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Mobile Money, Perception about Cash, and Financial Inclusion

Learning from Uganda's Micro-Level Data

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Mobile Money, Perception about Cash, and Financial Inclusion: Learning from Uganda's Micro-Level Data

Prepared by Félix F. Simione, Tara Muehlschlegel*

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ABSTRACT: Will mobile money render cash less dominant over time in Africa? Can it promote financial inclusion? We shed light on these questions by exploring individual-level and nationally representative survey data for Uganda, a country in a region that pioneered mobile money in the world. We use the Propensity Score Matching method to robustly compare mobile money users and non-users across a range of indicators that capture individuals' perceptions about cash, and the extent to which they remit, save, and borrow money. We present the first evidence that mobile money users, compared to non-users, are more likely to perceive cash as risky and less likely to prefer carrying large amounts of cash. We also confirm that mobile money users are more likely to receive and send remittances, save, and borrow. They also save and borrow larger amounts.

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Keywords:	Developing Country; Innovation; Digital Divide
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WORKING PAPERS

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1. Introduction

The debate about the future of cash has recently intensified as technology innovations in the financial sector accelerate digital payments and creation of new, digital forms of money. Several countries have embraced initiatives towards cashless or cash-light payments. In Sub-Saharan Africa (SSA), mobile money transactions have dominated the list of digital payment innovations. These innovations hold the potential to alter individuals' behavior towards cash. In fact, some neuroscience research shows that consumers' purchase intentions and pleasure differ with regards to whether they make cash or mobile payments (Ma et al., 2021; Runnemark et al., 2015). On the other hand, there is widespread expectation that digital payment innovations, such as mobile money, will help foster financial inclusion, particularly in developing countries. Will digital money lead to declining preference for cash? Will it help promote financial inclusion? We explore these questions with focus on mobile money adoption in Uganda.

Two characteristics make Uganda a relevant case study. First, Uganda is in the East Africa region, which pioneered the mobile money revolution in the world. Second, the country has registered a steady growth in the penetration of mobile money since its inception in 2009 (Figure 1). As a result, the value of mobile money transactions accounted for 94 percent of GDP in 2021, one of the highest penetration rates in Africa (Figure 2).

Figure 1. Uganda: Value of mobile money transactions

(Percent of GDP), 2009-2021

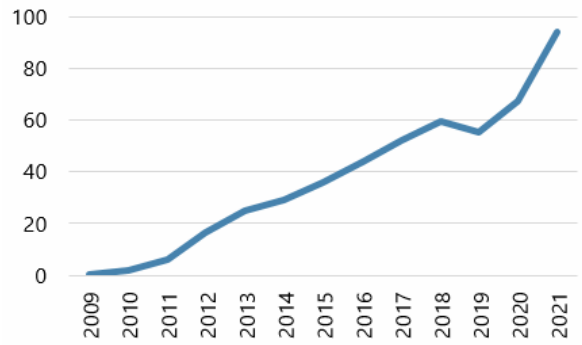
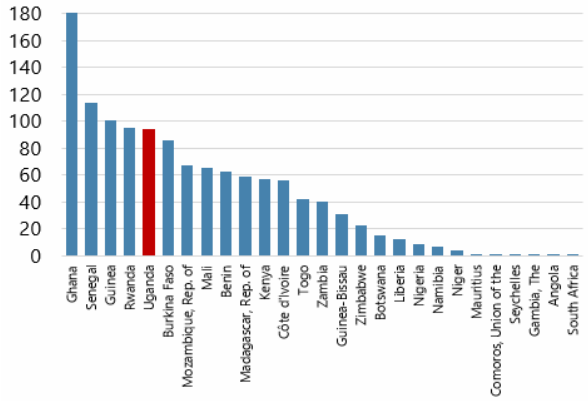


Figure 2. Sub-Saharan Africa: Value of mobile money transactions

(Percent of GDP), 2021



Source: IMF Financial Access Survey

Some hypotheses suggest that digital innovations will render cash less dominant in financial transactions over time on grounds that cash is "dirty" (i.e., prone to illegal activities), heavy, expensive, unsafe, and obsolete, while digital payments are regarded as "clean", traceable, safe, technologically advanced, cheap, and convenient (Drehmann et al., 2002). It should be noted that digital payment systems also entail risks related to privacy, consumer protection, fraud, network failure, and others (Levitin, 2018). On the other hand, there is emerging but inconclusive evidence suggesting that digital payments strengthen the effectiveness of monetary policy by increasing its transmission to retail interest rates (Erel at al., 2023) or to mobile money deposit balances as one study found in Uganda (Mawejje and Lakuma, 2019).

While some studies acknowledge ongoing substitution away from cash, they have shown skepticism to the end of cash hypothesis. For example, Drehmann et al (2002), exploring a sample of developed countries, find that the expansion of credit and debit card usage reduced cash usage by little, and that the substitution effect was limited partly because the availability of ATMs made cash more attractive. They further argue that, due to bad behavior such as illegal activities often paid for in cash, cash may not disappear at all.

Another study by Humphrey (2004) concludes that, while credit and debit cards replaced some cash in the United States, cash is not projected to disappear anytime soon. It also finds that, although the expansion of ATMs has made it easier to obtain cash, the even greater expansion of card terminals at the point of sale are the driving force behind the replacement of cash by cards during the 1990s. Along the same line, Bech and Faruqui (2018), using cross-country data for advanced and emerging market economies, find that despite increased use of electronic payments, there is little evidence of substitution away from cash. Other researchers found stronger evidence of substitution, however more accentuated for low denomination notes and coins than for high denomination ones, suggesting that high denomination notes are used for non-transactional purposes such as store of value (eg. Amromin and Chakravorti 2007). Similarly, Tarlin (2021) finds that, while the use of cash as a medium of exchange has declined, currency in circulation has remained steady, suggesting continued demand for cash as a store of value.

Other recent research is less hesitant about the declining role of cash. For example, in his *The Future of Money* book released in 2021, Eswar Prasad foresees that it is just a matter of time before cash recedes in importance and digital payment technologies take over. Along the same line, Brunnermeier et al. (2021) argue that cash could disappear, and payments could center around digital platforms rather than banks' credit provision.

Most of the studies referred to earlier focus on advanced economies. Evidence from SSA remains scant, although the region leads the world in terms of adoption of mobile money. It is therefore important to understand to what extent the unprecedented expansion of mobile money in SSA has led to, or could potentially lead to, a declining use of cash.

With regards to the impact of mobile money on financial inclusion, there are considerable studies focusing on Africa. Most assess the impact of mobile money on consumption smoothing, remittances, risk sharing, savings, and financial inclusion. For example, Jack and Suri (2014), exploring household survey data in Kenya, find that shocks reduce consumption by 7 percent for non-users of mobile money, while consumption is unaffected for users. They show that the positive consumption effects for users are driven by increases in remittances received and the diversity of senders. Similar findings are reported for Uganda by Munyegera and Matsumoto (2014) using household and community surveys. Abiona and Koppensteiner (2018) also find similar results for Tanzania. They find that, during shocks, households using mobile money are able to smooth consumption and maintain their investments in human capital.

Other studies have focused on the impact of mobile money on access to finance, productivity, and investment. Okello et al. (2018), using household data from Uganda, find that mobile money positively impacts financial inclusion, and that the effect is reinforced by social networks. Ky et al. (2018), exploring individual-level survey data from Burkina Faso, find that mobile money usage seems to increase the propensity of individuals to save for health emergencies. Gosavi (2018), exploring firm-level data in eastern Africa, finds that firms using mobile money are more likely to obtain loans or lines of credit, and are more productive than other firms. An earlier study by Jack and Suri (2013) also finds that mobile money users in Kenya have integrated more fully into the financial system through larger and more frequent financial transactions compared to non-users. Apiors and

Suzuki (2018), using survey data from Ghana, find that that mobile money users are more likely to save higher amounts, invest more in education, microbusinesses, land, and buildings, in addition to consuming more.

We are not aware of any study that investigated the impact of mobile money on perceptions about cash in Africa. This paper undertakes such investigation with application to Uganda. By focusing on Uganda, the paper addresses important gaps in the empirical literature. First, as noted earlier, there is very limited research from SSA on the relationship between digital money and demand for cash (Ahmad et al. 2020). Second, to measure digital money penetration, existing studies in advanced and emerging market economies focus mostly on the usage of debit and credit cards. These are not as relevant in SSA where mobile money dominates. Third, the few studies in SSA that have assessed the impact of financial technology on the demand for cash have addressed the issue from a macro-level perspective (eg. Mlambo and Msosa 2020; Kombe et al. 2020; Mawejje and Lakuma 2019). None has conducted the empirical analysis from a micro-level perspective using survey data. Survey data, in addition to be better suited for studying preferences and behavior, allow for larger samples (comprising over 3,000 individuals in our case) and hence more reliable empirical estimations.

The findings show that mobile money users, compared to non-users, are more likely to perceive cash as risky, and less likely to prefer carrying large amounts of cash. Mobile money users are also more likely to remit and receive money, and they save and borrow more. The estimation methodology used in the paper, robustness analysis, and a falsification test help reduce potential concerns about selection bias and reverse causality.

The remainder of the paper is as follows. Section 2 summarizes the data and the key features of the survey explored in the paper. Section 3 discusses the empirical strategy. Section 4 presents the results. Section 5 discusses the robustness of the estimates, and Section 6 concludes.

2. Data

We use data from the 2018 Uganda FinScope Survey which was commissioned by Financial Sector Deepening Uganda (FSD Uganda). FinScope surveys seek to track trends in financial inclusion and provide related policy insights, and they have been conducted in several countries in Africa and other regions over the last two decades. With some exceptions, the questions in the survey typically require a “yes/no” answer and hence the results should be read as a percentage or number of adult population who have, use or possess a financial product or service or have a particular variable of interest.

FinScope surveys employ a globally accepted and credible process of collecting and analyzing data. The Uganda FinScope survey employed a three-stage stratified sampling approach to arrive at a nationally representative sample of individuals aged 16 years and older (Financial Sector Deepening Uganda, 2018). In the first stage of sampling, geographic representation was ensured by selecting 320 enumeration areas (EAs) using a probability proportional to size, ensuring national, regional, and urban-rural representativeness. In the second stage, 10 households were selected randomly in each EA. In the final stage, one adult (i.e., an individual 16 years or older) was selected randomly from each of the selected households to be interviewed.

As recommended by the survey developers, our empirical estimates discussed later take explicitly into account the structure of the survey design by using the appropriate individual weights provided with the dataset.[1] This

[1] As our empirical analysis is conducted in Stata, the svyset command is employed to account for the survey design.

ensures that our findings can be interpreted as nationally representative of the Ugandan adult population estimated at 18.6 million at the time. Previous FinScope surveys for Uganda were conducted in 2006, 2009 and 2013. We use the 2018 survey because, in addition to being the most recent, it introduced questions on key variables—mobile money usage, perceptions about cash—that are among the key subjects of this paper.

2.1 Descriptive statistics

Table 1 provides a summary of the data focusing on relevant variables for this paper.

Mobile money usage. Our measure of mobile money adoption builds on the following yes/no survey question: "have you used mobile money in the past 12 months?" We classify individuals as "mobile money users" if their answer is "yes", regardless of whether they own the mobile phone or not. As reported in Table 1, about 53 percent of the individuals reported to have used mobile money. Of those, the majority (44 percent) used mobile money less than once a month, 17 percent used it once a week, and 3.2 percent used it daily.

Perception about physical cash. Our measure of perception about cash builds on related yes/no opinions about two statements in the survey: (1) "cash is risky"; and (2) "I dislike carrying large amounts of cash". For each of these statements we construct a dummy variable such that it takes the value 1 if the answer is "yes", and 0 otherwise. As shown in Table 1, about 69 percent of respondents perceive cash as riskier than cards and machines, and 73 percent dislikes carrying large amounts of cash.

Background characteristics. We also extract from the survey background characteristics of individuals, including age, gender, marital status, phone ownership, educational attainment, urban/rural location, access to a bank, among others. While not exhaustive, this information allows us to control for important confounders in the econometric estimates discussed later. About 52 percent of the respondents own a mobile phone. Women account for about 54 percent of the respondents. Most respondents have completed primary education (42 percent), while less than 3 percent of the respondents have a university degree. About 76 percent live in rural areas and only about 10 percent reported to have access to a bank account.

Table 1. Mobile Money Adoption-Selected Indicators, Uganda

(The data is described as percent of the sample, unless otherwise indicated)

	Percent of sample	Obvservations
Mobile money adoption and remittances		
Owns mobile phone	51.6	3,002
Used mobile money in the past 12 months	53.2	2,830
Daily*	3.2	
Once a week*	17.4	
Several times a month but not weekly*	26.3	
Less than once a month*	43.5	
Sent remittances in the past 12 months	38.1	2,835
Received remittances in the past 12 months	43.9	2,835
Behavior towards cash		
Prefer to pay in cash because everyone uses cash	82.4	2,716
Cash is riskier than cards and machines	68.8	2,392
Dislikes carrying cash	73.2	2,766
Background characteristics		
Female	53.8	2,999
Age (years, average)	36.0	2,999
Completed secondary education	7.9	2,994
Completed university	2.9	2,994
Completed primary education	42.4	2,994
Married	65.0	3,002
Rural	76.1	3,002
Has access to a bank account	10.4	3,002

*Percent of respondents who used MM in past 12 months.

Source: FinScope Uganda 2018; and authors' calculations.

Table 2 provides similar and further statistics, now contrasting mobile money users to non-users. Ownership of mobile phone is higher among mobile money users (81.8 percent) than among non-users (18.4 percent). While this is not surprising because access to a mobile phone is necessary to use mobile money, it is important to note that individuals are able to use mobile money even without owning a mobile phone.[2] On average, mobile

[2] Phone ownership and mobile money usage are distinct variables. An individual can use mobile money without owning a mobile phone. In Africa, it is not uncommon for individuals to borrow someone else's phone to receive or transfer funds.

money users are about 4 years younger than non-users. They also possess higher educational attainment. For example, the completion of primary and upper secondary schooling is higher among mobile money users (62.3 and 15.1 percent) than among non-users (22 and 1.1 percent), respectively. There is also a gender and income imbalance. The percentage of women is lower among mobile money users (62.4 percent) than among non-users (69 percent), while average income is much higher for mobile money users than non-users.

Financial behavior and perception about cash also seem sensitive to mobile money usage. The percentage of people who borrow, save, send, and receive money is much higher among mobile money users than among non-users. The percentage of people who prefer to make payments in cash is lower among mobile money users than among non-users. Consistently, the percentage of individuals who perceive cash as risky and dislike carrying cash is higher among mobile money users than among non-users. These differences are highly statistically significant as shown by very low p values in the last column of Table 2. However, additional analysis is needed to attribute these differences to mobile money usage. We discuss this in Section 3 where we lay out our empirical strategy.

Table 2. Mobile Money Adoption and Selected Indicators, Uganda

(The data is reported in percent of each subgroup, unless otherwise indicated)

	MM Users (N=1516)	Non-Users (N=1314)	p-value of diff
Background characteristics			
Owns mobile phone	81.8	18.4	0.000***
Age (years, average)	33.7	37.6	0.000***
Completed primary education	62.3	22.0	0.000***
Completed secondary education	15.1	1.1	0.000***
Completed university	5.8	0.0	0.000***
Female	62.4	69.0	0.001***
Married	65.1	62.6	0.172
Rural	60.4	85.5	0.001***
Acess to a bank account	17.7	1.7	0.001***
Annual income (in million Ugandan Shilling)	5.5	1.8	0.000***
Financial behavior			
Borrows money	48.8	35.8	0.000***
Saves money	60.2	39.5	0.000***
Sends money	67.8	5.1	0.000***
Receives money	78.6	6.9	0.000***
Behavior towards cash			
Prefers to pay in cash[1]	81.8	86.1	0.001***
Perceives cash as risky[2]	73.7	63.2	0.000***
Dislikes cash[3]	77.9	68.5	0.000***
Prefers face-to-face banking[4]	75.7	82.3	0.000***

***, ** and * denotes that the difference is statistically significant at 1, 5 and 10 percent level, respectively.

1/ N=1474 for MM users and N=1237 for non-users

2/ N=1363 for MM users and N=1024 for non-users

3/ N=1499 for MM users and N=1262 for non-users

4/ N=1450 for MM users and N=1177 for non-users

2.2 Mobile money, financial inclusion, and retail payment facts in Uganda

This section documents some statistics about mobile money in Uganda as it constitutes an important background for the research questions we explore in the paper. We also provide a macro-level picture on financial inclusion-related variables such as remittances, savings and borrowing in Uganda, given that these are among the key variables on which we assess the impact of mobile money.

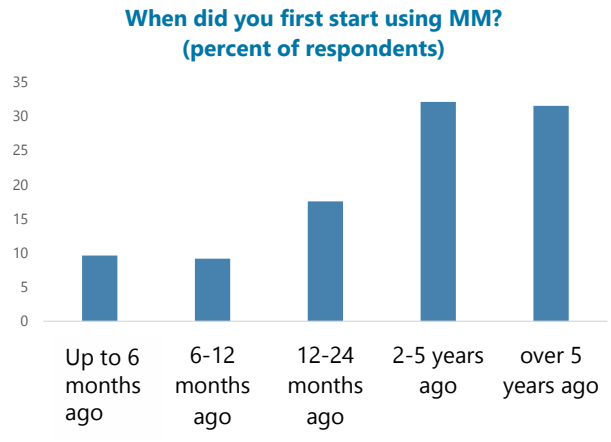
Mobile money in Uganda

Mobile money was introduced in Uganda in 2009 and is regulated by the central bank. Mobile money services are fully provided by private sector operators. As of September 2023, there were at least seven such operators. According to the IMF Survey on CBDC and Digital Payments, mobile money in Uganda is fully backed by bank deposits, and it can be exchanged for legal tender. As of December 2022, there were around 25 million registered mobile accounts in the country.

Some statistics on the rationale behind Ugandans' use of mobile money are reported in the panel charts in Figure 3 based on the Finscope survey. Of the respondents, 81% had been using mobile money for more than a year, which shows that they are familiar with the technology. The main aim to start using mobile money was to send (25.7%) and receive (58.4%) money from others, with the primary objective being to transfer remittances. More than half of the respondents (63.9%) have experienced network failures in the previous 12 months. However, 91% have not experienced any loss of funds. This shows that users trust the innovation to keep their money safe. Interoperability and the high cost of sending money across different mobile money providers are still challenges that are faced by mobile money users. Almost a quarter of respondents (24.4%) indicated that they could not receive money from users of another mobile money network. Additionally, 58.4% of respondents agree that sending money to users from a different network is associated with a higher cost.

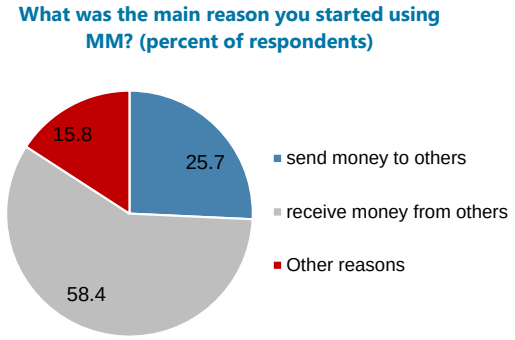
Figure 3. Perceptions about mobile money

Most respondents (81%) had been using mobile money for more than a year.

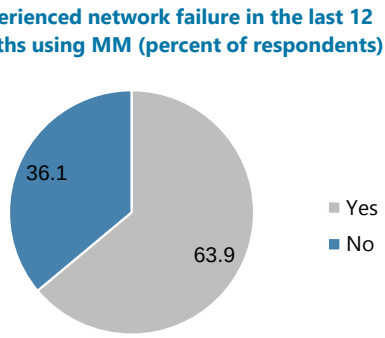


While network failures are still issues faced by mobile money users,

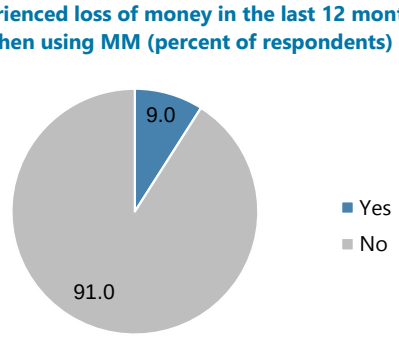
Most adopted it with the aim to receive and send money.



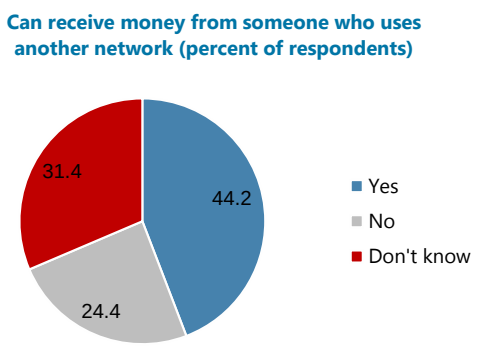
… they report low incidence of money loss.

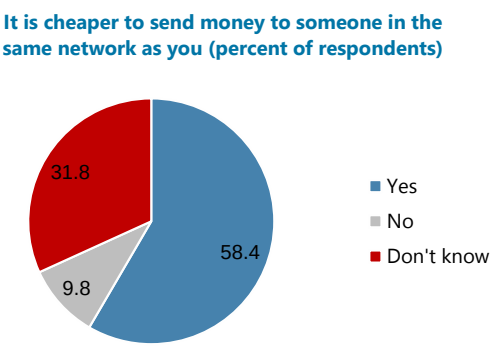


Interoperability is an issue when using mobile money.



Mobile money transactions are much cheaper within the same network.





Source: Finscope Survey, 2018.

Financial inclusion and retail payments in Uganda

The financial inclusion potential of mobile money in Uganda can be seen in the speed at which mobile money has spread relative to other forms of payments. For example, between 2018 and 2022, the number of debit and credit cards in Uganda increased by 20 and 25 percent, respectively, while the number of active mobile money accounts increased by 73 percent. As a result, by the end of 2022 the total number of debit and credit cards in the country stood at about 3.1 million and 10 thousand, respectively. As an interesting contrast, the number of active mobile money accounts stood over 25 million.

FinScope data also reveals that mobile money is important in savings and payments attitudes. For example, 23 percent of Ugandan savers save through mobile money compared to 11 percent who do so through traditional banks and over 60 percent through informal mechanisms or by keeping cash at home. Those who save through mobile money are most likely to save once than once a month. However, lending through mobile money is not as popular, accounting for only 2 percent of savers. Regarding payments, although most adult population still use cash to pay for goods and services including groceries and school fees, 28 percent do so through digital payments including mostly mobile money.

Mobile money also appears to be an important alternative to traditional bank accounts, particularly in rural areas. The proportion of individuals who have access to bank accounts is lower in rural areas compared to urban areas. In rural areas 6.6 percent have access to bank accounts, while this is almost four times higher in urban areas, where 22.6 percent of respondents have access to bank accounts (Figure 4). However, almost half of rural respondents (46.8 percent) were mobile money users, compared to 73.4 percent of urban users. This suggests that, while mobile money works as a bank account alternative for both the rural and urban population, this is more significant for rural households for whom access to bank accounts is limited.

Figure 4. Proportion of individuals with access to bank accounts in rural and urban regions

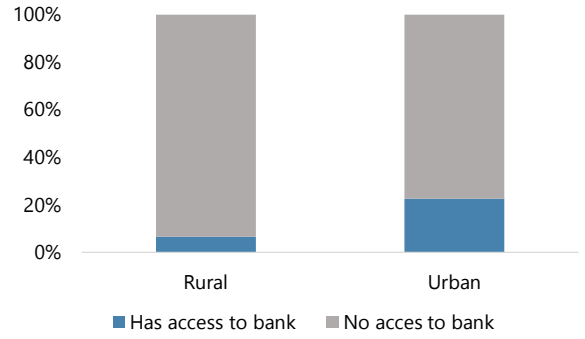
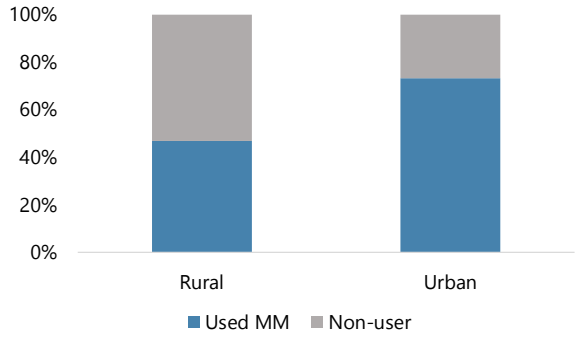


Figure 5. Proportion of mobile money users in rural and urban regions



Source: Finscope Survey, 2018.

Macro-level trends

Macro-level data suggest that mobile money users have been increasingly relying on their mobile accounts to store value. As shown in Figure 6, total outstanding balances on active mobile money accounts in Uganda grew rapidly from 0.07 percent of GDP in 2011 to 0.8 percent of GDP in 2022. Consistent with growing digitalization of payments, including but not limited through mobile money, the use of cash has reduced over time as it can be seen from receding currency in circulation which declined from about 30 percent of M2 in 2001 to around 24 percent in 2010. Following the introduction of mobile money in 2009, currency in circulation was initially volatile, although more recently it has been on a broadly declining path since 2015 (Figure 7).

Figure 6. Uganda: Outstanding balances on active mobile money accounts (Percent of GDP), 2009-2022

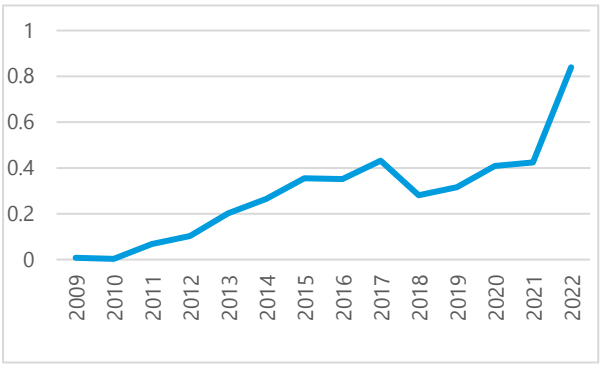
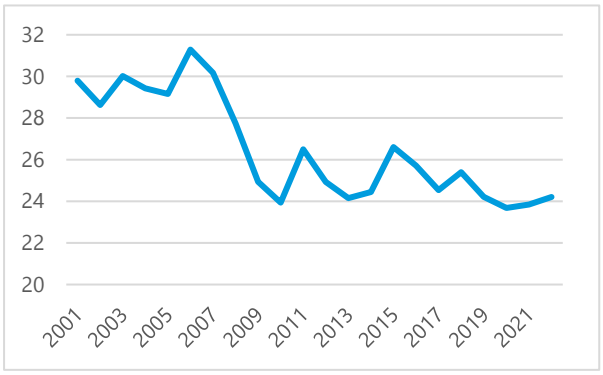


Figure 7. Uganda: Currency in circulation (Percent of M2), 2001-2022



Source: IMF Financial Access Survey (Figure 6) and Bank of Uganda (Figure 7).

Figure 8 shows the evolution of remittances, a variable closely linked to mobile money given that most individuals use it for remittances. Due to lack of better data, we focus on total remittances received in Uganda from abroad, which includes (but it is not limited to) money received through mobile money. Remittances grew from about USD 450 million in 2007 to USD 1.4 billion in 2019 before temporarily declining amid the pandemic. The same upward trend is seen in credit. Both total credit and household credit from commercial banks have increased over time (Figure 9). It is important to note that these trends do not necessarily suggest a causal relationship between the expansion of mobile money and currency in circulation, national remittances and borrowing. Assessing the causal relationship at a micro-level will be the object of the next section.

Figure 8. Uganda: Personal remittances received from abroad (US$ million), 1999-2022

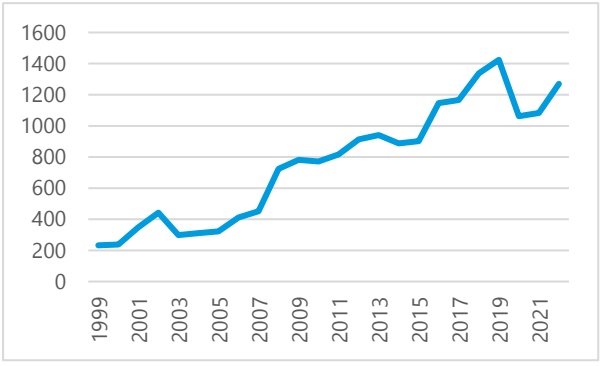
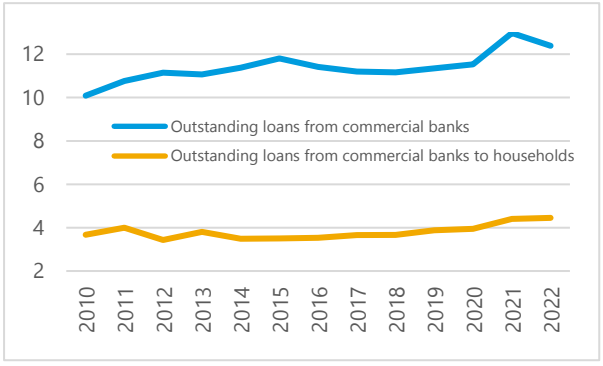


Figure 9. Uganda: Outstanding loans from commercial banks (Percent of GDP), 2010-2022



Source: World Development Indicators (Figure 8) and IMF Financial Access Survey (Figure 9).

3. Empirical Strategy

This section presents our empirical strategy to estimate the impact of mobile money usage on perceptions about cash, and on savings, borrowing and remittances.

3.1 Model specification

We estimate the following equations:

$$PROB\{Y_i = 1\} = \Phi(\alpha_0 + \alpha_1 MM_i + \alpha_2 X_i) \quad (1),$$

$$Z_i = \beta_0 + \beta_1 MM_i + \beta_2 X_i + \varepsilon_i \quad (2),$$

Equation (1) is estimated through a probit regression. Φ is the cumulative distribution function of a standard normal distribution. The dependent dummy variable Y_i captures different attributes in different regressions such that it takes the value 1 if individual i (i) perceives cash as risky, (ii) dislikes carrying cash, (iii) receives remittances, (iv) sends remittances, (v) saves money, and (vi) borrows money, and 0 otherwise. MM is a dummy variable that takes the value 1 if the individual used mobile money in the last 12 months, and 0 otherwise. X is a vector of control variables that includes age, educational attainment, gender, marital status, urban/rural location, access to a bank account and income. The main parameter of interest in Equation (1) is α_1 which gives the average treatment effect of mobile money usage, i.e., the change in the outcome variable caused by mobile money usage.

Equation (2) is estimated by OLS. The dependent variable Z_i is defined in different regressions as the natural log of the actual amount of money a given individual received, sent, saved, and borrowed. The main parameter of interest in Equation (2) is β_1 which gives the average treatment effect of mobile money usage on the outcome variables. ε_i is an error term.

3.2 Addressing endogeneity

The treatment coefficient β in equation (1) cannot be interpreted as a causal effect if the error term ε_i contains unobserved variables that are correlated with both mobile money usage and the outcome variables. This situation is very likely when the assignment of individuals to treatment (mobile money usage in this case) is not random, and this is the case in the survey we explore. In fact, as shown earlier in Table 2, mobile money users are systematically younger, more educated, comprise of more men than women, among other differences that may lead into a selection bias problem. To address this issue, we employ the Propensity Score Matching (PSM) procedure, which helps to reduce selection bias by increasing the sample balance across the covariates. We do this in three steps.

Step 1: PSM design

In line with economic theory, previous studies, and available data, we first condition mobile money usage on observable factors as follows.

$$PROB\{MM_i = 1|X\} = \Phi(\gamma_i + \rho X_i) \quad (3),$$

Equation (3) is the PSM function and is estimated through a probit model. It predicts the probability of selection into mobile money usage (MM) for individual *i* conditioned on the variables in vector X. The conditioning variables are the same controls used in equations (1) and (2).[3] Φ is the cumulative distribution function of a standard normal distribution. The fitted values represent the propensity scores that we use to match mobile money users to non-users in a way that their sample distributions look similar across the conditioning variables.

Step 2: Matching

Once Equation (3) is estimated, mobile money users (i.e., the treatment group) are matched with non-users (i.e., the control group) using the Nearest Neighbor method with a Caliper radius of 0.005, and without replacement (i.e., each observation in the control group is only used once in the matching process). In other words, we choose individuals from the group of non-users of mobile money as matching partners for mobile money users who lie within the caliper (range) and have the closest propensity score. Put differently, the method compares individuals from two groups by imposing a tolerance level of maximum propensity score, which is often referred to as "common support condition". This approach raises the matching quality because it avoids ending up with a very bad match if the nearest neighbor is too far away in terms of propensity score.

Step 3: Balance

Once the matching process is complete, we check that the resulting matched sample is better balanced on covariates compared to the original (unmatched) sample. The paper then uses the matched sample (which arguably looks more random and therefore less likely to entail the selection bias problem) to estimate Equation (1) and Equation (2). This allows the treatment effect of mobile money usage to be estimated with less concerns about endogeneity. While endogeneity could still be a problem if the PSM function in Equation (3) excludes unobservable variables that are correlated with mobile money usage and outcome variables, we conduct a falsification test in Section 5 which reduces this concern.

4. Results

4.1 Sample Balance

Table 3 reports results of the matching exercise. As expected, the differences between treatment and control group individuals are lower in the matched sample than in the original (raw) sample. For example, focusing on the covariate Age, the difference between mobile money users and non-users reduces from 3.6 years to only 0.6 years in the original and matched sample, respectively. In addition, the difference is no longer statistically significant in the matched sample as the higher p-value corroborates. The same is true for all other covariates for which there were significant differences in the raw sample, suggesting that the matched sample is better balanced. The differences in the sample mean between the raw and the matched samples reflect the different composition of the underlying samples. Because of the imposition of the common support condition mentioned earlier, the matched sample discards both mobile money users who are bad matches and non-users who are ultimately dropped in order to balance the sample across the two groups.

The table reports three additional test statistics that are used in the PSM literature to scrutinize the overall balance across covariates. The mean bias was reduced from 35.7 percent in the original sample to 2 percent in

[3] There is an open debate on the method to select conditioning variables. A common advice is to err on the side of including more rather than fewer variables (Stuart, 2010). We include variables based on past studies and common sense, although we are constrained by the scope of the FinScope survey objectives.

the matched sample (below the critical threshold of 5 percent), while the B and R statistics were also reduced to below the thresholds of 25 percent and the range of 0.5-2.0, respectively. This confirms that the matched sample is better balanced than the original across the control variables used in the model, minimizing concerns about selection bias.

Table 3. Test of Balance on Covariates, Uganda

Variable	Sample	MM Users	Non-Users	Difference	S.E	T-stat	p-value	Percent bias
Age	Raw	34.18	37.76	-3.59	0.60	-6.01	0.00	-24.10
	Matched	35.92	36.47	-0.55	0.73	-0.75	0.46	-3.7
Age squared	Raw	1343.86	1694.83	-350.97	52.11	-6.74	0.00	-26.9
	Matched	1496.36	1549.15	-52.79	63.24	-0.83	0.40	-4.0
Secondary educ.	Raw	0.15	0.01	0.14	0.01	12.59	0.00	53.3
	Matched	0.01	0.01	0.00	0.01	-0.73	0.47	-1.4
Female	Raw	0.60	0.67	-0.07	0.02	-3.59	0.00	-14.6
	Matched	0.64	0.63	0.01	0.02	0.42	0.68	2.1
Rural	Raw	0.63	0.86	-0.24	0.02	-13.72	0.00	-56.5
	Matched	0.82	0.82	0.01	0.02	0.26	0.80	1.2
Married	Raw	0.66	0.65	0.02	0.02	0.93	0.36	3.7
	Matched	0.67	0.68	-0.01	0.02	-0.37	0.71	-1.9
Log of income	Raw	14.06	13.17	0.89	0.07	12.07	0.00	49.1
	Matched	13.50	13.52	-0.02	0.09	-0.29	0.78	-1.4
Access to bank	Raw	0.19	0.02	0.17	0.01	13.58	0.00	57.2
	Matched	0.03	0.03	0.00	0.01	0.00	1.00	0.0

Bias diagnostics		
Mean Bias	Raw	35.7
	Matched	2.0
B statistics	Raw	87.6*
	Matched	7.1
R statistics	Raw	4.12*
	Matched	0.92

* if B>25%, R outside [0.5; 2]

As additional evidence of good balance in the matched sample, we also inspect the distributions of propensity scores across mobile money users and non-users both in the original and the matched samples. The distributions are notably unequal in the original sample but look very similar in the matched sample (Figure 6). Furthermore, Figure 7 confirms that the common support condition is met as there is a good overlap in propensity scores across mobile money users and non-users since mobile money users that are bad matches (green bars) are discarded in the matched sample.[4] All this again confirms that the matched sample is better balanced and less prone to the selection bias problem.

[4] As explained earlier, the matched sample discards both mobile money users who are bad matches and non-users who are ultimately dropped in order to balance the sample across the two groups.

Figure 6. Distribution of Propensity Scores

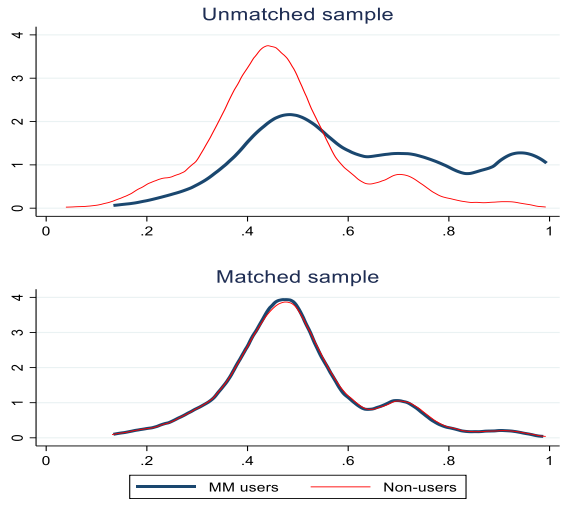
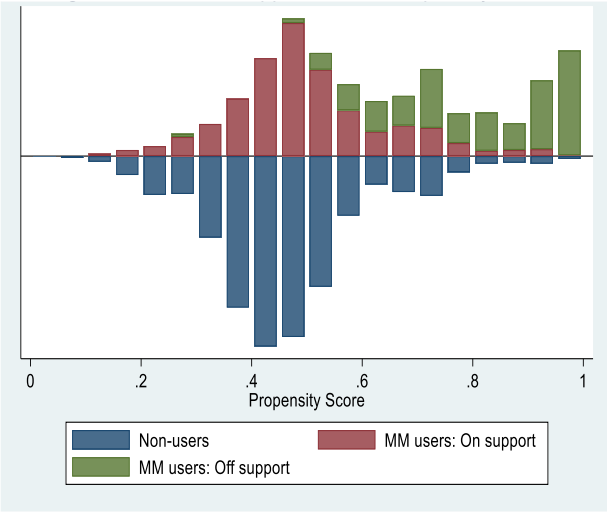


Figure 7. Common Support Area of Propensity Scores



4.2 Determinants of Mobile Money Adoption

This section assesses the probability of an individual being selected into treatment (i.e., the probability of using mobile money), based on the propensity score Equation (3). The results are reported in Table 4. Both age, educational attainment, gender, urban/rural location, income, and access to a bank are significantly associated with mobile money usage. There is non-linearity in the relationship between mobile money usage and age. As individuals get older, they are more likely to adopt mobile money, but up to a certain point when such probability starts declining (as evidenced by the negative coefficient on the square of age "agesq"). Individuals who at least completed upper secondary education are about 1 percentage point more likely to use mobile money than otherwise, while women are 0.2 percentage points less likely to use mobile money compared to men. Individuals living in rural areas are less likely to use mobile money compared to those in urban areas, while higher income and access to a bank account increase the probability of using mobile money.

Table 4. Determinants of Mobile Money Adoption

Dependent variable is a Dummy on Mobile Money User	
Age	0.023**
	(0.009)
Agesq	-0.0003***
	(0.000)
Secondary educ.	0.968***
	(0.163)
Female	-0.176***
	(0.057)
Rural	-0.577***
	(0.068)
Married	0.080
	(0.059)
log of income	0.098***
	(0.015)
Access to bank	0.940***
	(0.130)
Constant	-1.121***
	(0.281)
Pseudo R^2	0.1381
Observations	2467

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively.
Standard errors in brackets

4.3 Impact of Money Usage on Perceptions about Cash

This section assesses the extent to which mobile money usage impacts individuals' perceptions about cash. As discussed earlier, we focus on two statements in the FinScope survey: (i) "cash is risky" and (ii) "I dislike carrying cash". The regression results are reported in Table 5 where measures of perceptions about cash are regressed on mobile money usage, controlling for several variables.

The findings show that mobile money users are about 0.3 percentage points more likely than non-users to perceive cash as risky (column A). Consistently, column B shows that mobile money users are also about 0.3 percentage points more likely than non-users to dislike carrying cash. The associated coefficients are highly statistically significant, although the impact is small as judged by their size. These findings suggest that mobile money usage increases, although to a small extent, users' awareness of risks associated to cash transactions. We attribute this to a presumably higher sense of safety and affordability of conducting transactions with mobile money. Our data does not allow for a direct testing of this proposition. However, the survey analysis in Section 2.2 suggests that, while individuals acknowledge mobile money risks related to limited interoperability and network failure, their sense of safety and affordability of mobile money transactions is much positive.

Table 5. Impact of Mobile Money on Behavior Towards Cash

	(A)	(B)
Dependent variable is a dummy for	"Cash is risky"	"I dislike carrying cash"
Used Mobile Money	**0.286*** **	**0.255*** **
	(0.083)	(0.079)
Age	0.004	-0.001
	(0.015)	(0.013)
Agesq	-0.000	0.000
	(0.000)	(0.000)
Secondary ed.	0.173	0.702
	(0.355)	(0.476)
Female	0.074	0.016
	(0.079)	(0.071)
Rural	-0.049	-0.078
	(0.144)	(0.101)
Married	-0.086	0.032
	(0.091)	(0.077)
log of income	-0.074***	0.001
	(0.024)	(0.022)
Access to bank	0.414*	0.328
	(0.253)	(0.244)
Constant	1.278***	0.453
	(0.437)	(0.392)
Observations	1329	1557

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

4.4 Impact on Financial Inclusion: Remittances, Savings, and Borrowing

This section assesses the impact of mobile money adoption on remittances, savings, and borrowing. On Table 6, we report coefficients from regressions estimating the impact of adopting mobile money on the probability of receiving and sending remittances, and of saving and borrowing money over the previous 12 months. They show that, compared to non-users, mobile money users are 2.4 percentage points more likely to receive remittances (column A), 1.8 percentage points more likely to send remittances (column B), 0.3 percentage

points more likely to have savings (column C), and 0.3 percentage points more likely to borrow (column D). The estimates are highly statistically significant. They suggest that the impact of mobile money usage is much larger on the likelihood to receive and send remittances than on the likelihood to save and borrow. The findings are consistent with the analysis on Section 2.2 where it is shown that receiving and sending remittances are the main reasons why individuals adopt mobile money. While this implies potential two-way causality between mobile money usage and remittances, the estimates hold after controlling for reverse causality as we discuss later in Section 5.

Table 6. Impact of Mobile Money on the Likelihood to Send and Receive Remittances, Save, and Borrow

	(A)	(B)	(C)	(D)
Dependent variable is a dummy for	"I received money"	"I sent money"	"I saved money"	"I borrowed money"
Used Mobile Money	**2.370*** **	**1.795*** **	**0.347*** **	**0.314*** **
	(0.104)	(0.095)	(0.071)	(0.075)
Age	-0.006	0.019	0.027*	0.029**
	(0.016)	(0.015)	(0.014)	(0.013)
Agesq	0.000	-0.000	-0.000*	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Secondary ed.	0.383	0.581**	0.069	-0.182
	(0.596)	(0.290)	(0.362)	(0.334)
Female	0.245***	-0.146*	0.144*	-0.101
	(0.085)	(0.080)	(0.078)	(0.077)
Rural	-0.325**	-0.124	-0.135	0.141
	(0.134)	(0.125)	(0.124)	(0.099)
Married	-0.100	0.057	0.088	0.226***
	(0.100)	(0.090)	(0.079)	(0.082)
log of income	-0.037	0.087**	0.010	0.033
	(0.028)	(0.034)	(0.023)	(0.023)
Access to bank	0.150	0.318	0.491**	0.119
	(0.383)	(0.318)	(0.243)	(0.227)
Constant	-0.982**	-2.927***	-0.737*	-1.303***
	(0.499)	(0.539)	(0.441)	(0.403)
Observations	1582	1582	1582	1582

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

On Table 7, we report the impact of mobile money usage on the actual amounts of remittances received and sent, and money saved and borrowed (denominated in Ugandan currency). The results show that the amount of annual savings and borrowing is, respectively, about 43 percent and 66 percent larger for mobile money users than non-users (columns A and B), and the estimated coefficients are highly statistically significant. However, surprisingly, the impact is not statistically significant on the annual amount of remittances received and sent (columns C and D). This suggests that, although mobile money users are significantly more likely to receive and send money than non-users, they do not necessarily send a larger amount. This deviates from findings in other studies which found a positive impact of mobile money usage on the value of remittances. The insignificant coefficients may also reflect smaller samples given a smaller number of individuals who reported the amount of remittances sent and received, leading to larger standard deviations.

Table 7. Impact of Mobile Money on the Value of Savings, Borrowing, and Remittances

	(A)	(B)	(C)	(D)
Dependent variable is log of total value of	Amount saved	Amount borrowed	Remittances received	Remittances sent
Used Mobile Money	**0.431*** **	**0.655*** **	**0.094**	**-0.106**
	(0.146)	(0.095)	(0.164)	(0.200)
Age	-0.026	0.074***	0.062***	-0.008
	(0.032)	(0.026)	(0.015)	(0.021)
Agesq	0.000	-0.001**	-0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Secondary ed.	0.299	0.079	1.538***	-0.033
	(0.396)	(1.238)	(0.559)	(0.510)
Female	-0.583***	-0.035	-0.294***	-0.065
	(0.161)	(0.104)	(0.102)	(0.111)
Rural	-0.037	0.084	-0.078	-0.026
	(0.174)	(0.162)	(0.164)	(0.194)
Married	-0.010	0.233**	0.048	-0.008
	(0.164)	(0.110)	(0.092)	(0.103)
log of income	0.110*	0.206***	0.134***	0.090***
	(0.057)	(0.038)	(0.028)	(0.031)
Access to bank	-0.457	0.742	0.568	-0.038
	(0.318)	(0.456)	(0.413)	(0.309)
Constant	8.699***	5.831***	7.594***	9.294***
	(1.082)	(0.685)	(0.481)	(0.650)
R^2	0.064	0.174	0.123	0.072
Observations	744	733	586	461

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.

5. Robustness

Our estimation methodology helps reduce endogeneity by balancing the sample of mobile money users and non-users through the PSM technique. However, omitted variable bias could still be an issue if the PSM function excludes conditioning variables that are correlated with both mobile money adoption and the output variables. Furthermore, one could argue that our estimates are simply capturing the fact that, for example, those individuals who are naturally more averse to cash, or those who already send and receive more remittances, are the ones choosing to adopt mobile money. In this case, mobile money adoption would be a consequence, and not a driver, of perceptions about cash and the likelihood to receive and send remittances. We attempt to address these potential concerns by directly controlling for reverse causality and conducting a falsification test.

In Table 8, we compare baseline estimates (columns A and C) with estimates from extended versions (columns B and D) of regressions assessing the impact of mobile money usage on the likelihood to receive and send remittances. In the extended versions, we add a regressor that captures those individuals who adopted mobile money because they wanted to receive remittances (column B) or wanted to send them (column D). By adding these regressors, we potentially account for reverse causality. Nevertheless, the estimated coefficients remain highly statistically significant and are only a little smaller than in the baseline specification.

Table 8. Impact of Mobile Money on Remittances (Reverse Causality Controlled)

	(A)	(B)	(C)	(D)
Dependent variable is a dummy for	"I received money"		"I sent money"	
	Baseline	Reverse causality addressed	Baseline	Reverse causality addressed
Used Mobile Money	**2.370*** **	**1.950*** **	**1.795*** **	**1.598*** **
	(0.104)	(0.124)	(0.095)	(0.102)
"Receive money" was the main reason for adopting mobile money	...	0.805***	...	...
	...	(0.128)	...	...
"Send money" was the main reason for adopting mobile money	...	...	...	0.950***
	...	...	...	(0.136)
Control variables (same in all regressions)	Yes	Yes	Yes	Yes
Observations	1582	1582	1582	1582

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

To further check that are our findings are not biased by omitted confounders, we conduct falsification tests on Table 9, 10 and 11. Specifically, we re-estimate equation (1), but this time using only the sub-sample of non-users of mobile money. Within this sub-sample, we assign some individuals to 'false' treatment. More specifically, we 'falsely' assign as mobile money adopters all individuals for whom the estimated propensity score is above the average, while the remaining individuals are "correctly" assigned as non-users.[5] Intuitively, this means that we assign to treatment certain individuals who, given their characteristics in terms of the conditioning variables (age, education, gender, marital status, income, etc.), would have been expected to adopt mobile money but actually do not. If the estimated coefficient of the 'fake' mobile money usage treatment remains statistically significant, that could be an indication that our baseline findings suffer from bias, given that in reality no one in the sub-sample adopts mobile money. As reported in Table 9, 10 and 11, the coefficients on the 'false' treatment variable are almost in all cases statistically insignificant compared to the baseline. In the only exceptional case (Table 10, column D), the coefficient is much smaller and less statistically significant.

We also check that the insignificant coefficients under the placebo samples in columns 9, 10 and 11 are not driven by smaller sample size. To rule this possibility out, we run the original baseline regressions using a randomly selected sub-sample of about the same size as the placebo samples. The results are shown in columns B and E in Table 9 and 11, and Annex 1 reports equivalent results for Table 10. They all show that the coefficients of interest remain statistically significant as in the original baseline with the larger sample. Although the placebo tests remain a function only of observable variables, which could raise concerns about possible bias, the performed robustness checks overall help reduce major concerns over potential omitted variable bias.

[5] We use the propensity score threshold of 0.55 which is the average in the distribution of the estimated propensity scores. The rationale is that, by design of PSM method, individuals with above-average scores are more likely to fall in the treatment category (i.e., adopt mobile money) than individuals with below-average scores.

Table 9. Impact of Mobile Money on Behavior Towards Cash - Falsification Test

	(A)	(B)	(C)	(D)	(E)	(F)
Dependent variable is a dummy for	"Cash is risky"			"I dislike carrying cash"		
	Baseline		Placebo	Baseline		Placebo
	Original	Smaller sample		Original	Smaller sample	
Used Mobile Money	**0.286*** **	**0.383*** **	**0.060**	**0.255*** **	**0.286*** **	**-0.165**
	(0.083)	(0.106)	(0.243)	(0.079)	(0.098)	(0.188)
Control variables (same in all regressions)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1329	644	640	1557	793	775

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

Table 10. Impact of Mobile Money on the Likelihood to Receive and Send Remittances, Save, and Borrow - Falsification Test

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Dependent variable is a dummy for	"I received money"		"I sent money"		"I saved money"		"I borrowed money"	
	Baseline	Placebo	Baseline	Placebo	Baseline	Placebo	Baseline	Placebo
Used Mobile Money	**2.370*** **	**0.030**	**1.795*** **	**0.574** **	**0.347*** **	**0.089**	**0.314*** **	**-0.171**
	(0.104)	(0.236)	(0.095)	(0.278)	(0.071)	(0.200)	(0.075)	(0.200)
Control variables (same in all regressions)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1582	791	1582	791	1582	791	1582	791

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

Table 11. Impact of Mobile Money on the Value of Savings and Borrowing - Falsification Test

	(A)	(B)	(C)	(D)	(E)	(F)
Dependent variable is log of total value of	Amount saved			Amount borrowed		
	Baseline		Placebo	Baseline		Placebo
	Original	Smaller sample		Original	Smaller sample	
Used Mobile Money	**0.431*** **	**0.306***	**-0.313**	**0.655*** **	**0.690*** **	**0.290**
	(0.146)	(0.184)	(0.407)	(0.095)	(0.143)	(0.272)
Control variables (same in all regressions)	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.064	0.063	0.061	0.174	0.213	0.109
Observations	744	315	326	733	326	322

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.

6. Conclusion and Policy Implications

This paper assesses the impact of mobile money usage on perceptions about cash, and on financial inclusion in Uganda. The findings show that mobile money users, compared to non-users are more likely to perceive cash as risky and less likely to prefer carrying large amounts of cash. To the best of our knowledge, this constitutes the first empirical evidence on the impact of mobile money usage on perceptions about cash in Africa. Thus, the findings contribute to the growing empirical literature on the impact of digitalization of payments on the usage of cash. They corroborate the widespread finding that digitalization of payments has led to reduced role of cash in transactions but to a small extent.

The findings also show that mobile money users are more likely to receive and send remittances, save, and borrow. They also save and borrow larger amounts. These findings are broadly consistent with similar studies in Africa. However, unlike in other studies, we observe no significant difference with regards to amounts of remittances received and sent, an issue that would benefit from follow-up research with more recent FinScope data. The estimates are robust after controlling for potential sources of endogeneity. While there could be some bias because our placebo tests remain a function of observables, we do not expect the bias to be large.

Two implications emerge from the findings. First, the rapid expansion of fintech technologies in Africa, notably in low-income countries, is likely to reduce, although slowly, the demand for and usage of cash over time. It is worth noting that the estimated negative impact of mobile money usage on the willingness to carry cash is not large. This potentially masks differential behaviors from individuals if different functions of cash are considered. We are not able to test this differential response given the limitations of the data. However, we hypothesize that, while the “mean of payment” function of cash, particularly for retail operations, would be gradually overtaken by digital alternatives, the “store of value” function could remain little impacted given the context of African economies. Put differently, issues such as network failure and limited interoperability, as well as lack of reliable electricity, may lead individuals to prefer to store their wealth in the form of cash even if they perceive cash as riskier than mobile money. Follow-up research could help shed light on this.

Second, if mobile money usage promotes higher remittances, savings, and borrowing, a key implication is that the expansion of fintech technologies could help promote financial inclusion in Africa. While mobile money is widespread in Uganda and other African countries, there is significant room to further expand it along with other low-cost digital payment systems, particularly in rural areas where penetration is relatively low. Although mobile money services in Africa are entirely provided by private sector operators, their expansion would benefit from further public investments in foundational infrastructure—such as electricity, mobile networks—that the public sector is well positioned to undertake, or coordinate given the economies of scale involved.

A comprehensive assessment of policy implications would also have to include considerations about the potential impact of mobile money, or more generally digital payments, on the conduct of monetary policy, financial stability, consumer protection, cybersecurity threats, among several other dimensions. These issues are beyond the scope of this paper and would benefit from separate research.

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Annex

Annex 1. Impact of Mobile Money on the Likelihood to Receive and Send Remittances, Save, and Borrow - Smaller random sample

	(A)	(B)	(C)	(D)
Dependent variable is a dummy for	"I received money"	"I sent money"	"I saved money"	"I borrowed money"
Used Mobile Money	**2.346*** **	**1.926*** **	**0.370*** **	**0.393*** **
	(0.141)	(0.145)	(0.101)	(0.101)
Observations	801	801	801	801

***, ** and * denotes statistical significant at 1, 5 and 10 percent level, respectively. Standard errors in brackets.
Pseudo R^2 not available from Stata's "svy: probit" command

PUBLICATIONS

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