.429***	-0.0337	0.112*	-0.0001	0.380**	-0.0138	0.131*	0.105
	(0.134)	(0.0363)	(0.0611)	(0.137)	(0.16)	(0.109)	(0.068)	(0.147)
1 if plot is intercropped	7.207***	0.301	-0.400**	-0.156	6.876***	0.277	-0.263	-0.564
	(0.356)	(0.405)	(0.159)	(0.395)	(0.336)	(0.198)	90.162)	(0.447)
Log of population density	0.213***	-0.0531	0.0242	0.0724*	0.318***	-0.169**	-0.0456	0.0719
	(0.079)	(0.129)	(0.023)	(0.039)	(0.112)	(0.078)	(0.053)	(0.128)
Constant	-2.053	-9.555**	6.172***	10.33***	-5.32	-0.504	5.324***	9.885***
	(2.48)	(3.952)	(0.921)	(1.817)	(3.308)	(2.474)	(1.209)	(2.24)
Observations	2837	2836	2837	1,540	2,837	2,836	2,837	1,540
R-squared	0.304	0.285	0.167	0.17	0.557	0.736	0.453	0.564
District by time	YES	YES	YES	YES	YES	YES	YES	YES
Household FE					YES	YES	YES	YES

Notes

1)Estimation sample comprises of a pool sample of banana plots reported in RePEAT 2012 & 2015. 2)Additional controls include; Number of men, women & children in the household, household head's gender, age & years of schooling. Distance in time from homestead to plot, plot altitude, & a binary indicator of plot ownership. Community population density, distance to district town and market. 3)Community clustered errors are in parenthesis.

Table 4.13: Mobile money and market participation(Panel data)

	MAIZE		BANANA	
VARIABLES	1 if participated in market	Proportion of sales	1 if participated in market	Proportion of sales
1 if mobile money adopter	-0.00662	0.0456	0.00442	-0.0227
	(0.0366)	(0.121)	(0.042)	(0.032)
1 if own mobile phone	0.0505	-0.253	0.179***	0.162***
	(0.047)	(0.185)	(0.062)	(0.047)
MEN	-0.00087	0.00199	-0.00707	-0.00655
	(0.012)	(0.032)	(0.016)	(0.012)
WOMEN	-0.00208	-0.0368	0.00741	0.00374
	(0.008)	(0.033)	(0.012)	(0.009)
CHILD	0.00549	0.102	0.0155	0.0028
	(0.018)	(0.08)	(0.023)	(0.017)
1 if Head is female	0.00322	-0.0223	0.0763	0.0695
	(0.086)	(0.087)	(0.089)	(0.065)
Head's years of schooling	-0.00658	-0.0182	0.0123	0.0033
	(0.0076)	(0.026)	(0.0077)	(0.0058)
Head's age in years	-0.00115	-0.0178	0.00201	0.000838
	(0.001)	(0.011)	(0.003)	(0.002)
log value of total assets	0.0051	0.0815*	0.0208	0.00795
	(0.0203)	(0.043)	(0.026)	(0.020)
Land holding	0.125***	-0.13	0.0395	0.0161
	(0.036)	(0.145)	(0.044)	(0.035)
log of distance to market	0.00483	0.0342	0.0168	-0.0356*
	(0.020)	(0.023)	(0.025)	(0.0191)
log of distance to district town	0.0281	-0.0906	0.02	-0.00421
	(0.033)	(0.074)	(0.042)	(0.031)
log of population density	0.0347***	-0.0182	-0.0229	-0.0177
	(0.010)	(0.050)	(0.016)	(0.012)
Constant	0.276	1.108	-0.167	-0.0655
	(0.302)	(0.997)	(0.42)	(0.319)
Observations	1,470	1,466	1,071	1,029
R-squared	0.093	0.089	0.16	0.142
District by time	YES	YES	YES	YES
Number of households	775	773	621	608
Household FE	YES	YES	YES	YES

Notes

1)*** p<0.01, ** p<0.05, * p<0.1 2)Community clustered standard errors are in parenthesis

Table 4.14A: Mobile money and Income(Robustness check. Panel data)

	OLS			RE		
	Income	Farm income	Crop income	Income	Farm income	Crop income
1 if mobile money adopter	0.0492	-0.0899	-0.0434	0.0492	-0.0883	-0.0417
	(0.066)	(0.057)	(0.056)	(0.065)	(0.064)	(0.065)
Constant	1.313**	2.793***	3.272***	1.303***	2.596***	3.118***
	(0.519)	(0.541)	(0.53)	(0.443)	(0.427)	(0.431)
Observations	1,243	1,243	1,243	1,243	1,243	1,243
R-squared	0.411	0.392	0.387			
District by time	YES	YES	YES	YES	YES	YES
Number of Household				636	636	636

1)Panel household from RePEAT 2003 & 2005
3)Additional controls include: Household head's age, gender and education, land and asset holding, household size, population size of the community and distance to district town
2)Community clustered standard errors in parenthesis
3)*** p<0.01, ** p<0.05, *p<0.1

Table 4.14B: Mobile money and Input use (Robustness check.Panel data)

	OLS			RE		
	Labor cost	Fertilizer cost	Seed cost	Labor cost	Fertilizer cost	Seed cost
1 if mobile money adopter	-0.0091	0.04	0.131	-0.0741	0.0355	0.127
	(0.368)	(0.053)	(0.16)	(0.698)	(0.076)	(0.141)
Constant	-7.478**	5.046***	3.312***	-17.13***	5.118***	3.528***
	(2.911)	(0.584)	(0.917)	(4.785)	(0.504)	(0.974)
Observations	1,243	1,243	1,243	1,243	1,243	1,243
R-squared	0.281	0.216	0.261			
District by time	YES	YES	YES	YES	YES	YES
Number of Household				636	636	636

1)Panel household from RePEAT 2003 & 2005
3)Additional controls include: Household head's age, gender and education, land and asset holding, household size, population size of the community and distance to district town
2)Community clustered standard errors in parenthesis 3)*** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1: Propensity score based Difference in differences estimation(Panel data)

Variables	Educ.exp	log Educ exp	Educ.Share
1 if mobile money adopter	70.41***	0.396***	0.134***
	(11.48)	(0.046)	(0.014)
1 if mobile phone owned	-9.797	-0.0436	0.00326
	(9.532)	(0.038)	(0.011)
1 if household(hh) head is female	2.611	0.0766	0.000793
	(15.86)	(0.0645)	(0.019)
Years of schooling of household head	-1.83	0.00386	-0.00143
	(1.897)	(0.007)	(0.002)
log household size	-54.29**	-0.182*	-0.0364
	(25.5)	(0.104)	(0.031)
log of size of landholding in acre	1.51	0.0447**	0.00581
	(5.142)	(0.020)	(0.006)
log of value of assets	4.882	0.0689***	-0.00335
	(3.799)	(0.015)	(0.0047)
Constant	24.06	1.177***	0.180*
	(86.09)	(0.35)	(0.108)
Observations	988	988	988
R-squared	0.257	0.404	0.45
Number of Household	494	494	494
Household FE	YES	YES	YES
District by time	YES	YES	YES

1)Estimation using only RePEAT 2009 and 2015 observations with similar probability of adopting mobile money in 2015 given baseline(2009) characteristics
2)Additional regressors include ;Number of public and private schools in each community, population size of each community, community level average of heads schooling and land holdings,# of boys and girls
3)Robust standard errors in parentheses
4)Community clustered errors in parenthesis
5)Significance level *** p<0.01, **
p<0.05,*p<0.1
6)Outcome variables are in 1000 UGX

Table A2: Mobile Money and Educational Investment(FE-IV estimation)

VARIABLES	Educ Exp	Log of Educ Exp	Educ share
1 if Mobile money adopter	87.56	3.585	0.508
	(225.4)	(2.25)	(0.332)
Observations	2,133	2,133	2,133
R-squared	0.192	0.454	0.498
F-statistics	2.54	2.54	2.54
Number of hhdid	711	711	711
Household FE	YES	YES	YES
District by time	YES	YES	YES

Notes

1)Natural log of distance to secondary school is used as an instrument for Mobile money.

2)Average distance to secondary school is 14.1, 11.6 & 7.7 Km for 2009, 2012 & 2015 respectively

2)Additional regressors include ;Household head's age, gender and years of schooling. Household demographic characteristics, land and asset holding and a binary indicator of mobile phone ownership,Number of public and private schools in each community, population size of each community,community level average of heads schooling and land holdings

3)community clustered errors in parentheses

4)Significance level *** p<0.01, ** p<0.05, * p<0.1

Table A3: Mobile money and School choice(Multinomial logit estimation)

Reference category: Public School=1		
VARIABLES	1 if not schooling	1 if attending private school
1 if mobile money adopter	-0.306	0.753***
	(0.201)	(0.152)
1 if own mobile phone	-0.302*	0.326**
	(0.163)	(0.136)
Number of Private School	0.0492	0.0913
	(0.115)	(0.088)
Number of Public School	-0.322**	-0.481***
	(0.132)	(0.106)
Observations	2,922	2,922
District by time	YES	YES
BIRTH YEAR FE	YES	YES

Notes

1)Estimation is done using a pooled sample of children aged 5-16

2)Additional regressors include ; An indicator of orphan hood , first child , gender, age, log of land, asset and household size, population of each community, community level average of heads schooling ,# of boys and girls

3)Community clustered standard errors in parentheses

3)Significance level *** p<0.01, ** p<0.05, * p<0.1

Table A4: Mobile money and disaggregated Farm income(Propensity based Estimations-Panel data)

VARIABLES	Income	Farm income	Non farm income	Crop income	Livestock income	Farm wage income
1 if mobile money adopted	0.197*	0.166*	0.0362	0.169*	-0.0179	-0.0541
	(0.105)	(0.087)	(0.049)	(0.088)	(0.174)	(0.043)
1 if own mobile phone	0.0336	0.0377	0.0792	0.0529	0.113	-0.0505
	(0.156)	(0.136)	(0.069)	(0.138)	(0.209)	(0.054)
MEN	-0.0539	-0.0719**	0.0144	-0.0778**	-0.061	0.0120*
	(0.036)	(0.030)	(0.016)	(0.029)	(0.049)	(0.006)
WOMEN	-0.0421*	-0.0483**	0.0249*	-0.0481**	0.0747*	0.00368
	(0.024)	(0.018)	(0.012)	(0.018)	(0.040)	(0.006)
CHILD	0.0478	-0.03	-0.0101	0.0505	-0.0229	0.0114
	(0.047)	(0.041)	(0.022)	(0.042)	(0.080)	(0.011)
1 if Head is female	-0.162	-0.15	-0.168*	-0.148	-0.216	-0.0242
	(0.24)	(0.22)	(0.09)	(0.228)	(0.348)	(0.065)
Head's years of schooling	0.00831	-0.00707	0.0136	-0.00725	-0.0514	0.00668
	(0.020)	(0.015)	(0.008)	(0.015)	(0.037)	(0.008)
Head's age in years	0.00425	0.000531	-0.0013	0.000499	0.00695	-0.00015
	(0.003)	(0.003)	(0.0015)	(0.003)	(0.006)	(0.001)
log value of total assets	0.138***	0.00729	0.0426**	0.00223	-0.0248	0.00714
	(0.052)	(0.044)	(0.016)	(0.045)	(0.066)	(0.006)
Land holding	0.300**	0.467***	-0.029	0.453***	0.0611	-0.0518
	(0.13)	(0.088)	(0.051)	(0.086)	(0.163)	(0.042)
1 if own improved cattle	0.193	0.0188	0.0725	0.0451	0.37	-0.0764**
	(0.148)	(0.126)	(0.085)	(0.128)	(0.259)	(0.033)
log of distance to district town	0.235***	0.0273	0.0277	0.0369	-0.344**	0.0434
	(0.049)	(0.097)	(0.04)	(0.098)	(0.135)	(0.03)
log of distance to market	0.00516	0.012	-0.0196	0.0103	-0.0524	0.0247
	(0.037)	(0.039)	(0.018)	(0.039)	(0.090)	(0.031)
log of population density	0.0311*	0.00916	0.0350**	0.00926	0.0394	-0.0155
	(0.015)	(0.031)	(0.017)	(0.030)	(0.083)	(0.024)
Constant	3.118***	5.519***	-0.661**	5.570***	3.722***	3.827***
	(0.805)	(0.647)	(0.288)	(0.655)	(1.126)	(0.213)
Observations	976	976	976	976	976	976
R-squared	0.321	0.28	0.232	0.288	0.186	0.525
District by time	YES	YES	YES	YES	YES	YES
Number of Households	494	494	494	494	494	494
Household FE	YES	YES	YES	YES	YES	YES

1)Sample comprises of households with similar probability of adopting mobile money in 2015 given their baseline(2009) characteristics

2)Community clustered standard errors in parenthesis

Table A5: Correlates of Attrition

	Dep Variable : Attrition=1 if Household attrited in 2012 and/or 2015	
	OLS	PROBIT
1 if owns mobile phone	0.0151	0.0167
	(0.025)	(0.025)
Head's years of schooling	0.00344	0.00369
	(0.003)	(0.002)
1 if female headed	0.0534	0.0607
	(0.038)	(0.039)
Head's age in years	-0.00696	-0.00666
	(0.005)	(0.005)
Head's age in years(squared)	6.94E-05	6.66E-05
	(5.31E-0)	(4.69E-0)
Land holding in acres	0.0158	0.0164
	(0.022)	(0.023)
log of Household size	-0.0309	-0.0301
	(0.023)	(0.026)
Log value of total asset	-7.226	-7.577
	(13.44)	(13.98)
Community population size	-0.000282	-0.000338
	(0.000281)	(0.000324)
Community Avg of Head's years of Schooling	0.0181**	0.0199**
	(0.0085)	(0.0094)
Average land holding in Community	0.00555	0.00514
	(0.0046)	(0.0049)
Constant	45.12	
	-83.52	
Observations	912	912
R-squared	0.35	0.37

Notes: Estimation samples are drawn from RePEAT. Out of the 912 Households sampled in 2009, 128 households attrited by 2015.

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