Tsukuba Economics Working Papers
No. 2019-002

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by

Askar Ismailov

Albert Benson Kimaro

Hisahiro Naito

November 2019

UNIVERSITY OF TSUKUBA
Graduate School of Humanities and Social Sciences
1-1-1 Tennodai
Tsukuba, Ibaraki 305-8571
JAPAN

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Askar Ismailov *†
Central Bank of The Republic of Uzbekistan
University of Tsukuba

Albert Benson Kimaro *‡
Ministry of Agriculture, Government of Tanzania
University of Tsukuba

Hisahiro Naito *§
Graduate School of Humanities and Social Sciences
University of Tsukuba

November 20, 2019

*This research was conducted while A.I. and A.K. were affiliated with the University of Tsukuba. A.I. appreciates the financial support from the Asian Development Bank; A.K. appreciates the financial support from the Joint Japan World Bank Graduate Scholarship; and H.N. appreciates the support from the university's research fund. The opinions expressed in this paper do not represent the opinions of the Asian Development Bank, the Japanese government, the World Bank, or any organizations with which A.I., A.K., and H.N. are affiliated. The authors are responsible for all remaining errors. The authors appreciate the comments from Yuko Nakano, Zeng Fei, and Mari Minowa.

†Email: asqar.ismailov@gmail.com Address: 6 Islom Karimov Street, Tashkent, Uzbekistan Postal code: 100001

‡Email: albenson10@gmail.com Address: Tanzania Cooperatives Development Commission, 41101 Uhuru Street, P.O Box 201 Dodoma, Tanzania

§Email: naito@dpipe.tsukuba.ac.jp Address: Graduate School of Humanities and Social Sciences, 1-1-1, Tennodai, Tsukuba City, Ibaraki Prefecture Japan Postal Code: 305-8573.

Abstract

This study examines the effect of the use of mobile money services on financial behavior using data from Tanzania. We estimate the causal effect of the use of mobile money on borrowing, receiving remittances, and saving by applying a two-stage least squares estimation using the shortest distance to the border of areas with multiple mobile phone networks, which is a proxy for accessibility to a mobile network, as an instrumental variable. We find that when a household experiences a negative shock, non-users of mobile money increase borrowing, while mobile money users do not. Further, the use of mobile money increases the probability of saving in mobile money savings accounts and of receiving remittances, while it decreases the probability of saving in less liquid assets such as livestock. On the other hand, we find that the effect of the use of mobile money on receiving remittances is the same for those who experience a negative shock and those who do not. This evidence suggests that the use of mobile money increases the receipt of remittances regardless of negative shocks and changes the saving portfolio, allowing a household to prepare for negative shocks. Hence, a household that uses mobile money does not need to increase borrowing in the face of a negative shock. Consistent with this interpretation, the negative shock does not decrease the livelihood of mobile money users, while it does reduce that of non-users.

1 Introduction

In June 2019, Facebook, the largest social network service provider in the world, announced a plan to introduce a cryptocurrency, Libra. Facebook stated that 1.7 billion people do not use banks and that Libra could reach many of them (Facebook, 2019). Although many regulating organizations issued concerns about Libra, any regulation needs to be balanced between its cost and benefit. To those without a bank account, providing access to financial services could change their lives dramatically. For example, in many sub-Saharan African countries, a substantial percentage of households do not use banks, as Facebook recognizes. Lacking a formal bank account makes it difficult for households to save safely and prepare for potential future negative shocks.

However, recent technological developments have started to change the financial access of non-bank users due to the development of mobile money technology. Mobile money allows the holder of a SIM card of a mobile phone to transfer money to another holder with a different SIM card.[1] In addition, mobile money operators often offer a savings account in which customers can save with a reasonable interest rate by depositing money with the nearest mobile money agent.

According to a financial inclusion survey by th World Bank (World Bank, 2014), only 55, 19, and 17 percent of adults have a bank account in Kenya, Tanzania, and Zimbabwe, respectively, whereas 58, 32, and 32 percent of adults already have mobile money accounts. Mobile money has thus proliferated at an accelerated rate. In Tanzania, mobile money was officially introduced in 2008. In 2009, the user rate of mobile money was just 1.1 percent; however, this rose to 49.9 percent in 2013 and 55.8 percent in 2017. The function of mobile money has also expanded. For example, 51 percent of adult household heads in Tanzania have saved in the past 12 months, one-third of which have saved in a mobile money savings account (see also Table 2 in Section 4).

This high speed of market penetration and expanding function of mobile money is attracting the attention of policymakers and researchers for several reasons. First, in developing countries, the lack of access to a safe method of saving can lead to

[1] A mobile money account is attached to a mobile phone SIM card, not the mobile phone itself. In developing countries, each individual often owns a SIM card, but shares a mobile phone with others, especially in rural areas. Hence, even in such cases, it is possible for each individual to hold his or her own mobile money account as long as he or she owns a SIM card.

insufficient saving, which makes it difficult for a household to buffer negative shocks. Hence, the availability of saving methods through mobile money might make it easier to smooth consumption. Second, mobile money operators often partner with traditional banks. As a result, people in developing countries can access traditional banking services through mobile money accounts. Third, to overcome the lack of access to credit in developing countries, which is one of the key problems for households, mobile money operators have started to offer borrowing services. Fourth, given the recently expanding role of mobile money in an economy, governments in developing countries have started to recognize that mobile money transactions are an attractive target for taxation. For example, Kenya, Tanzania, and Uganda, which have developed successful domestic mobile money industries, have started to impose taxes on mobile money transfer fees or transfer amounts (Rukundo, 2017; Ndungu, 2019). In addition, regulators in the financial sector aim to balance the regulation of traditional financial sectors with that in the mobile money industry (Klein and Mayer, 2011; Lal and Sachdev, 2015; Khiaonarong, 2014). To evaluate the economic cost of taxes and regulation on the mobile money industry, it is thus critical to evaluate how mobile money affects economic activity. Fifth, to evaluate the impact of a new financial service such as Libra, the evaluation of the broader impact of mobile money is useful. For these reasons, it is beneficial to study how the use of mobile money affects financial behavior such as borrowing and saving in developing countries.

Theoretically, there are several channels through which the use of mobile money affects borrowing. First, when a household lacks access to a formal financial institution, the availability of borrowing from a mobile money operator might increase borrowing (new source effect) when it experiences a negative shock. Second, on the contrary, if a household already has access to borrowing from a formal financial institution, the use of mobile money allows it to switch the source of that borrowing to a mobile money operator (substitution effect). This, however, would not affect the probability of borrowing. Third, having a mobile money account makes it easy for a household to borrow from relatives or friends in the face of negative shocks because of the low transfer fee, which increases borrowing (connection effect). Fourth, the presence of low-cost money transfers might increase the possibility of households forming mutual insurance groups (Jack and Suri, 2014) (insurance effect). This insurance effect is likely to lower the need for borrowing, although it will increase remittances (Ratha et al., 2003; Yang and Choi, 2007). Fifth, a mobile money user can receive more remittances because of the low cost of transferring money for altruistic reasons (Agarwal and Horowitz, 2002; Vanwey, 2004). Hence, when a household can receive more remittances, the need for borrowing falls (income effect).

Regarding saving behavior, similar arguments hold. The new source effect will increase saving. The substitution effect will not change the total amount of saving but the composition of different saving methods will. The insurance effect will decrease the need for saving. The income effect is likely to increase saving. Thus, from these theoretical points, it is not clear whether the use of mobile money will increase or decrease borrowing and saving.

In this study, we examine the effect of the use of mobile money on financial behavior and show that the use of mobile money mitigates the effect of experiencing negative shocks on households borrowing. We also find that the use of mobile money changes a saving portfolio from less liquid saving to more liquid saving. In addition, the use of mobile money increases the probability of receiving remittances, regardless of experiencing a negative shock. This evidence suggests that the use of mobile money helps households prepare for future negative shocks; hence, users of mobile money do not need to borrow when they experience such shocks. Consistent with this interpretation, we find that a negative shock does not decrease the livelihood of mobile money users, whereas it does reduce that of non-users.

Our study is related to several strands of the literature. Given the rapid increase in mobile money usage, researchers have started to examine its effect on the economy. Aker et al. (2016) and Muralidharan et al. (2016) analyze the role of the secure payment method in Niger and India, respectively. Blumenstock et al. (2015) conduct a randomized experiment to test the effectiveness of using mobile money to pay salaries. Dupas and Robinson (2013a) analyze the role of mobile money as a secure way to deposit daily cash in micro-enterprises in Kenya. Jack and Suri (2014) theoretically show that the development of mobile money decreases the transaction cost of risk sharing and increases the means to absorb a negative income shock on a household through an increase in remittances. Additionally, the authors empirically demonstrate that, in Kenya, a household that uses mobile money does not decrease consumption when faced with a negative income shock. Munyegera and Matsumoto (2016) show that, in Uganda, a mobile money user receives remittances more frequently and has higher real per capita consumption than a non-user. Blumenstock et al. (2016) and Riley (2018) analyze whether mobile money is useful to smooth consumption for households that experience negative shocks. Suri and Jack (2016) analyze the long-run effect of the use of mobile money and find that 2 percent of Kenyan households have moved out of poverty since its availability in the country because of increases in saving and financial resilience.

Second, several studies examine the effect of having a bank account on financial behavior. Burgess and Pande (2005) find that the state-led bank expansion in rural India has reduced poverty. Bruhn and Love (2009) analyze the expansion of a Mexican bank that offered both saving and credit products. They estimate that the new bank opening led to 7 percent higher income for both men and women. Dupas and Robinson (2013b) show that providing a safe place to save increases health-related saving by 60 percent in Kenya. Agarwal et al. (2017) analyze the effect of a large financial inclusion program in India and find that the region exposed to the program now lends more to borrowers. Dupas et al. (2018) analyze the effect of having a bank account on saving using field randomization in three countries, Uganda, Malawi, and Chile. They find no discernible intention-to-treat effects on savings but a large treatment-on-the-treated effect due to the low take-up rate.

To study the effect of the use of mobile money on financial behavior, several considerations are needed. First, using mobile money is a choice variable. A financially distressed household might set up a mobile money account or it might not. This would introduce endogeneity bias. Second, an important variable that is not among the control variables, which might affect the financial decision, could be correlated with mobile money usage. This would lead to omitted variable bias. To treat those problems, in this study, we apply two-stage least squares (2SLS) estimation and use information on the network strength of G2 mobile phone networks as an instrumental variable.

For the instrumental variable, we first map the areas covered by the mobile networks of Vodacom Tanzania and Tigo Mobile, whose market shares for mobile money are 54 percent and 29 percent, respectively. Then, we extract the intersection of the areas covered by the networks of both mobile money operators and calculate the shortest distance from each households location to the border of the intersection of the networks using GPS information on each household location. We use the shortest distance as the instrumental variable.[2]

In addition, to reduce the risk of the bias that comes from omitting important variables, we restrict the sample to the heads of the households who live within ± 10 km of the border of areas with multiple mobile networks. It is likely that households who live within a 20 km bandwidth are relatively homogeneous. To guarantee the exogeneity of the instrumental variable further, we include as control variables observed demographic characteristics, 30 region dummies, and the shortest distance to different types of financial institutions. To control for the difference in economic activity in different areas, we calculate the population density and average intensity of night lights within a 5 km radius of each household and include them as control variables. In the robustness check, we restrict the sample to heads of households who live within ± 7.5 km of the border of areas with multiple mobile networks. We also control for potential heterogeneity by including 170 district dummies in some of the specifications. Our analysis shows that our estimation results are robust to those robustness checks (Section 6).

The organization of the remainder of this paper is as follows. In Section 2, we explain the institutional background in Tanzania. Section 3 explains our main model and identification strategy. Section 4 describes the data and how we code each variable. Section 5 shows the main regression results. In Section 6, we present several robustness checks and demonstrate that our estimation results are robust. Section 7 concludes.

2 Institutional Background in Tanzania

In 2007, mobile network operators were allowed to offer payment services under the amendment to the Bank of Tanzania Act (2006). In 2008, Vodacom Tanzania introduced mobile money services through M-Pesa products, and Tigo Mobile and Airtel introduced Tigo Pesa and Airtel Money in 2009, respectively. In 2010, Zantel introduced Ezy Pesa. By 2015, Vodacom had reached a market share of 54 percent with M-Pesa mobile money services followed by Tigo Pesa, 29 percent, Airtel Money, 13

[2] If a household is located inside the intersection, we assign a negative value to the distance.

percent, and Ezy Pesa, 4 percent.

Regarding the content of the services of those products, the bilateral connections between mobile network operators and bank payment systems have enabled customers to transfer funds between bank accounts and mobile wallets in both directions. More specifically, mobile money users can save to their bank account in three ways. First, those with a smartphone can use mobile money applications (Tigo Pesa, MPESA, HaloPesa, TTCL Pesa) to send to or save money in bank accounts. Second, those with GSM cellular phones can use Unstructured Supplementary Services Data (USSD), which has the option to send to or save money in bank accounts. Third, mobile money users can visit their nearest mobile money agent to save money to their bank accounts. In similar ways, mobile money users can withdraw money from their bank accounts.

Regarding saving, mobile money providers offer safe interest-bearing savings accounts, and these increased the proportion of Tanzanians who saved using mobile financial services by 20 percent from 2011 to 2014. The interest rates of those mobile money operators are generally above the average interest rates provided by banks. A mobile money savings account allows each customer to save up to 3 million TZS or 1,400 USD (World Bank, 2017b).

Regarding borrowing, although borrowing from mobile money operators has become feasible, its size remains small, as we show in the next section. Only 2.5 percent of households borrow from mobile money operators. Among those who borrow from any source, 90 percent borrow from the informal sector. This suggests that the direct effect of the use of mobile money on borrowing from mobile money operators is minor.

3 Model and Identification Strategy

We consider the following model based on previous studies (Jack and Suri, 2014; Munyegera and Matsumoto, 2016):

$$y_i = \beta_0 + \beta_1 \text{Mobile}_i + \gamma x_i + \epsilon_{1i} \tag{1}$$

where y_i is the outcome variable such as the borrowing, saving, or receiving a remittance dummy. If a household borrowed (saved) in the past 12 months, this is equal to one and zero otherwise. For the receiving a remittance dummy, if a household received a remittance in the past 12 months, it is equal to one and zero otherwise. Mobile $_i$ is a dummy variable equal to one if household i uses mobile money. x_i is a vector of the household characteristics such as the education level of the head of the household, age of the household head, household size, and source of income as well as the geographical variables such as the region or district dummy and distance to different types of financial institutions (e.g., commercial banks, community banks, and microfinance institutions). x_i also includes a negative shock dummy since one of the motives of borrowing is experiencing a negative shock. Additionally, x_i includes the mobile phone ownership dummy following the specification used in Jack and Suri (2014) and Munyegera and Matsumoto (2016).[3] Our parameter of interest is β_1.

In addition to equation (1), we estimate the following model as an extension:

$$y_i = \beta_0 + \beta_1 \text{Mobile}_i + \beta_2 \text{Negative}_i + \beta_3 \text{Mobile}_i \times \text{Negative}_i + \gamma x_i + \epsilon_{1i} \tag{2}$$

where Negative_i is a dummy variable indicating whether a household experienced at least one negative shock in the past 12 months. In equation (2), β_2 shows the extent to which experiencing at least one negative shock affects saving, borrowing, or receiving remittances in the past 12 months for those who do not use mobile money. β_3 shows the extent to which experiencing at least one negative shock affects saving, borrowing, or receiving remittances differently for a household that uses mobile money compared with a household that does not use mobile money. β_1 shows the extent to which the use of mobile money affects saving, borrowing, or receiving remittances for those who did not experience a negative shock in the past 12 months.

Using the ordinary least squares (OLS) estimation to estimate equation (1), there are several reasons why the estimated coefficient of β_1 would be inconsistent. First, having a mobile money account is a choice variable. In other words, a household wishing to save might decide to open such an account. In this case, the mobile money

[3] Although the mobile phone ownership dummy is included as a control variable in previous studies of the effect of the use of mobile money on consumption (Jack and Suri, 2014; Munyegera and Matsumoto, 2016), we recognize that this dummy is also an endogenous variable; hence, including it as a control variable would introduce bias in the estimated coefficient of β_1 even when mobile money use is instrumented. We discuss the effect of including the mobile phone ownership dummy on the estimation of β_1 later in this subsection.

dummy and error term ϵ_{1i} would be positively correlated, and estimating (1) using OLS would thus generate upward bias.

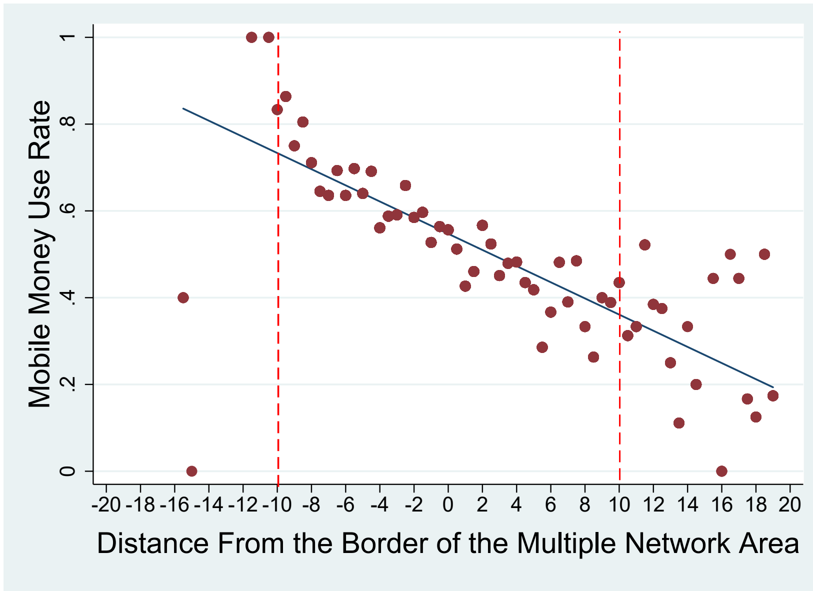
Second, a household that uses mobile money may differ from a household that does not in terms of other characteristics. When some of the households' characteristics that influence saving behavior and mobile money is not observed, estimating (1) using OLS generates an inconsistent estimate of β_1.

To solve the endogeneity bias and omitted variable bias resulting from applying OLS to (1), we estimate (1) using a 2SLS estimation. For the instrumental variable, we use the shortest distance from each household's location to areas in which multiple mobile networks are available. The basic idea of using this distance as the instrumental variable is that if a household's connection to a mobile phone network is better, it has more incentive to use mobile money because using a mobile money service requires to have a good connection to a mobile phone network.

As in many developed countries, the area classified as being able to connect to a mobile network by each operator does not imply that a customer within this area can always connect her or his mobile phone to that network and that a customer outside this area cannot. Instead, mobile phone operators theoretically calculate the strength of the radio of the mobile network and calculate the probability that a household can connect to a mobile network. Then, a mobile phone operator draw a threshold line to determine whether a household can access to mobile phone network with a reasonable probability. Thus the shortest distance from the border of the intersection of the two network available areas is likely to a good proxy of the accessibility to a mobile phone network. If a household's location is far outside the area in which multiple mobile networks are available, it is likely that the network connection is unstable or weak. When a household cannot connect his or her mobile phone to the mobile network easily, then he or she is unlikely to use mobile money; by contrast, a household that can access the mobile network easily is more likely to use mobile money.

Figure 1 shows the relationship between the shortest distance to areas in which multiple networks are available and usage rate of mobile money. To make this figure clearer, we restrict the sample to households whose shortest distance to the border of the multiple network areas is less than 20 km. Figure 1 shows a clear relationship between the shortest distance to the border of areas in which multiple mobile networks

Figure 1: The First Stage Relationship of 2SLS.
The Shortest Distance to the Border of Multiple Network Areas
and Mobile Money Usage Rate



Notes: The multiple mobile network area is the area in which both networks of Vodacom Tanzania and the Tigo mobile are accessible. The mobile money use rate is the proportion of households that use mobile money. For each 0.5 km, the average mobile money use rate is calculated. The reference vertical lines are shown at the point where the distance is equal to -10 km or 10 km. The above graph shows that when the distance is within [-10,10], the relationship between the distance and the average mobile money use rate is almost on the same line. The estimated coefficient of the slope of the fitted line is -0.0188 and the robust standard error is 0.0003599. R^2=0.75. For the estimation of the fitted line above, all observations within [-20,20] are used.

are available and mobile money usage rate. This is consistent with our hypothesis that a household located within an area with multiple mobile networks, or close to such an area, has a stronger network connection and is thus more likely to use mobile money.

However, one might argue that the relationship between the shortest distance to areas with multiple mobile networks and mobile money usage rate is generated by other unobservable factors such as local economic activity instead of the strength of the radio of the mobile network. If a mobile network company sets up the network in an area in which a household has higher education or income, the relationship in Figure 1 may not be driven by the strength of the network of the mobile phone operator, but by other characteristics. In addition, in an area close to or inside the areas with multiple mobile networks, there might be more financial institutions such as commercial banks. Since those characteristics may affect saving, using the shortest distance to areas with multiple mobile networks as an instrumental variable could introduce bias into the 2SLS estimation.

To reduce the possibility that other characteristics are correlated with both the distance and the dependent variable as much as possible, we include various control variables and estimate the following first-stage equation in the 2SLS regression:

$$\text{Mobile}_i = \alpha_0 + \alpha_1 \text{Distance}_i + \alpha_2 x_i + \epsilon_{2i} \tag{3}$$

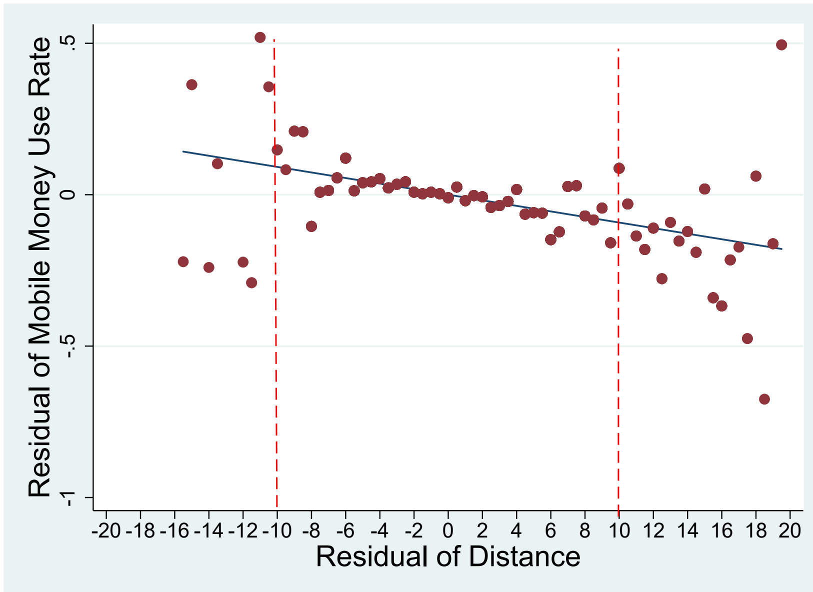
where x_i is the control variables and $Distance_i$ is each household's shortest distance to the areas in which multiple mobile networks are available. As x_i, we include the ownership of the mobile phone, the age of the household head, family size, the education level of the household head, sources of household income (eight dummies for 9 categories), the region dummy (30 region dummies), average night lights, the population density of the area around the household, and the distance to commercial banks, community banks, and microfinance institutions. In the robustness checks, we also include the district dummy (170 district dummies), the transportation equipment ownership dummy and its interaction to distance to financial institution as control variables[4]

Figure 2 shows the relationship between each household's shortest distance to areas with multiple mobile networks and mobile money usage rate after controlling for the effect of those control variables. For the horizontal axis, we measure the residual from regressing each household's shortest distance to areas with multiple mobile network accessibility on control variables. For the vertical axis, we measure the residual from regressing the mobile money usage dummy on those control variables.

As Figure 2 shows, even after controlling for the effect of those covariates, there is a clear relationship between the usage rate of mobile money and the shortest distance of the household to areas with multiple mobile networks. In particular, Figure 1 and

[4]we include ownership of transportation equipments and its interaction to distance to financial institution to control the time distance to financial institutions. We do not include those variable in the base specification due to the potential endogeneity of transportation equipments.

Figure 2: Shortest Distance to the Border of Multiple Network Areas and the Use of Mobile Money after Controlling for the Effect of Covariates



Notes: The vertical axis is the residual of the regression regressing the distance on all the covariates. The vertical axis is the residual of the regression regressing the mobile use dummy on all the covariates. The size of the bin is 0.5 km. The reference vertical lines are shown at the point where the distance is equal to -10 km or 10 km. The above graph shows that when the distance is within [-10,10], the relationship between the distance and the average mobile money use rate is almost on the same line. The estimated coefficient of the slope of the fitted line is -0.011 and the robust standard error is 0.00039. R^2=0.52. For the estimation of the fitted line above, all observations within [-20,20] are used.

Figure 2 show that the relation between the distance to areas with multiple mobile networks is almost linear when the distance is within 10 km. When the sample includes households whose distance to an area with multiple mobile networks is in $[-20, -10]$ or $[10, 20]$, the variance rises. This is partly because the number of households whose distance to areas with multiple mobile networks is in $[-20, -10]$ or $[10, 20]$ is small. When we restrict the sample to the households whose distance to the multiple mobile network area is in $[-20, -10]$ or $[10, 20]$, we have only 270 households, while the number of households whose distance is in $[-10, 10]$ is 4127.

Due to this relatively small sample size of households located outside $[-10, 10]$ and large variance in the mobile money usage rate in this group, we restrict the sample to households whose distance to areas with multiple mobile networks is in $[-10, 10]$. This restriction is likely to guarantee that these sample households are more homogeneous. To examine the robustness of our result, we also use the sample where the distance to the area with multiple mobile networks is within 7.5 km and within 15 km. Our robustness checks show that our estimates are robust with those two sub-sample[5].

For the instruments of estimating equation (2), we use each household's shortest distance to areas with multiple mobile networks and its interaction with the negative shock dummy as the instrumental variables. We also show that the negative shock is orthogonal to the instrumental variable. More specifically, we estimate the following equation as the first stage of equation (2):

$$\text{Mobile}_i = \alpha_0 + \alpha_1 \text{Distance}_i + \alpha_3 \text{Distance}_i \times \text{Negative Shock}_i + \alpha_3 x_i + \epsilon_{2i} \quad (4)$$

4 Dataset and Summary Statistics

Dataset

We use the nationally representative survey of FinScope Tanzania 2017. This dataset is commissioned by the Financial Sector Deepening Trust in partnership with the Bank of Tanzania, Ministry of Finance and Planning, National Bureau of Statistics, Office of Chief Government Statistician Zanzibar, representatives of providers of financial services, and nongovernmental organizations and other private sector players. The survey was conducted by Ipsos Tanzania under the technical advisory of Yakini Development Consulting. The Tanzania Population and Housing Census 2012 was used as a base sampling frame to achieve a representative individual-based sample for the population aged 16 years and older through the application of a three-stage stratified sampling approach. In the first stage of the three-stage sampling, the enumeration areas were randomly sampled. In the second stage, from the sampled enumeration areas, 10 households were selected at random, and in the third stage, from the list of all adult household members in the sample, one adult household member was randomly selected to be interviewed. In our analysis, we restrict the sample to households where the head of the household was respondent to the interview.

[5] For this robustness check, please see Section 6.5

The FinScope Tanzania 2017 dataset provides detailed information on financial behavior such as borrowing, saving, and receiving remittances. It also has information on GPS location as well as the demographic characteristics of the households surveyed.

Regarding saving behavior, the survey asks about the use of different saving methods in the past 12 months, such as saving in livestock, saving in cash at home, saving in bank and saving in saving groups. We divide saving groups into two categories: saving groups that use mobile money technology to collect money from members and saving groups that do not. For each saving method, we make a dummy variable which is equal to one if a household saved in a corresponding saving method in the past 12 months and zero otherwise. Similarly, the survey asks about different sources of borrowing such as banks, microfinance institutions, friends and relatives, and saving groups. We also make a dummy variable for each source of borrowing.

Regarding financial difficulty to pay regular expenses, the responses are categorized into five groups: always struggle to pay unexpected expenses, very often struggle, sometimes struggle, rarely struggle, and never struggle. Based on this information, we make a financial difficulty to pay regular expenses dummy and set it equal to one if a household chooses the first two choices and set it equal to zero otherwise.

Regarding negative shocks, the survey asked about several types of negative shocks: having unforseen large expenses in the last 12 months, experiencing unforseen drop of the price of the output in the last 12 months and unforseen drop of the volume of the output in the last 12 months. We code the negative shock dummy equal to one if a household experiences at least one of the above negative shocks.[6]

The education level of the heads of households is classified into eight categories. The variables representing the income sources of the households are classified into nine categories.

The shortest distance to areas with multiple mobile networks is calculated as follows. First, we choose two of the largest mobile money operators in Tanzania, Vodacom and Tigo Mobile, whose market shares are 54 percent and 29 percent, respectively. Then, we overlay their 2G mobile phone network availability maps using ArcGIS and extract

[6]The survey asked additionally whether a household received less money than expected. However, since this question might include a case where a household received less remittance than a household expected and since we are also interested in the effect of intrinsic negative shocks on the receipt of remittance, we do not include this case in the category of negative shocks.

their intersection. Using GPS information on each household's location, we calculate the shortest distance to the border of the intersection of the networks. We use the negative value if a household is located inside the intersection (Figure A1).

For each financial institution (commercial banks, community banks, and microfinance institutions), the Financial Sector Deepening Trust has surveyed financial sectors and published a GIS map of all branches of commercial banks, saving cooperatives, microfinance institutions, and postal offices in Tanzania in the Financial Access Maps Dataset. We calculate the distance variables representing the distance of each household to the nearest bank branch, community bank branch, and microfinance institution office using the Financial Access Maps Dataset (Figure A2).

Population density is created using the dataset of the population count of Tanzania for 2015 provided by the Center for International Earth Science Information Network (Center for International Earth Science Information Network - CIESIN - Columbia University, 2016). To measure local economic activity, we use the night lights data produced by the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (National Geophysical Data Center, 2019) following the work by Henderson, Storeygard and Weil (2012). To prevent endogeneity, namely that mobile money affects economic activity and thus night lights, we use night lights data from 2007, the year before mobile money was introduced in Tanzania.

Summary Statistics

Tables 1 and 2 provide the summary statistics of the main variables. In total, 58 percent of heads of households use the mobile money service, while 71 percent own a mobile phone. For each household, we measure the shortest distance to the border of the area in which multiple mobile networks (Vodacom and Tigo mobile) are available. This distance becomes negative when a household live within such an area. The mean of the shortest distance to areas with a multiple mobile network is -1.6 km. The share of households who live in an area in which multiple mobile networks are available is 75 percent.

Table 2 calculates the summary statistics of the variables of financial activity in the past 12 months. About 50 percent of households did not save at all in the past 12 months and 43 percent borrowed. Almost half (49 percent) of households received

Table 1. Summary Statistics

VARIABLES	Mean	Std. Dev.
Mobile money and Network		
Mobile money use dummy	0.58	0.49
Mobile Phone Owners	0.71	0.45
Living in Multiple Networks Area	0.75	0.44
Distance from the multiple network area(km)	-1.60	3.79
Demographic Characteristics and Negative Shock		
Households' Size	4.03	2.42
Age of Household Head	39.76	12.08
Household head being Male	0.63	0.48
Negative shock dummy	0.584	0.493
Population density and Distance		
Population Density	0.0189	0.0768
Night Light Index	5586	22350
Distance to nearest commercial bank (km)	24.2	22.3
Distance to nearest community bank (km)	170.5	122.8
Distance to nearest micro-finance (km)	39.8	39.4

Notes: The sample is restricted to households in FinScope Tanzania in which the age of the head is 15 to 65 years and whose distance to the border of areas with multiple mobile networks is less than or equal to 10 km. This distance is classified as a negative value if a household lives inside areas with multiple mobile networks. N=4127.

remittances.

Regarding formal saving, 19 percent of households saved using a mobile money account and 10 percent saved in a bank. Thus, among those who saved, more than one-third of households saved in mobile money savings accounts.

Regarding informal saving, 12.8 percent of households saved in cash, 2.1 percent saved in saving groups that use mobile money technology to collect money from members, and 4 percent saved in saving groups that do not use mobile money technology. 4.9 percent saved in livestock and other real assets.

Among those who borrowed, more than 90 percent of households borrowed from informal sources such as friends, relatives, and saving groups. Specifically, 33 percent borrowed from friends and relatives in the past 12 months, 12.6 percent borrowed from saving groups that do not use mobile money technology, and 4 percent borrowed money

Table 2. Summary Statistics of Financial Behavior in the Last 12 Months

VARIABLES	Mean	Std. Dev.
Saved, Borrowed and Received Remittance		
Saved in the last 12 months	0.511	0.500
Borrowed in the last 12 months	0.489	0.500
Received Remittance in the last 12 months	0.434	0.496
Saving Methods		
Saved in Mobile Money Account	0.190	0.393
Saved in Bank	0.100	0.300
Saved in SACCO	0.012	0.108
Saved in Micro Finance Instituion	0.008	0.088
Saved in Saving Group with MM technology	0.040	0.197
Saved in Saving Group without MM technology	0.128	0.334
Saved in Cash	0.213	0.409
Saved to Relatives, Church or Communities	0.045	0.206
Saved to Livestocks and other real assets	0.049	0.216
Borrowing Methods		
Borrowed from Mobile Money Operator	0.025	0.155
Borrowed from Bank	0.015	0.123
Borrowed from SACCO	0.009	0.093
Borrowed from Micro-financial institutions	0.012	0.109
Borrowed from Saving Group with MM technology	0.039	0.194
Borrowed from Saving Group without MM technology	0.126	0.332
Borrowed from Relative and Friends	0.333	0.471

Notes: The same notes as Table 1 apply. All the variables are dummy variables. SACCOS denotes the Saving and Credit Cooperative Society. Saving Group with MM technology denotes a saving group that uses mobile money to collect money from members. Each variable is equal to one if the condition applies. N=4127.

from saving groups that use mobile money technology. Only 2.5 and 1.5 percent of households borrowed from banks and mobile money operators, respectively.

5 Results

5.1 Effect on Borrowing

In Table 4, we estimate the effect of using mobile money and experiencing a negative shock on borrowing. The dependent variable is the borrowing dummy, which is equal to one if a household borrowed in the past 12 months and zero otherwise. The main explanatory variables are the use of mobile money dummy and negative shock dummy. The use of mobile money dummy is equal to one if the head of the household uses mobile money and zero otherwise. The negative shock dummy is coded one if a household experienced at least one negative shock in the past 12 months and zero otherwise.

Table 3. Estimation Results of the OLS Estimation
Estimated Coefficients of the Mobile Money Use Dummy on Borrowing

Dependent Variable	Borrowing Dummy				
	(1)	(2)	(3)	(4)	(5)
Panel A					
Use of Mobile Money Dummy	0.134***	0.132***	0.141***	0.110***	0.111***
	(0.0174)	(0.0176)	(0.0179)	(0.0186)	(0.0187)
R-squared	0.041	0.041	0.041	0.055	0.056
Panel B					
Use of Mobile Money Dummy	0.121***	0.119***	0.130***	0.100***	0.101***
	(0.0173)	(0.0174)	(0.0178)	(0.0185)	(0.0185)
Negative Shock	0.188***	0.187***	0.183***	0.178***	0.178***
	(0.0162)	(0.0162)	(0.0163)	(0.0163)	(0.0163)
R-squared	0.071	0.072	0.069	0.082	0.082
Panel C					
Use of Mobile Money Dummy	0.122***	0.119***	0.137***	0.104***	0.104***
	(0.0246)	(0.0247)	(0.0250)	(0.0255)	(0.0256)
Mobile Money × Negative Shock	-0.00136	-0.000530	-0.0111	-0.00593	-0.00626
	(0.0307)	(0.0307)	(0.0304)	(0.0302)	(0.0302)
Negative Shock	0.189***	0.188***	0.189***	0.182***	0.181***
	(0.0234)	(0.0234)	(0.0234)	(0.0233)	(0.0233)
R-squared	0.071	0.072	0.069	0.082	0.083
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Lights		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. All the specifications include the sources of income dummy. For the source of income, there are nine categories and eight dummies. For the demographic characteristics, the education level, age, and gender of the head of the household and household size are included. *** p<0.01, ** p<0.05, * p<0.1.

In all the tables below, the sample is restricted to the head of the household. To

Table 4. First-Stage Estimation Results of the 2SLS Estimation

Endogenous Variable	Use of Mobile Money Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	-0.0153***	-0.0146***	-0.0130***	-0.0106***	-0.00909***
	(0.00178)	(0.00178)	(0.00185)	(0.00180)	(0.00186)
R-squared	0.226	0.235	0.294	0.353	0.356
Kleibergen-Paap Rank Wald	73.93	67.56	49.22	34.23	24.01
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

control for the types of jobs of each household head, we include the source of income dummy (eight categories) of each household in all specifications. In column (2), to control for the economic activity at each household's location, we include population density in 2015 and average index of night lights in 2007 at the household's location. In addition, in Column (3), we include the region dummy (31 regions). In Column (4), we add the demographic characteristics as the control variables. For the demographic characteristics, we include the education level, age, and gender of the head of the household as well as household size. In Column (5), we include the distance to commercial banks, community banks, and microfinance institutions. Panel A of Table 3 shows that the effect of the use of mobile money increases the probability of borrowing by about 11–14 percentage points in all the specifications. The estimated coefficient is stable and statistically significant in all specifications.

One of the reasons that a household borrows money is experiencing a negative shock. Panel B of Table 3, which includes the negative shock dummy in the explanatory variables, shows that experiencing a negative shock does not change the estimated coefficient of the use of mobile money dummy. As shown in Panel B of Table 3, the use of mobile money increased the probability of borrowing by 10–13 percentage points and the experience of a negative shock increases the probability of borrowing by 18-19 percentage points.

In Panel B of Table 3, we assume that the effect of a negative shock on borrowing is similar between those who use mobile money and who do not. However, the effect of a negative shock can differ between mobile money users and non-mobile money users.

Panel C of Table 3 examines the effect of experiencing a negative shock, the use of mobile money, and their interaction on the probability of borrowing. This panel shows that when a household experiences a negative shock, the probability of borrowing increases by 18 percentage points and the use of mobile money increases the probability of borrowing by about 10 percentage points. The estimated coefficient of the interaction term is small and statistically insignificant. Thus, the effect of experiencing at least one negative shock on the probability of borrowing for mobile money users is not different from the ones of non-users.

However, Table 3 could be subject to endogeneity bias because the use of mobile money is a choice variable instead of a randomly assigned variable. To overcome endogeneity bias, we apply a 2SLS estimation. Table 4 shows the estimation results of the first stage of the 2SLS estimation; the second stage is in Panel A of Table 5. In Table 4, the dependent variable is the mobile money use dummy and the excluded instrumental variable is the shortest distance to areas in which multiple mobile networks are available. The estimated coefficients of the instrumental variable are highly statistically significant and stable. Column (1) of Table 4 shows that if a household is located 10 km away from the border of areas with multiple mobile networks, the probability of using mobile money decreases by 15 percentage points. Column (5) shows that after controlling for all the control variables, this probability changes to 9 percentage points. The Kleibergen–Paap Rank Wald statistics, which are the heteroscedasticity robust version of the F-test of the weak instrument, are greater than 10.[7]

Table 5 shows the second-stage results of the 2SLS estimation. Panel A of Table 5 shows the effect of the use of mobile money when we do not include experiencing a negative shock as a control variable. In contrast to the corresponding OLS estimation in Panel A of Table 3, the estimated coefficient of the use of mobile money dummy on the probability is small, has the opposite sign, and is statistically insignificant. The

[7]To save space, the first-stage results that correspond to Panels B and C of Table 5 are shown on Appendix A.

size of the estimated coefficients are also economically insignificant. In Column (5), the estimated coefficient is equal to -0.0138. Panel B controls for experiencing a negative shock. The estimated coefficients of the use of mobile money in Panel B of Table 5 are still small, negative, and statistically insignificant. In contrast, the estimated coefficients of experiencing a negative shock are statistically and economically significant, positive, and stable. Column (5) shows that experiencing a negative shock increases the probability of borrowing by about 18.5 percentage points.

Panel B of Table 5 assumes that the effect of a negative shock is the same between mobile money users and non-mobile money users. Panel C of Table 5 relaxes this assumption and introduces the interaction term of the negative shock dummy and mobile money user dummy. For the instrumental variable of the interaction term, we use the negative shock dummy times the distance to areas with multiple mobile networks.

Panel C of Table 5 shows that for non-mobile money users, experiencing a negative shock increases the probability of borrowing by about 47 percentage points. However, since the estimated coefficient of the interaction term is -50 percentage points, the effect of a negative shock is almost zero for mobile money users. Since about 58 percent of the households in our dataset use mobile money, the average effect of a negative shock on the whole population is $0.47 - 0.58 \times 0.5 = 0.185$. This is close to the estimated coefficients of the negative shock dummy in Panel B of Table 5.

Similarly, the effect of the use of mobile money on borrowing is different for those who experience a negative shock and who do not. For those who do not experience a negative shock, the use of mobile money increases the probability of borrowing by 23 percentage points, although its statistical precision is low. For those who experience a negative shock, the use of mobile money decreases the probability of borrowing by 50 percentage points. Since 59 percent of the households in our dataset experience a negative shock, the average effect of using mobile money on borrowing is $0.23 - 0.59 \times 0.5 = -0.06$, which is close to the estimated coefficients of the mobile money use dummy in Panel B of Table 5.

Panel C of Table 5 uses the interaction term to examine the different effect of a negative shock for users and non-users of mobile money. One might wonder if our estimation strategy relies on the functional form and whether the results are robust.

Table 5. Estimation Results of the 2SLS Estimation

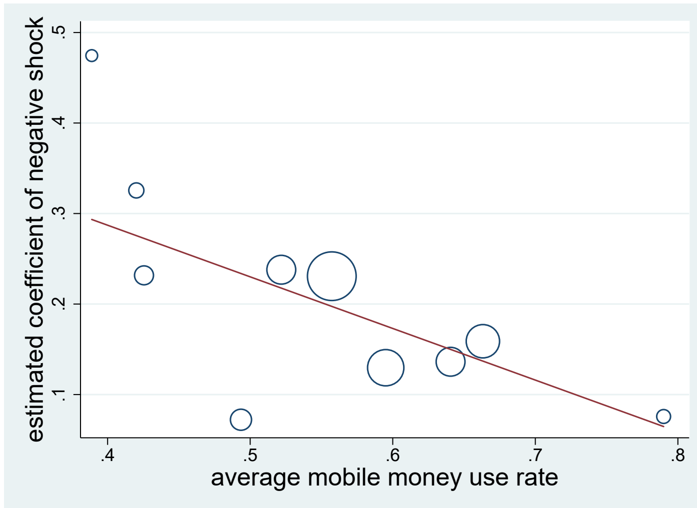
Estimated Coefficients of the Mobile Money Use Dummy on Borrowing

Dependent variable	Borrowing Dummy				
	(1)	(2)	(3)	(4)	(5)
Panel A					
Use of Mobile Money Dummy	-0.167	-0.194	-0.0456	-0.0567	-0.0138
	(0.138)	(0.146)	(0.166)	(0.204)	(0.244)
R-squared	-0.029	-0.039	0.016	0.037	0.046
Kleibergen-Paap Rank Wald	73.93	67.56	49.22	34.23	24.01
Panel B					
Use of Mobile Money Dummy	-0.144	-0.167	-0.0568	-0.0744	-0.0573
	(0.133)	(0.140)	(0.164)	(0.202)	(0.243)
Negative shock dummy	0.205***	0.205***	0.192***	0.186***	0.185***
	(0.0186)	(0.0187)	(0.0185)	(0.0186)	(0.0196)
R-squared	0.018	0.010	0.044	0.062	0.066
Kleibergen-Paap Rank Wald	75.08	68.71	49.05	33.98	23.56
Panel C					
Use of Mobile Money Dummy	0.0968	0.0750	0.211	0.182	0.205
	(0.152)	(0.157)	(0.180)	(0.214)	(0.250)
Mobile Money × Negative Shock	-0.469**	-0.471**	-0.505***	-0.490***	-0.501***
	(0.195)	(0.196)	(0.189)	(0.187)	(0.189)
Negative Shock	0.472***	0.473***	0.480***	0.466***	0.470***
	(0.114)	(0.115)	(0.111)	(0.110)	(0.112)
R-squared	-0.049	-0.059	-0.025	-0.005	-0.002
Kleibergen-Paap Rank Wald	25.24	24.35	20.57	15.23	10.83
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

For a robustness check, we examine the effect of a negative shock for mobile money users and non-mobile money users graphically. More specifically, based on our instrumental variable, namely each households distance to areas with multiple mobile networks,

Figure 3: The Differential Effect of Negative Shocks across Households with a Different Probability of Using Mobile Money



Notes: The sample is divided into 10 groups based on each household's distance to areas with multiple mobile networks. For each group, equation (5) is estimated by OLS. Then, the size of the estimated coefficient of the negative shock dummy is measured on the vertical axis. For the horizontal axis, for each group, the average probability of using mobile money is calculated and measured on the horizontal axis. The size of each circle is the sample size of each group. For those 10 plots, weighted OLS is applied. The slope of the fitted line is -0.57 and the R-squared is 0.38. The vertical intercept at the horizontal value being 0 is 0.51 and the vertical value at the horizontal value being 1 is equal to -0.07.

we divide the main sample into 10 groups from -10 km to 10 km in increments of 2 km. Then, for each group, we estimate the following equation and plot the estimated coefficient of the negative shock dummy on the vertical axis:

$$\text{Borrowing}_i = \beta_0 + \beta_1 \text{Negative Shock}_i + \gamma x_i + \epsilon_{1i} \tag{5}$$

In the third step, for each group, we calculate the average use rate of mobile money and plot it on the horizontal axis. Figure 3 illustrates the plotted x-axis and y-axis, showing how the effect of a negative shock differs for different values of the use of mobile money rates. The variation of the horizontal axis is driven by the different values of the instrument. Thus, the slope in Figure 3 should be similar to the interaction term estimated in Panel C of Table 5. Figure 3 shows that as the average use rate of mobile money falls, the effect of a negative shock rises. In the figure, the slope of the fitted line is -0.57 and the vertical intercept is 0.51. The vertical value at the horizontal value being 1 is equal to -0.07. This implies that when the average use rate of mobile money is zero, the effect of experiencing a negative shock on the probability of borrowing is 0.57; moreover, when the average use rate of mobile money is equal to one, the effect of experiencing a negative shock is -0.07. These results are consistent with Panel C of Table 5.

Table 5 and Figure 3 show that the effect of an experience of negative shock on borrowing for mobile money user is almost equal to zero while for non-user an experience of negative increases the probability of borrowing by 47 percentage points.

5.2 Orthogonality of Negative Shocks to the Instrumental Variable

One natural question from Figure 3 and Panel C of Table 5 is whether a household that is far away from areas with multiple mobile networks experiences different types of negative shocks than a household located inside those areas. To examine whether such a case is plausible, we estimate the effect of the distance from the areas with multiple networks on the frequency of negative shocks. If the nature of a negative shock differs by location, its frequency is also likely to be different. For this purpose, in Table 6, we regress the negative shock dummy on the distance from areas with multiple mobile networks with several control variables by OLS. The estimated coefficients are economically and statistically insignificant. This shows that when the distance to areas with multiple mobile networks is 10 km away, the probability of experiencing a negative shock falls only by 2.1 percentage points (P-value=0.3). Thus, the frequency of experiencing a negative shock is the same in households with different locations. This indicates that the criticism that the nature of the negative shocks is different at different location is unlikely.

5.3 Effect on Remittances and Savings

In Section 5.2, we have shown that the use of mobile money mitigates the effect of negative shocks on borrowing. More specifically, for non-users of mobile money, a negative shock increases the probability of borrowing, whereas it does not increase the

Table 6. Orthogonality of Negative Shocks: The Effect of Distance on Negative Shocks (OLS)

	Negative Shock Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	0.00174	0.00192	-0.000753	-0.00100	-0.00214
	(0.00195)	(0.00196)	(0.00202)	(0.00204)	(0.00211)
R-squared	0.108	0.109	0.154	0.162	0.163
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard error in parenthesis. Notes in Table 3 apply.

probability of borrowing for users.

There are several possible reasons for this difference. The first is that with the availability of mobile money, households can form mutual insurance networks easily and thus receive remittances when they experience a negative shock because the availability of mobile money lowers the cost of transferring remittances. The second reason is that the use of mobile money increases the probability of receiving remittances regardless of experiencing a negative shock because of altruism by friends and relatives. Large remittances increase household resources and reduce demand for borrowing when a household experiences a negative shock. The third reason is that a household with access to mobile money can increase its total savings. The fourth reason is that a household can change a portfolio from savings through less liquid savings (e.g., savings in livestock and savings in the church and communities) to savings in mobile money and banks. As the above-mentioned channels are not mutually exclusive, it is difficult to identify which factor is the exact mechanism that generates the results in Table 5 and Figure 3.

To narrow the possible mechanisms that generate the results in Table 5 and Figure 3, we first examine whether the use of mobile money increases the probability of receiving remittances, and in Table 7, whether the use of mobile money increases receiving remittances when a household experiences a negative shock. In Table 7, the dependent variable is the receipt of the remittance dummy, which is equal to one if a household received a remittance in the past 12 months and zero otherwise. The estimated coefficient shows that the use of mobile money increases the probability of receiving remittances by 72 percentage points. The estimated coefficient of experiencing a negative shock is 12.8 percentage points, but its statistical precision is low. In addition, the estimated coefficient of the interaction term of the negative shock dummy and use of mobile money dummy is negative (and statistically insignificant). Table 7 suggests that a mobile money user receives more remittances, but this receipt of remittances is not correlated with experiencing a negative shock. In particular, there is no evidence that a mobile money user receives remittances with a higher probability when a household experiences a negative shock.

Another possible channel through which a mobile money user does not need to borrow when he or she experiences a negative shock is that a household can change a saving portfolio, so that it can prepare for a future negative shock. As a result, when it experiences a negative shock, it does not need to borrow. To examine whether such a hypothesis is supported, we examine the probability of saving for each saving method. Since we are interested in the average effect of using mobile money on each saving method, we do not include the interaction term of the use of mobile money dummy and negative shock dummy. However, we include the negative shock dummy itself as a control variable.[8]

[8] To save the space, we report only the estimated coefficient of the use of mobile money dummy. But the negative shock dummy is included in the control variable in all specification. In all cases, the estimated coefficient of the negative shock dummy is very small and statistically insignificant. In addition, we also estimated the specifications where the interaction term of the negative shock dummy and the use of mobile dummy is included. In all specification, the estimated coefficient of the interaction term is economically very small and statistically insignificant. The estimation results are available from the author upon request.

Table 7. Second-Stage Estimation Results of the 2SLS Estimation
Estimated Coefficients of Mobile Money Use, Negative Shocks, and Their Interaction on the Receipt of Remittances

Panel A					
Dependent variable	Receipt of Remittance Dummy				
	(1)	(2)	(3)	(4)	(5)
Use of Mobile Money Dummy	0.698***	0.703***	0.689***	0.681***	0.752***
	(0.126)	(0.130)	(0.148)	(0.176)	(0.209)
Mobile Money × Negative Shock	-0.107	-0.104	-0.145	-0.158	-0.157
	(0.160)	(0.160)	(0.159)	(0.157)	(0.160)
Negative Shock	0.0958	0.0943	0.113	0.125	0.120
	(0.0932)	(0.0934)	(0.0926)	(0.0921)	(0.0947)
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
R-squared	0.261	0.260	0.247	0.255	0.243
Kleibergen-Paap Rank Wald	25.24	24.35	20.57	15.23	10.83
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes of Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Second-Stage Estimation Results of the 2SLS Estimation

Estimated Coefficients of the Mobile Money Use Dummy on Various Saving Methods

	Dependent variable				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
	Less Liquid Saving				
Use of Mobile Money Dummy	-0.240***	-0.250***	-0.334***	-0.351**	-0.361**
	(0.0866)	(0.0912)	(0.114)	(0.142)	(0.173)
Panel B.					
	Saving in Cash				
Use of Mobile Money Dummy	-0.179	-0.193*	-0.0595	-0.0793	-0.00983
	(0.110)	(0.116)	(0.137)	(0.170)	(0.204)
Panel C.					
	Saving in Mobile Money Account				
Use of Mobile Money Dummy	0.640***	0.623***	0.724***	0.682***	0.600***
	(0.104)	(0.108)	(0.136)	(0.165)	(0.191)
Panel D.					
	Saving in Saving Groups with MM Technology				
Use of Mobile Money Dummy	0.190***	0.196***	0.200***	0.214***	0.220**
	(0.0512)	(0.0537)	(0.0653)	(0.0827)	(0.102)
Panel E.					
	Saving in Saving Groups without MM Technology				
Use of Mobile Money Dummy	0.0361	0.0195	0.0213	0.0144	0.110
	(0.0931)	(0.0971)	(0.116)	(0.142)	(0.171)
Panel F.					
	Saving at least in one method				
Use of Mobile Money Dummy	0.365***	0.334**	0.421***	0.346*	0.370
	(0.130)	(0.135)	(0.163)	(0.199)	(0.242)
Control Variables					
Negative Shock Dummy	Yes	Yes	Yes	Yes	Yes
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
Kleibergen-Paap Rank Wald	75.08	68.71	49.05	33.98	23.56
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes of Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

Panel A of Table 8 shows that the use of mobile money decreases the probability of saving in less liquid savings by 30 percentage points. We code the method of saving a less liquid one if a household saves in livestock or through the church and communities. Panel B of Table 8 shows that the use of mobile money does not change the probability of saving in cash. In Panel B, the estimated coefficient is less than 3 percentage points and is statistically insignificant.

In contrast, Panel C and Panel D of Table 8 show that the use of a mobile money increases saving in a method which uses mobile money technology. More specifically, the use of mobile money increases the probability of saving in a mobile money account and saving in a saving group that uses mobile money as a form of collection by 60 percentage points and 22 percentage points, respectively. Panel E shows that the use of mobile money does not increase the probability of saving in a saving group that does not use mobile money for collection of money from members.

Finally, Panel F shows the effect of the use of mobile money on the probability of saving in at least one method. Columns (1) to (4) show that the estimated coefficients are stable, with the use of mobile money affecting the probability of saving in at least one method by 33–42 percentage points. In column (5), the estimated coefficient becomes insignificant although the size of the estimated coefficient is very similar to the ones in column (1) to column (4). In the robustness check, we find that although the estimated coefficients are similar, they are often statistically insignificant. For example, in Table B4 Panel F, the estimated coefficients are significant only for column (1) and (2). This suggests that we do not find a strong evidence that the use of mobile money increases the probability of saving at least in one asset.

5.4 Effect of Mobile Money on Livelihood

The final question is how much the use of mobile money affects households' livelihood. Table 9 examines the effect of the use of mobile money on the probability of experiencing financial difficulty to pay regular expenses. To examine the effect of the use of mobile money on those who experience a negative shock, we include the non-negative shock dummy instead of the negative shock dummy and its interaction with mobile money usage. In Panel A, the estimated coefficient of the use of mobile money dummy, which measures the effect of the use of mobile money for a household that experiences a negative shock, ranges from -0.5 to -0.68 (statistically significant). Panel A also shows that when a household does not experience a negative shock, the probability of experiencing financial difficulty decreases by 23 percentage points. The estimated coefficient of the interaction term implies that the effect of the use of mobile money on experiencing financial difficulty for those who do not experience a negative shock is 28 percentage points smaller than for those who experience a negative shock, although the estimated coefficients are not statistically precise. To see the effect of experiencing a negative shock on difficulty to pay regular expenses for those who use the mobile money, we examine whether the sum of the coefficient of the interaction term and non-negative shock dummy is equal to zero. The bottom raw of Panel A shows the chi-squares and its p-value. The calculated P-value implies that we cannot reject the null hypothesis the effect of experiencing a negative shock on financial difficulty for those who use mobile money is equal to zero.

Panel B shows the estimates of the effect of the use of mobile money and a non-negative shock without the interaction term. Without this term, the estimated coefficient of the use of mobile money is the average effect of the use of mobile money. Panel B shows that the use of mobile money decreases the probability of experiencing financial difficulty by 49 percentage points. Panel B also shows that the effect of experiencing a negative shock will increases the financial difficulty to pay regular expenses by 6 percentage points.

6 Robustness Checks

6.1 Controlling District Fixed Effect

In the analysis in section 5, we have included regional dummy (30 region dummies) in addition to population density and average night light of the area in which a household is located. The idea of including the population density and the average night light is to control the difference of the economic activity of the areas in which households are located. One might argue, however, that to control the difference of economic activity of different areas by the region fixed effect, the population density and the average night lights is not sufficient.

In this robustness checks, we include the district dummy (170 district dummies) to

Table 9. Second-Stage Estimation Results of the 2SLS Estimation
Estimated Coefficients of the Mobile Money Use Dummy on Financial Difficulty

Dependent variable	Financial Difficulty to Pay Regular Expenses				
Variable	(1)	(2)	(3)	(4)	(5)
Panel A.					
Use of Mobile Money Dummy	-0.495***	-0.501***	-0.638***	-0.678***	-0.629**
	(0.155)	(0.160)	(0.189)	(0.230)	(0.265)
Mobie Money × No Negative Shock	0.258	0.255	0.265	0.290	0.284
	(0.172)	(0.173)	(0.177)	(0.179)	(0.178)
No Negative Shock	-0.209**	-0.208**	-0.215**	-0.231**	-0.225**
	(0.0998)	(0.100)	(0.103)	(0.105)	(0.105)
Kleibergen-Paap Rank Wald	25.24	24.35	20.57	15.23	10.83
Testing Coef. of Mobiee Money × No Negative Shock+ Coef. of No Negative Shock=0					
Chi-squared	0.419	0.387	0.362	0.539	0.557
P-value	0.518	0.534	0.547	0.463	0.456
Panel B					
Use of Mobile Money Dummy	-0.370***	-0.377***	-0.513***	-0.540***	-0.494**
	(0.120)	(0.126)	(0.156)	(0.195)	(0.230)
No Negative Shock	-0.0622***	-0.0628***	-0.0642***	-0.0660***	-0.0636***
	(0.0167)	(0.0167)	(0.0174)	(0.0177)	(0.0184)
Kleibergen-Paap Rank Wald	75.08	68.71	49.05	33.98	23.56
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. The last column of Panel A tests the null hypothesis that the sum of the coefficient of the non-negative shock dummy and the interaction term of the mobile money usage dummy and non-negative shock dummy is equal to zero. The chi-squared value and its P-value are shown in the last row. *** p<0.01, ** p<0.05, * p<0.1.

control the difference of economic activity of different areas. Table B1-Table B5 show the first stage and the second stage results when we include the 170 district dummies as control variables in addition to other control variables. The estimated coefficients and their standard errors are quite similar to the ones in Section 5. The only difference is that Kleibergen-Paap Rank Wald statistics which tests the strength of the first stage of 2SLS estimation. When we include all control variables and 170 district dummies, the Kleibergen-Paap Rank Wald statistics become 9.1, which is slightly smaller than the threshold value, 10. This is likely due to including so many control variables. However, all estimated coefficients and the standard errors do not change substantially compared with the one with a smaller set of control variables and 170 district dummies. This suggests that even controlling the district fixed effect, our results are quite robust.

6.2 Endogeneity of Mobile Phone Ownership

In all analysis in section 5, we have included the mobile phone ownership dummy as a control variable in x_i. Although the inclusion of the mobile phone ownership dummy follows the literature (Jack and Suri, 2014; Munyegera and Matsumoto, 2016), its inclusion could bias the estimate of β_1 because mobile phone ownership is the outcome variable and controlling for it introduces bias when estimating the causal effect (Angrist and Pischke, 2008). To observe how this occurs, assume that mobile phone ownership is a negative function of our instrumental variable, distance to areas with multiple mobile networks, and a positive function of unobserved characteristics z_{1i}. Assume that z_{1i} is a variable such as unobserved income and familiarity with technology, which is positively correlated with financial activity. When the distance decreases, the probability of the use of mobile money increases. However, it also affects the probability of mobile phone ownership positively. Thus, a decrease in the instrumental variable (distance) while controlling for mobile phone ownership implies that z_{1i} must decrease and that financial behavior decreases because of the fall in z_{1i}. Thus, the 2SLS estimation while controlling for mobile phone ownership (without the instrumental variable on mobile phone ownership) will give a downward bias to the estimate of β_1, even if we were to use the instrumental variable for mobile money use. On the other hand, if we were to exclude mobile phone ownership in the 2SLS estimation as a control variable in x_i, the coefficient of the mobile money use dummy would capture not only the effect of mobile money use but also the effect of mobile phone ownership, since the instrumental variable (mobile phone network coverage dummy) is also correlated with mobile phone ownership.[9] To address this problem, we run the 2SLS estimation without the mobile phone ownership dummy as one of the control variables. Tables B1–B6 in Appendix B show that the estimated coefficient of mobile money use in the 2SLS estimation does not change to a large extent. This implies that the bias induced by including the mobile phone ownership dummy is unlikely to be serious.[10]

6.3 Controlling for Income

In Section 5, we have included the negative shock dummy to examine the different effect of the use of mobile money. In the analysis, we did not include income as a control variable for two reasons. First, income is the outcome variable if a household that received remittances through mobile money invested in productive assets and grew its income. Including the outcome variable would thus cause the same problem as including the mobile phone ownership dummy, as we discuss in the above subsection. Second, information on income includes information on the negative shock. Thus, the estimated coefficient of the negative shock dummy while controlling for income would bias the estimated coefficients of the negative shock dummy in a downward direction.

On the other hand, one might argue that the instrumental variable is correlated with income and thus that not including income in the control variables might bias our estimates. In this case, the effect of the use of mobile money could include the effect of income and the estimated coefficient is upwardly biased.

Column (1) of each table in Appendix C corresponds to Column (5) in Section 5. Column (2) of each table shows the estimated coefficients when we control for income. The tables in Appendix C show that controlling for the effect of income does not affect the estimated coefficient. This suggests that the bias caused by excluding income from

[9]One way to solve this problem is to find another instrumental variable correlated with mobile phone ownership but not with financial behavior. However, finding another instrument is difficult.

[10]Another possible reason behind the similarity between the 2SLS estimates of β_1 with and without the mobile phone ownership dummy is that z_{1i} is not positively correlated with financial behavior but is negatively correlated with financial behavior. The assumption of a positive correlation between z_{1i} and financial behavior is not testable, since we cannot observe z_{1i}. However, we can still check whether the observable variables that affect mobile phone ownership positively are correlated with financial behavior following Altonji et al. (2005). When we regress saving or borrowing and mobile phone ownership on the education of respondents and the wage earner dummy, we find that those variables are positively correlated with both mobile phone ownership and financial behavior (saving and borrowing).

the control variables is not serious.

6.4 Controlling Time Distance to Financial Institutions

In the analysis in Section 5, we have included as the control variable the physical distance to several financial institutions such as distance to commercial bank, distance to community bank and distance to micro-finance institution. Note that the time distance depends on the ownership of transportation equipment (bicycle, motorcycle, and car) and that the ownership of that equipment is the outcome variable. A household that receives a substantial amount of remittances might purchase a motorcycle. Due to this endogeneity, we use the physical distance as a control variable. To examine the sensitivity of our analysis by controlling for the time distance, we re-run the regression by controlling for the time distance instead of the physical distance. To do so, the ownership of transportation equipment is included a control variable and they are interacted with the physical distance. Column (3) of each table in Appendix C shows that the estimation results when transportation equipment and the interaction term with the physical distance are included in the control variable. The column (3) of Tables in Appendix C shows that the estimated coefficients and standard errors are quite similar to the ones in Section 5.

6.5 Using Different Sub-samples

In the analysis in Section 5, we have used households whose distance to areas with multiple mobile networks is less than or equal to 10 km because of the clear first-stage relationship and relatively large sample of this group. One might ask whether our estimates are sensitive to the selection of the sample. In column (4) of each table in Appendix C, we used, as the sample, the household whose distance to the areas with multiple mobile networks is less than or equal to 7.5 km. The estimated coefficients and the standard errors are quite similar to the one obtained in Section 5. In column 5, we used, as the sample, the household whose distance to the areas with multiple mobile networks is less than or equal to 15 km. Again, our estimated coefficients are similar to the ones obtained in Section 5. This suggest that as long as we choose the distance to the areas with multiple mobile network as small as possible, the household selected are similar and our estimated coefficients do not change so much.

7 Discussion and Conclusion

The findings by this study can be summarized as follows. First, we show that the use of mobile money decreases the effect of a negative shock on borrowing. For non-mobile money users, when they experience a negative shock, the probability of borrowing increases by about 50 percentage points, while the probability of borrowing does not increase for mobile money users. Second, we find that the use of mobile money increases the probability of receiving remittances by 75 percentage points and that its effect is independent of experience of a negative shock. This indicates that remittances are unlikely to work as insurance. Third, the use of mobile money affects the composition of saving methods. In particular, the use of mobile money decreases the probability of saving using less liquid saving methods such as saving through livestock, the church, and communities by 36 percentage points while the use of mobile money increases saving in a mobile money account 36 percentage points as well as in saving groups that adopt mobile money technology by 22 percentage points. These evidences suggest that the use of mobile money increases the receipt of remittances regardless of negative shocks and changes the saving portfolio, so a household can prepare for negative shocks. Hence, a household that uses mobile money does not need to increase borrowing in the face of a negative shock. Consistent with interpretation, we find that the negative shock increase financial difficulty to pay regular expenses for non-users by 23 percentage points while it does not affect the financial difficulty to pay regular expenses for users.

Regarding the relationship to the literature on the effect of mobile money on economy, our analysis is consistent with previous analyses that show that mobile money affects many dimensions of economic activities (Jack and Suri, 2014; Munyegera and Matsumoto, 2016). Our results, however, slightly differ from studies in the literature that show that the use of mobile money works like insurance in the sense that they show that a household receive remittance more when a household experience a negative shock. In contrast, our analysis suggests that the use of mobile money help to absorb shocks through an increase of remittance in normal periods and by change of saving portfolio. Our result is consistent with the work of Naito (2017), which shows that in

Zimbabwe the receipt of remittances does not depend on experiencing a negative shock but the remittance helps to mitigate financial difficulty sending children to school.

Regarding the relationship to the literature on the effect of having a bank account on economic activity and welfare, our results is consistent with the previous results which show that a bank account affects financial behavior in a reasonable magnitude. For example, using randomized experiments, Dupas et al. (2018) find a large treat effect on treated, which is consistent with our finding. Our finding contributes to this literature showing that mobile money change saving portfolio and help household to absorb negative shock through self-preparation.

Mobile money is becoming an important policy issue. The governments of developing countries recognize that mobile money transfers are an attractive tax base because of their size and the ease of understanding the transaction(Rukundo, 2017; Ndungu, 2019). Financial regulation aims to balance the traditional banking sector and mobile money operators(Klein and Mayer, 2011; Khiaonarong, 2014; Lal and Sachdev, 2015). The introduction of Libra by Facebook could affect millions of non-bank users(Facebook, 2019), and the regulators of the financial sector has many concerns about the introduction of Libra.

On the other hand, for any regulation and taxation policy, their cost and benefit need to be balanced. Our analysis shows that mobile money affects various financial behaviors. For example, using mobile money means that many households do not need to borrow in the face of negative shocks. They receive more remittances and reduce less liquid saving as well as increase savings in mobile money savings accounts and in saving groups that use mobile money technology.

In poor countries, the lack of access to credit and the lack of safe and liquid saving methods are often policy targets. Mobile money solves those issues to some degree. This implies that the efficiency cost of taxation on mobile money transactions and strict regulations on the mobile money industry will not be low. The regulators of mobile money operators and tax planning authorities in developing countries therefore need to be careful when implementing tax and regulation policies on mobile money and mobile money industry.

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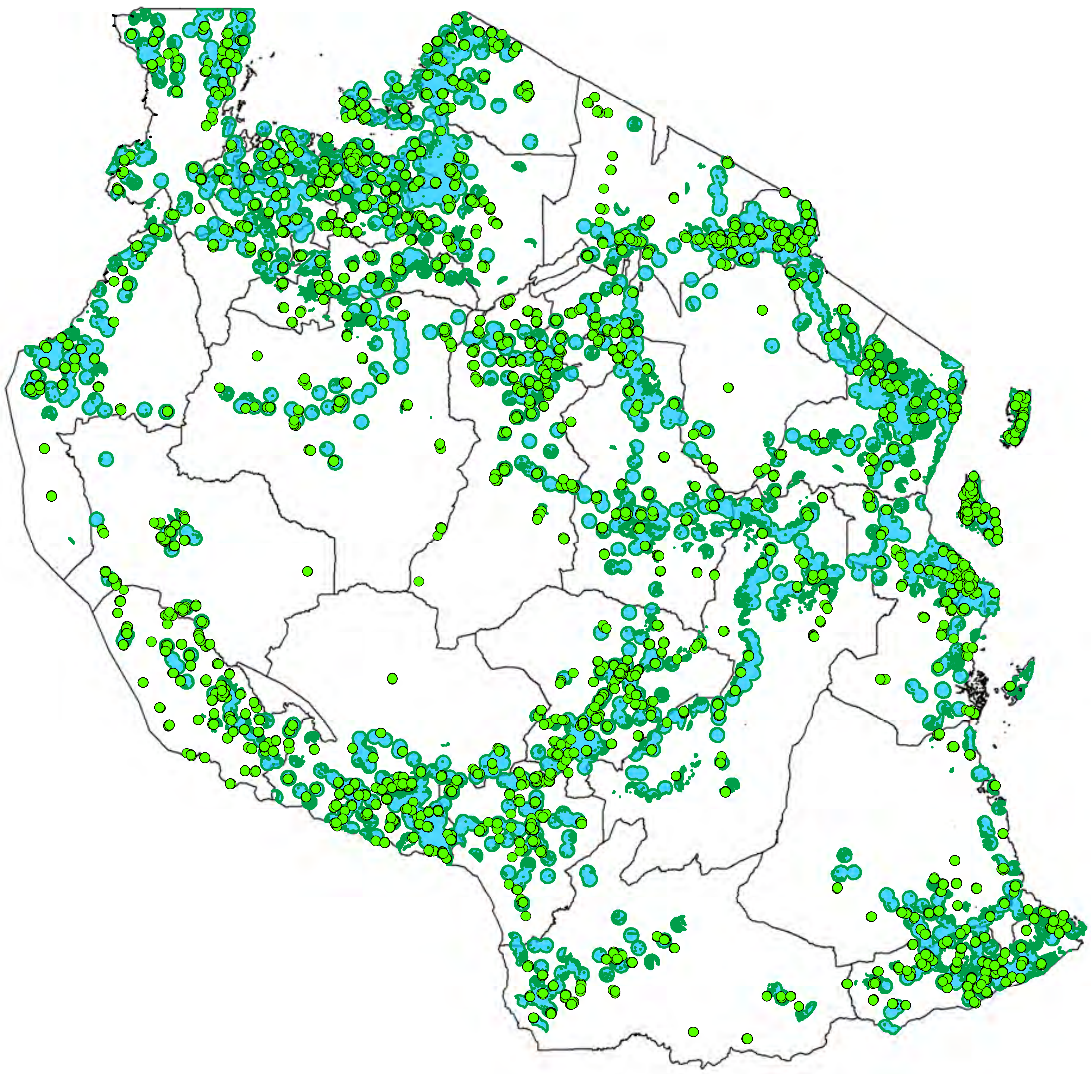
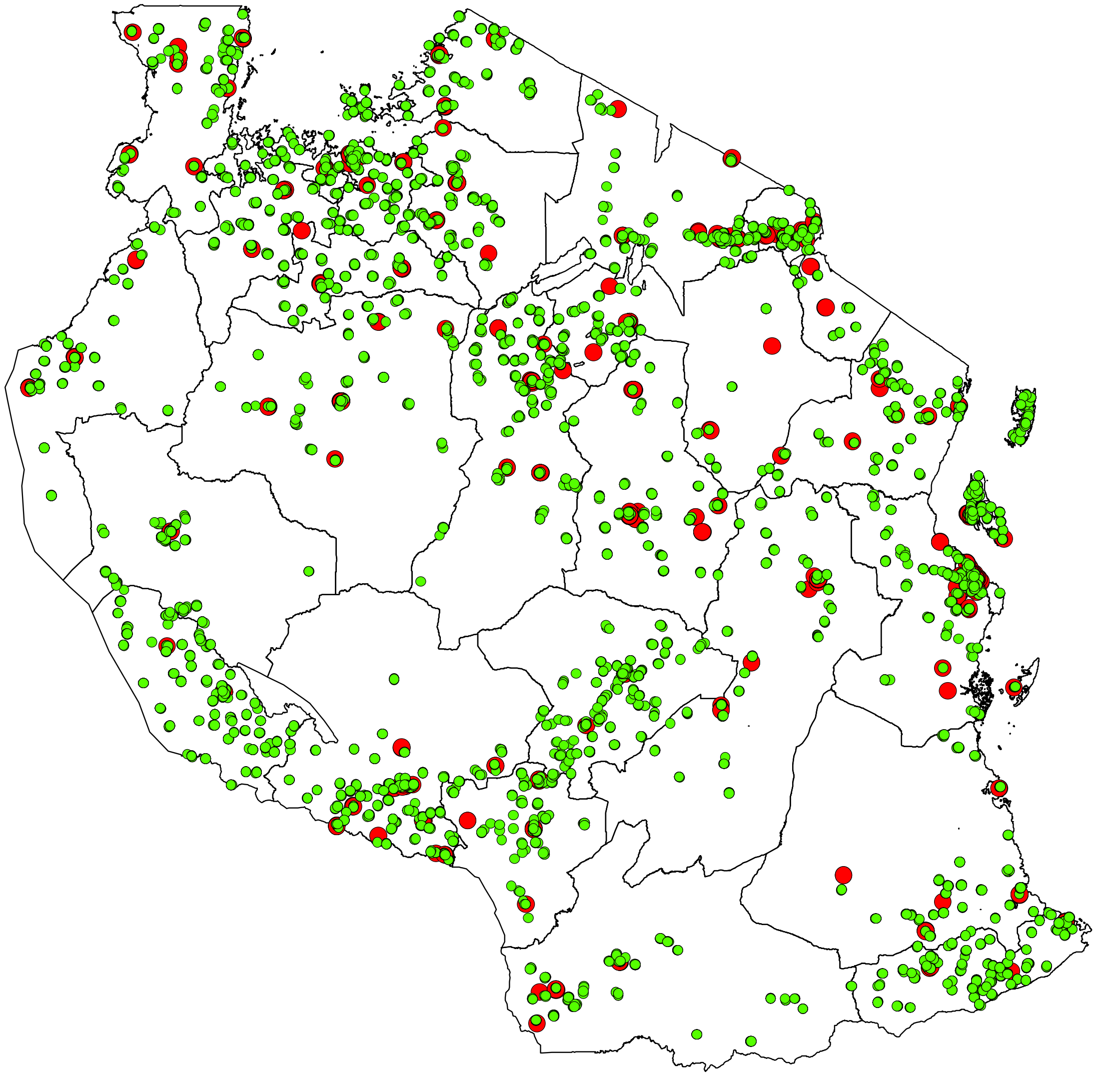
Figure A1: Locations of Households in the Sample and the Areas Where Vodacom and Tigo Mobile are Accessible in Tanzania



Notes: Green circles show the location of the households surveyed in Finscope data set. The blue areas show the areas where the networks of both Vodacom and Tigo mobile are accessible.

Figure A2: The Locations of Households of the Sample and Financial Institutions in Tanzania



Notes: Green circles show the location of the households surveyed in Finscope data set. The red circles show the location of the financial institutions (commercial banks, community banks and microfinance institutions.

(Online Appendices A, B and C are included for the purpose of refereeing. They are not for publication. They will be put on the online data page.)

Online Appendices A: First-Stage Results Corresponding to Panel B and Panel C of Table 5

Table A1. First-Stage Estimation Results of the 2SLS Estimation (2)

Endogenous Variable	Use of Mobile Money Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	-0.0154***	-0.0147***	-0.0129***	-0.0105***	-0.00900***
	(0.00178)	(0.00178)	(0.00185)	(0.00180)	(0.00185)
Negative shock dummy	0.0655***	0.0628***	0.0511***	0.0425***	0.0434***
	(0.0144)	(0.0144)	(0.0143)	(0.0137)	(0.0137)
R-squared	0.230	0.238	0.296	0.354	0.358
Kleibergen-Paap Rank Wald	73.93	67.56	49.22	34.23	24.01
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. This first-stage results correspond to the second-stage estimation shown in Panel B of Table 6. *** p<0.01, ** p<0.05, * p<0.1.

Table A2. First-Stage Estimation Results of the 2SLS Estimation (3)

Endogenous Variable	Use of Mobile Money Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	-0.0172***	-0.0166***	-0.0146***	-0.0120***	-0.0106***
	(0.00261)	(0.00261)	(0.00260)	(0.00253)	(0.00257)
Distance from Network Area ×	0.00315	0.00314	0.00291	0.00250	0.00276
Negative shock	(0.00349)	(0.00349)	(0.00345)	(0.00332)	(0.00332)
Negative shock	0.0706***	0.0679***	0.0558***	0.0466***	0.0478***
	(0.0158)	(0.0157)	(0.0157)	(0.0151)	(0.0150)
R-squared	0.230	0.238	0.296	0.354	0.358
Endogenous Variable	Use of Mobile Money Dummy × Negative Shock				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	0.00374***	0.00406***	0.00485***	0.00635***	0.00709***
	(0.000793)	(0.000796)	(0.000996)	(0.00110)	(0.00117)
Distance from Network Area ×	-0.0201***	-0.0201***	-0.0204***	-0.0206***	-0.0205***
Negative shock	(0.00252)	(0.00252)	(0.00254)	(0.00250)	(0.00250)
Negative shock	0.570***	0.569***	0.564***	0.560***	0.560***
	(0.0108)	(0.0108)	(0.0111)	(0.0110)	(0.0110)
R-squared	0.463	0.465	0.482	0.501	0.503
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Region (31 regions)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
Kleibergen-Paap Rank Wald	25.24	24.35	20.57	15.23	10.83
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. This first-stage results correspond to the second-stage estimation shown in Panel C of Table 6. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendices B: Controlling with District Dummy.

Table B1. First-Stage Estimation Results of 2SLS

Endogenous Variable	Use of Mobile Money Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	-0.0153***	-0.0146***	-0.0112***	-0.00961***	-0.00929***
	(0.00178)	(0.00178)	(0.00219)	(0.00212)	(0.00217)
R-squared	0.226	0.235	0.333	0.384	0.387
Kleibergen-Paap Rank Wald	73.93	67.56	25.92	20.54	18.29
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Districts (171 Districts)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table B2. The Estimation Results of 2SLS

Estimated Coefficients of Mobile Money Use Dummy on Borrowing

Dependent variable	Borrowing Dummy				
	(1)	(2)	(3)	(4)	(5)
Panel A					
Use of Mobile Money Dummy	-0.167	-0.194	-0.169	-0.172	-0.0865
	(0.138)	(0.146)	(0.230)	(0.263)	(0.276)
R-squared	-0.029	-0.039	-0.028	0.003	0.032
Kleibergen-Paap Rank Wald	73.93	67.56	25.92	20.54	18.29
Panel B					
Use of Mobile Money Dummy	-0.144	-0.167	-0.152	-0.160	-0.112
	(0.133)	(0.140)	(0.222)	(0.255)	(0.272)
Negative shock dummy	0.205***	0.205***	0.201***	0.194***	0.190***
	(0.0186)	(0.0187)	(0.0204)	(0.0200)	(0.0205)
R-squared	0.018	0.010	0.014	0.039	0.055
Kleibergen-Paap Rank Wald	75.08	68.71	26.21	20.66	18.11
Panel C					
Use of Mobile Money Dummy	0.0968	0.0750	0.241	0.216	0.294
	(0.152)	(0.157)	(0.230)	(0.266)	(0.282)
Mobie Money × Negative Shock	-0.469**	-0.471**	-0.643***	-0.613***	-0.627***
	(0.195)	(0.196)	(0.198)	(0.194)	(0.194)
Negative Shock	0.472***	0.473***	0.567***	0.543***	0.547***
	(0.114)	(0.115)	(0.118)	(0.115)	(0.115)
R-squared	-0.049	-0.059	-0.080	-0.048	-0.031
Kleibergen-Paap Rank Wald	25.24	24.35	12.83	10.24	9.107
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Districts (171 Districts)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table B3. The Second Stage Estimation Results of 2SLS
Estimated Coefficients of Mobile Money Use, Negative Shock and Their Interaction on Receipt of Remittance

Panel A					
Dependent variable	Receipt of Remittance Dummy				
	(1)	(2)	(3)	(4)	(5)
Use of Mobile Money Dummy	0.698***	0.703***	0.744***	0.761***	0.843***
	(0.126)	(0.130)	(0.186)	(0.215)	(0.233)
Mobie Money × Negative Shock	-0.107	-0.104	-0.0328	-0.0565	-0.0579
	(0.160)	(0.160)	(0.165)	(0.163)	(0.168)
Negative Shock	0.0958	0.0943	0.0429	0.0600	0.0557
	(0.0932)	(0.0934)	(0.0979)	(0.0964)	(0.0997)
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Districts (171 Districts)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
R-squared	0.261	0.260	0.211	0.218	0.188
Kleibergen-Paap Rank Wald	25.24	24.35	12.83	10.24	9.107
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes of Table 3 apply. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B4. The Second Stage Estimation Results of 2SLS
Estimated Coefficients of Mobile Money Use Dummy on Varioius Saving Methods

	Dependent variable				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
	Less Liquid Saving				
Use of Mobile Money Dummy	-0.240***	-0.250***	-0.419**	-0.443**	-0.454**
	(0.0866)	(0.0912)	(0.164)	(0.191)	(0.206)
Panel B.					
	Saving in Cash				
Use of Mobile Money Dummy	-0.179	-0.193*	-0.0554	-0.0625	-0.0633
	(0.110)	(0.116)	(0.182)	(0.213)	(0.226)
Panel C.					
	Saving in Mobile Money Account				
Use of Mobile Money Dummy	0.640***	0.623***	0.676***	0.640***	0.592***
	(0.104)	(0.108)	(0.170)	(0.195)	(0.204)
Panel D.					
	Saving in Saving Groups with MM Technology				
Use of Mobile Money Dummy	0.190***	0.196***	0.226***	0.234**	0.229**
	(0.0512)	(0.0537)	(0.0854)	(0.101)	(0.109)
Panel E.					
	Saving in Saving Groups without MM Technology				
Use of Mobile Money Dummy	0.0361	0.0195	0.0450	0.0336	0.141
	(0.0931)	(0.0971)	(0.149)	(0.171)	(0.185)
Panel F.					
	Saving at least in one method				
Use of Mobile Money Dummy	0.365***	0.334**	0.329	0.265	0.213
	(0.130)	(0.135)	(0.212)	(0.243)	(0.260)
Control Variables					
Negative Shock Dummy	Yes	Yes	Yes	Yes	Yes
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density & Night Light		Yes	Yes	Yes	Yes
Districts (171 Districts)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
Kleibergen-Paap Rank Wald	75.08	68.71	26.21	20.66	18.11
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes of Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table B5. The Second Stage Estimation Results of 2SLS
Estimated Coefficients of Mobile Money Use Dummy on Financial Difficulty

Dependent variable	Financial Difficulty to Pay Regular Expenses				
Variable	(1)	(2)	(3)	(4)	(5)
Panel A.					
Use of Mobile Money Dummy	-0.495***	-0.501***	-0.772***	-0.815***	-0.756**
	(0.155)	(0.160)	(0.250)	(0.288)	(0.299)
Mobie Money × No Negative Shock	0.258	0.255	0.331*	0.354*	0.355*
	(0.172)	(0.173)	(0.187)	(0.188)	(0.186)
No Negative Shock	-0.209**	-0.208**	-0.257**	-0.271**	-0.269**
	(0.0998)	(0.100)	(0.111)	(0.112)	(0.110)
Panel B					
Use of Mobile Money Dummy	-0.370***	-0.377***	-0.643***	-0.678***	-0.631**
	(0.120)	(0.126)	(0.219)	(0.258)	(0.273)
Negative Shock Dummy	-0.0622***	-0.0628***	-0.0683***	-0.0694***	-0.0665***
	(0.0167)	(0.0167)	(0.0196)	(0.0197)	(0.0199)
Control Variables					
Mobile Phone Ownership	Yes	Yes	Yes	Yes	Yes
Population Density& Night Light		Yes	Yes	Yes	Yes
Districts (171 Districts)			Yes	Yes	Yes
Demographic Characteristics				Yes	Yes
Distance to Financial Institutions					Yes
N	4,127	4,127	4,127	4,127	4,127

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

Online Appendices C: Estimation with Different Specifications

Table C1. First-Stage Estimation Results of 2SLS

Endogenous Variable	Use of Mobile Money Dummy				
	(1)	(2)	(3)	(4)	(5)
Distance from Network Area	-0.00929***	-0.00900***	-0.00912***	-0.00896***	-0.00885***
	(0.00217)	(0.00185)	(0.00186)	(0.00212)	(0.00158)
R-squared	0.387	0.361	0.356	0.356	0.362
Kleibergen-Paap Rank Wald	18.29	23.62	25.92	17.82	31.41
Specifcation					
Not Control Mobile Phone Ownership	Yes				
Control Income		Yes			
Transportation equipment			Yes		
|Distance|≤ 7.5km				Yes	
|Distance|≤15km					Yes
N	4,127	4,127	4,127	3,867	4,236

Notes: Robust standard errors in parentheses. Column (1)-(5) use the specificaiotn of column (5) in Table 4 except the specification described above. Column (1) in the above table include all control variables in Table 4 except mobile phone owership dummy. Coloum (2) include all control variable in column (5) of Table 4 and income as control variables. Column (3) in the above table includes the tranportation equipment (bicycle, motorcycle and car) ownership dummy and their interaction with the phyiscial distance to financial instituions in addtion to all control variables used in column (5) of Table 4. Column (4) in the above table uses as the sample the housheolds whose shortest distance to the areas with multiple mobile network areas is less than or equal to 7.5km. Column (5) uses as the sample the households whose shortest distance to the areas with multiple mobile networks is less than or equal to 15 km. *** p<0.01, ** p<0.05, * p<0.1.

Table C2. The Estimation Results of 2SLS

Estimated Coefficients of Mobile Money Use Dummy on Borrowing

Dependent variable	Borrowing Dummy				
	(1)	(2)	(3)	(4)	(5)
Panel A					
Use of Mobile Money Dummy	-0.0865	0.00216	-0.0460	-0.181	0.0138
	(0.276)	(0.246)	(0.245)	(0.290)	(0.214)
R-squared	0.032	0.051	0.040	0.000	0.052
Kleibergen-Paap Rank Wald	18.29	23.62	23.94	17.82	31.41
Panel B					
Use of Mobile Money Dummy	-0.112	-0.0417	-0.0744	-0.213	-0.00508
	(0.272)	(0.245)	(0.202)	(0.289)	(0.212)
Negative shock dummy	0.190***	0.183***	0.186***	0.192***	0.181***
	(0.0205)	(0.0198)	(0.0186)	(0.0218)	(0.0185)
R-squared	0.055	0.071	0.062	0.019	0.077
Kleibergen-Paap Rank Wald	18.11	23.14	33.98	17.58	31.14
Panel C					
Use of Mobile Money Dummy	0.294	0.222	0.170	0.0276	0.224
	(0.282)	(0.254)	(0.251)	(0.306)	(0.237)
Mobie Money × Negative Shock	-0.627***	-0.510***	-0.508***	-0.409*	-0.350**
	(0.194)	(0.188)	(0.191)	(0.240)	(0.162)
Negative Shock	0.547***	0.474***	0.476***	0.422***	0.376***
	(0.115)	(0.111)	(0.113)	(0.139)	(0.0932)
R-squared	-0.031	0.000	-0.015	-0.025	0.049
Kleibergen-Paap Rank Wald	9.107	10.66	10.62	8.683	15.64
Specifications					
Not Control Mobile Phone Ownership	Yes				
Control Income		Yes			
Transportation equipment			Yes		
∣Distance∣≤ 7.5km				Yes	
∣Distance∣≤15km					Yes
N	4,127	4,127	4,127	3,867	4,236

Notes: Robust standard errors in parentheses. This table is the robustness check of column (5) of Table 5 in section 5. Notes in Table C1 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table C3. The Second Stage Estimation Results of 2SLS
stimated Coefficients of Mobile Money Use, Negative Shock and Their Interaction on Receipt of Remittance

Panel A					
Dependent variable	Receipt of Remittance Dummy				
	(1)	(2)	(3)	(4)	(5)
Use of Mobile Money Dummy	0.843***	0.746***	0.744***	0.705***	0.918***
	(0.233)	(0.211)	(0.186)	(0.259)	(0.204)
Mobie Money × Negative Shock	-0.0579	-0.150	-0.0328	0.0645	-0.178
	(0.168)	(0.160)	(0.165)	(0.203)	(0.141)
Negative Shock	0.0557	0.117	0.0429	-0.00503	0.128
	(0.0997)	(0.0944)	(0.0979)	(0.117)	(0.0809)
Control Variables					
Not Control Mobile Phone Ownership	Yes				
Control Income		Yes			
Transportation equipment			Yes		
|Distance|≤ 7.5km				Yes	
|Distance|≤15km					Yes
R-squared	0.188	0.244	0.244	0.217	0.193
Kleibergen-Paap Rank Wald	9.107	10.66	10.62	8.683	15.64
N	4,127	4,127	4,127	3,867	4,236

Notes: Robust standard errors in parentheses. This table is the robustness check of column (5) of Table 7 in section 5. Notes in Table C1 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table C4. The Second Stage Estimation Results of 2SLS

Estimated Coefficients of Mobile Money Use Dummy on Varioius Saving Methods

	Dependent variable				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
	Less Liquid Saving				
Use of Mobile Money Dummy	-0.454**	-0.359**	-0.396**	-0.377*	-0.315**
	(0.206)	(0.175)	(0.175)	(0.196)	(0.149)
Panel B.					
	Saving in Cash				
Use of Mobile Money Dummy	-0.0633	-0.0145	-0.0475	-0.0130	-0.0937
	(0.226)	(0.207)	(0.204)	(0.240)	(0.180)
Panel C.					
	Saving in Mobile Money Account				
Use of Mobile Money Dummy	0.592***	0.604***	0.618***	0.661***	0.485***
	(0.204)	(0.193)	(0.192)	(0.227)	(0.153)
Panel D.					
	Saving in Saving Groups with MM Technology				
Use of Mobile Money Dummy	0.229**	0.214**	0.220**	0.208*	0.132
	(0.109)	(0.102)	(0.102)	(0.118)	(0.0845)
Panel E.					
	Saving in Saving Groups without MM Technology				
Use of Mobile Money Dummy	0.141	0.0982	0.0792	0.0997	0.184
	(0.185)	(0.173)	(0.171)	(0.197)	(0.145)
Panel F.					
	Saving at least in one method				
Use of Mobile Money Dummy	0.213	0.355	0.326	0.276	0.195
	(0.260)	(0.243)	(0.240)	(0.280)	(0.209)
Control Variables					
Negative Shock Dummy	Yes	Yes	Yes	Yes	Yes
Not Control Mobile Phone Ownership	Yes				
Control Income		Yes			
Transportation equipment			Yes		
$\lvert$Distance$\rvert \leq$ 7.5km				Yes	
$\lvert$Distance$\rvert \leq$15km					Yes
Kleibergen-Paap Rank Wald	75.08	68.71	26.21	18.11	20.66
N	4,127	4,127	4,127	3,867	4,236

Notes: Robust standard errors in parentheses. This table is the robustness check of column (5) of Table 8 in section 5. Notes in Table C1 apply. *** p<0.01, ** p<0.05, * p<0.1.

Table C5. The Second Stage Estimation Results of 2SLS

Estimated Coefficients of Mobile Money Use Dummy on Financial Difficulty

Dependent variable	Financial Difficulty to Pay Regular Expenses				
Variable	(1)	(2)	(3)	(4)	(5)
Panel A.					
Use of Mobile Money Dummy	-0.756**	-0.617**	-0.627**	-0.595**	-0.371*
	(0.299)	(0.266)	(0.266)	(0.288)	(0.202)
Mobie Money × No Negative Shock	0.355*	0.278	0.278	0.373*	0.106
	(0.186)	(0.176)	(0.178)	(0.214)	(0.145)
No Negative Shock	-0.269**	-0.222**	-0.221**	-0.273**	-0.115
	(0.110)	(0.104)	(0.105)	(0.123)	(0.0829)
Panel B					
Use of Mobile Money Dummy	-0.631**	-0.483**	-0.489**	-0.441*	-0.335*
	(0.273)	(0.232)	(0.229)	(0.259)	(0.192)
Negative Shock Dummy	-0.0665***	-0.0631***	-0.0619***	-0.0629***	-0.0554***
	(0.0199)	(0.0186)	(0.0182)	(0.0195)	(0.0167)
Control Variables					
Not Control Mobile Phone Ownership	Yes				
Control Income		Yes			
Transportation equipment			Yes		
|Distance| ≤ 7.5km				Yes	
|Distance| ≤15km					Yes
N	4,127	4,127	4,127	3,867	4,236

Notes: Robust standard errors in parentheses. This table is the robustness check of column (5) of Table 9 in section 5. Notes in Table C1 apply. *** p<0.01, ** p<0.05, * p<0.1.