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The Effect of Mobile Money on Borrowing and Saving: Evidence from Tanzania

by

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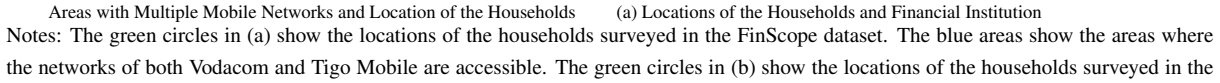
Figure 2: Locations of the Households and Financial Institution
and the Areas Where Vodacom and Tigo Mobile are Accessible in Tanzania



Notes: The green circles in (a) show the locations of the households surveyed in the FinScope dataset. The blue areas show the areas where the networks of both Vodacom and Tigo Mobile are accessible. The green circles in (b) show the locations of the households surveyed in the FinScope dataset. The red circle shows the location of the financial institution.

The shortest distance to the areas covered by 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 network availability maps using ArcGIS and extract 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 a negative value if a household is located inside the intersection (Figure 2(a)).

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 the 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 2(b)).

Summary Statistics

Tables 1 and 2 provide the summary statistics of the main variables. In total, 58 percent of the heads of the 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 lives within such an area. The mean of the shortest distance to the areas with a multiple mobile network is -1.6 km. The share of households that live in an area in which multiple mobile networks are available is 75 percent.

Table 2 shows 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 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, 21.3 percent of households saved in cash, 4 percent saved in saving groups that use mobile money technology to collect money from members, and 12.8 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 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.

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

Variables	Mean	Std. Dev.
Saved, Borrowed, and Received Remittances		
Saved in the past 12 months	0.511	0.500
Borrowed in the past 12 months	0.489	0.500
Received Remittances in the past 12 months	0.434	0.496
Frequency of Receiving Remittances in the past 12month	14.86	57.52
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 Microfinance Institution	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 in Relatives, Church, or Communities	0.045	0.206
Saved in Livestock 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 Microfinance Institution	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 Relatives 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.

4. Results

4.1. Effect on Borrowing

In Table 4 and Table 5, 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 dummies are coded one if a household experienced at least one negative shock in the past 12 months and zero otherwise. The sample is restricted to the head of the household. To control for the types of jobs of each household head, we include the income source dummy (nine categories) of each household in all the specifications. In Column (2), to control for the economic activity at each household's location, we include population density in 2015 and average night light luminosity in 2007 at the household's location. In addition, in Column (3), we include the region dummy (30 region dummies). In Column (4), we add the demographic characteristics as control variables, such as 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.

Table 3 shows the OLS estimation results. Table 4 shows the estimation results of the first stage of the 2SLS estimation. In Table 4, the dependent variable is the mobile money use dummy and the excluded instrumental variable is the shortest distance to the areas in which multiple mobile networks are available. The estimated coefficients of the instrumental variable are highly statistically significant and stable. Column (1) of Panel A of Table 4 shows that if a household is located 10 km away from the border of the areas covered by multiple mobile networks, the probability of using mobile money decreases by 15 percentage points.[13] 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.

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 the variable of 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 borrowing dummy variable is small, has the opposite sign, and is statistically insignificant. The sizes of the estimated coefficients are also economically insignificant. In Column (5), the estimated coefficient is -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. Thus, the difference in the estimated coefficient of the use of mobile money between the OLS estimation and 2SLS estimation means that the OLS estimation of the use of mobile money on the borrowing dummy variable is upward biased, suggesting that households that use mobile money are those who need to borrow. In contrast, the estimated coefficients of experiencing a negative shock are statistically and economically significant, positive, and stable in the 2SLS

[13] To be able to compare the effect of distance on using mobile money graphically, we consider a thought experiment of increasing distance by 10 km instead of 1 km.

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 income source dummy. For income source, there are nine categories. 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.

estimation. Column (5) of Panel B of Table 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-users of mobile money. Panel C of Table 5 relaxes this assumption and introduces the interaction term of the negative shock dummy and mobile money use dummy. For the instrumental variable of the interaction term, we use the negative shock dummy times the distance to the areas covered by 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 $0.47 - 0.58 \times 0.5 = 0.18$. 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 those who do not. For those who do not experience a negative shock, the use of mobile money increases the probability of borrowing by 20.5 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 $0.205 - 0.59 \times 0.5 = -0.09$, 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 effects of a negative shock for users and non-users of

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

Endogenous Variable	Use of Mobile Money Dummy				
Panel A	(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
Panel B					
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
Panel C					
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
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 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. Notes of Table 3 apply. ***p< 0.01, ** p<0.05, * p<0.1.

mobile money. For a robustness check, we examine the effect of a negative shock on mobile money users and non-mobile money users graphically. More specifically, we divide the sample households into those that experienced a negative shock and those that did not. Then, using the shortest distance from the border of the area with multiple mobile networks, we make 40 bins, where the size of each bin is 0.5 km. For households that did not experience a negative shock, we calculate the average probability of borrowing (red circle). Similarly, we calculate the average probability of borrowing for households that experienced at least one negative shock in the same bin (blue square).

Figure 3(a) shows that for households that are likely to use mobile money (households whose distance is negative and large), the effect of a negative shock on borrowing is relatively small. For households unlikely to use mobile money (distance to the border is positive and large), the effect of negative shocks is relatively large.

Figure 4 shows this exercise more concretely using regression analysis. First, we divide the main sample into 20 groups from -10 km to 10 km in increments of 1 km. Then, for each group, we regress the borrowing dummy on the negative shock dummy and a set of control variable. Next, we plot the estimated coefficient of the negative shock dummy on the vertical axis. In the third step, for each group, we calculate the average mobile money use rate and plot it on the horizontal axis. Figure 4 shows that as the average use rate of mobile money falls, the effect of a negative shock rises.

In summary, Table 5 shows that the effect of experiencing a negative shock on borrowing is almost equal to zero for mobile money users, while for non-users, it increases the probability of borrowing by 47 percentage points. Figure 3 and Figure 4 are consistent with those results. In the following subsections, we investigate why we observe this pattern of the effect of the use of mobile money and negative shocks on borrowing.

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 Dummy	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 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. Notes of Table 3 apply. *** p<0.01, ** p<0.05, * p<0.1.

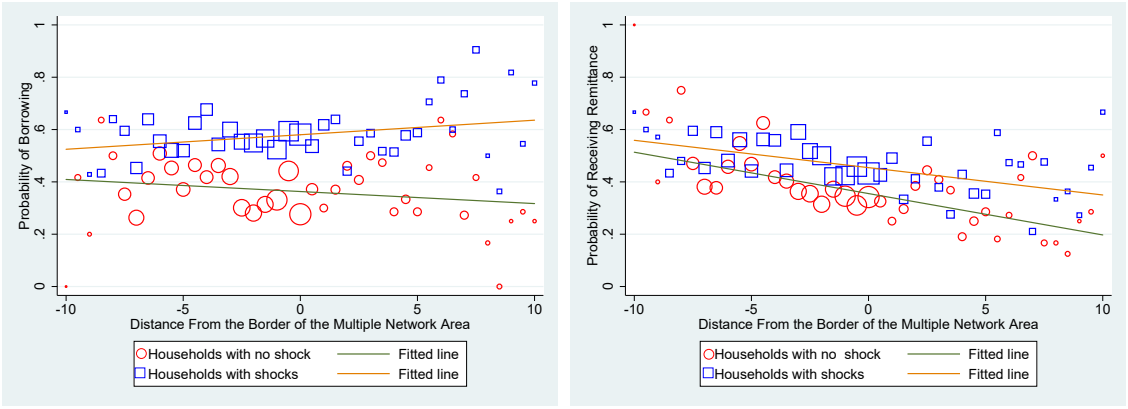
4.2. Orthogonality of Negative Shocks to the Instrumental Variable

One natural explanation of Panel C of Table 5 and Figure 3 is that a household that is far away from the areas covered by multiple mobile networks experiences different types of negative shocks than a household located inside those areas. Table S2 of the Supplemental Information examines such a possibility by regressing the frequency of negative shocks on the distance from the area with multiple mobile networks. The regression results show that the frequency of negative shocks is almost equal to zero and statistically insignificant, suggesting that different negative shocks are unlikely to arise in different locations.

4.3. Effect on Remittances

Several mechanisms may explain the difference in borrowing patterns between non-user and users of mobile money. First, 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. Second, the use of mobile money increases the probability of receiving remittances regardless of experiencing a negative shock due to the altruism of relatives and friends. A large amount of past remittances allows households to have sufficient savings. Sufficient savings can reduce demand for borrowing when a household experiences a negative shock. The third channel is that a household can change from saving through less liquid savings (e.g., savings in livestock and in the church and com-

Figure 3: The Probability of Borrowing and Receiving Remittances for Households with and without a Negative Shock

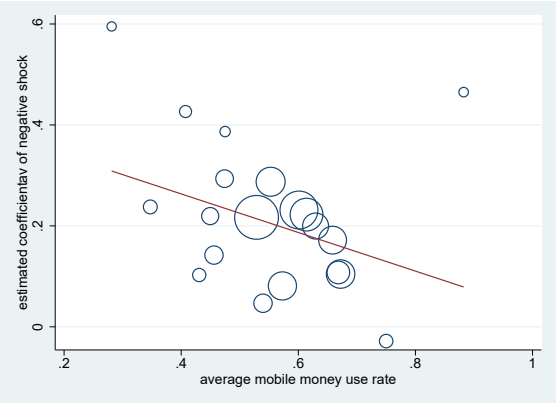


(a) Probability of Borrowing and Distance

(b) Probability of Receiving Remittances and Distance

Notes: Using the shortest distance from the border of the areas covered by multiple mobile networks, we make 40 bins, where the size of each bin is 0.5 km. For each bin, we calculate the average probability of borrowing (a) and receiving remittances (b) for two types of households: those that experienced at least one negative shock (blue square) and those that did not (red circle). The size of the circles and squares is the sample size of each cell. In (a), the slopes of the two lines have the opposite signs, while in (b), the slopes of the two lines have the same signs and the two lines are parallel. This shows that in (a) when a household is likely to use mobile money (distance is negative and large), the difference between the two fitted lines becomes small, showing that the effect of a negative shock on the probability of borrowing is small. In (b), when a household is likely to use mobile money, the difference between the two fitted lines does not change, showing that the effect of a negative shock on the probability of receiving remittances does not change.

Figure 4: The Differential Effect of Negative Shocks across Households with a Different Probability of Using Mobile Money



Notes: The sample is divided into 20 groups based on each household's distance to the areas covered by multiple mobile networks. For each group, the borrowing dummy is regressed on the negative shock dummy using OLS. The size of the estimated coefficient of the negative shock dummy is measured on the vertical 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.

munities) to saving in mobile money and banks.[14]

To narrow the possible mechanisms that generate the results in Table 5, Figure 3(a), and Figure 4, we first examine in Table 6 whether the use of mobile money increases the probability and frequency of receiving remittances when a household experiences a negative shock. Table 8 shows the 2SLS estimation results. In Panel A, the dependent variable is the receiving remittances dummy, which is equal to one if a household received a remittance in the past 12 months and zero otherwise. In Panel B, the dependent variable is the frequency of receiving remittances in the past 12 months.

In Panel A, the estimated coefficients show that the use of mobile money increases the probability of receiving remittances by 75 percentage points. The estimated coefficient of experiencing a negative shock is small (12 percentage points) compared with the effect of the use of mobile money and statistically insignificant.

In addition, the estimated coefficient of the interaction term is small, negative, and statistically insignificant. This implies that when a household experiences a negative shock, the probability that a user of mobile money receives a remittance is lower than that of a non-user. Thus, the pattern of receiving remittances is unlikely to explain the pattern of borrowing.

In Panel B, the effect of the use of mobile money is large but the estimated coefficient of the negative shock and its interaction term are small and statistically insignificant. Thus, both Panel A and Panel B of Table 6 show that the effect of a negative shock on receiving remittances and the frequency of remittances are unlikely to depend on the use of mobile money.

[14]The abovementioned 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.

Table 6. The Effect of the Use of Mobile Money, Negative Shocks, and Its Interaction on the Receipt and Frequency of the Receipt of Remittances (2SLS Estimation)

	Dependent Variable				
	(1)	(2)	(3)	(4)	(5)
Panel A	Receipt of Remittances Dummy				
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)
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
Panel B	Frequency of the Receipt of Remittances				
Use of Mobile Money Dummy	52.67***	51.96***	50.63***	54.51**	43.25*
	(15.19)	(15.42)	(18.09)	(22.08)	(26.05)
Mobile Money × Negative Shock	5.217	5.031	1.230	0.339	-1.153
	(19.60)	(19.55)	(19.42)	(19.61)	(19.25)
Negative Shock	-5.337	-5.238	-3.202	-2.500	-1.020
	(10.98)	(10.95)	(10.84)	(11.05)	(10.89)
R-squared	-0.042	-0.038	-0.031	-0.036	0.004
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 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. Notes of Table 3 apply. Both Panel A and Panel B show the estimation results of 2SLS estimation when the dependent variable is the receipt of remittance dummy and the frequency of receiving remittances. *** p < 0.01, ** p<0.05, * p < 0.1.

Figure 3(b) shows the reduced-form relationship between the distance from the border of the area with multiple mobile networks and average probability of receiving remittances. The red circles show the average probability of the receipt of remittances for households that did not experience negative shocks. The blue circles show the average probability for households that experienced negative shocks.

4.4. Effect on Saving and Saving Methods

Another possible channel through which a mobile money user does not need to increase borrowing when he or she experiences a negative shock is changing the saving portfolio to prepare for a future negative shock. As a result, when he or she experiences a negative shock, he or she does not need to borrow. To examine whether such a hypothesis is supported, we examine the probability of saving under 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.[15]

Panel A of Table 7 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 as less liq-

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

uid 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 statistically insignificant.

In contrast, Panels C and D of Table 7 show that the use of mobile money increases saving in a 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 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 the 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 similar to that in Columns (1) to (4). In the robustness check, we find that although the estimated coefficients are similar, they are often statistically insignificant. For example, in Panel F of Table B4, the estimated coefficients are significant only for Columns (1) and (2). This suggests that we do not find strong evidence that the use of mobile money increases the probability of saving in at least one asset.

4.5. Effect of Mobile Money on Livelihood

The final question is the extent to which the use of mobile money affects households' livelihood. Table 8 examines the effect of the use of mobile money on the probability of experiencing difficulty paying 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 use. 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 a negative shock for a mobile money user is almost equal to zero (-0.23+0.28=0.05). To see the effect of experiencing a negative shock on the difficulty in paying regular expenses for those who use 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 row of Panel A shows the chi-square and its p-value. The calculated P-value implies that we cannot reject the null hypothesis that the effect of experiencing a negative shock on financial difficulty for those who use mobile money is 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 such use. Panel B shows that the use of mobile money decreases the probability of experiencing financial difficulty by 49 percentage points. It also shows that experiencing a negative shock increases the difficulty paying regular expenses by 6 percentage points.

5. Robustness Checks

In Section S5 of SI, we conduct variety of robustness checks which include controlling district fixed effect, controlling income, controlling time distance to financial institution, controlling the pattern of mutual help of community of each respondent, using different subsample and checking the sensitivity of estimated coefficients by the inclusion of mobile phone ownership dummy. Our robustness checks show that the estimation results are quite robust.

6. Summary and Discussion

The findings of 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 frequency of negative shocks is not correlated with the distance from the border of mobile networks or use of mobile money. Third, we find that the use of mobile money affects the composition of saving methods. In particular, it decreases the probability of saving using less liquid saving methods such as saving through livestock, the church, and communities by 36 percentage points, while it increases saving in a mobile money account by 36 percentage points as well as in saving groups that adopt mobile money technology by 22 percentage points. Fourth, we show that the use of mobile money increases the probability of receiving remittances by 75 percentage points and that its effect is independent of experiencing a negative shock. This evidence suggests that the use of mobile money changes the saving portfolio, thereby 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, whereas a household that does not use mobile money needs to increase borrowing when such a shock occurs. Consistent with this interpretation, we find that experiencing a negative shock increases the difficulty paying regular expenses for non-users by 23 percentage points, while it does not affect the difficulty paying regular expenses for users.

Regarding the effect of mobile money on the economy, our analysis is consistent with previous analyses that show that mobile money affects many dimensions of economic activities. In particular, our results are consistent with previous studies that show that the use of mobile money mitigates negative shocks (Jack and Suri, 2014; Blumenstock et al., 2016; Riley, 2018).

Table 7. 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 Lights		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. All panels show the 2nd stage results of 2SLS estimation. *** p<0.01, ** p<0.05, * p<0.1.

However, they differ slightly from those of studies that show that the use of mobile money works like insurance, as they highlight that a household receives remittances more when experiencing a negative shock. In contrast, our analysis indicates that the use of mobile money increases the receipt of remittances, but its effect on the receipt of remittances is independent of negative shocks.

A natural question is why we have different results on the effect of the use of mobile money on the receipt of remittances for households with and without negative shocks. In Tanzania, mobile money was introduced in 2008 and our survey was conducted in 2017. Thus, a household that has been using mobile money in the intervening nine years could have saved sufficiently in liquid assets through increased remittances. Such a household does not need to decrease consumption in the presence of negative shocks. In addition, the negative shocks in our survey may be relatively small and the increased liquid savings through a change in the saving portfolio in previous years could offset the negative shock. Naito (2017) shows that the effects of the use of mobile money on the receipt of remittances in Zimbabwe are similar regardless of whether a household experiences a negative shock, which is consistent with our results. If this is so, the difference between the literature and our result indicates that the timing of the survey is critical. This should be explored in future research.

Regarding the effect of having a bank account on economic activity and welfare, our results are consistent with previous results that show that a bank account affects financial behav-

Table 8. Second-Stage Estimation Results of the 2SLS Estimation
Estimated Coefficients of the Mobile Money Use Dummy on Financial Difficulty

Dependent Variable	Financial Difficulty Paying 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)
Mobile 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
Joint F-test					
Testing Coef. of Mobile 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 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. Panel of the Join F-test 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. *** p<0.01, ** p<0.05, * p<0.1.

ior to a reasonable degree. For example, using randomized experiments, Dupas et al. (2018) find a large treatment effect on the treated, which is consistent with our finding. Our findings thus contribute to this literature by showing that mobile money changes saving portfolios and helps households absorb negative shocks through preparation.

7. Conclusion

Mobile money is becoming an important policy issue. The governments of developing countries recognize that mobile money transfers are an attractive tax base (Rukundo, 2017; Ndung'u, 2019) and financial regulators are planning to more strictly regulate the mobile money industry to balance the traditional banking sector and mobile money operators (Klein and Mayer, 2011; Khiaonarong, 2014; Lal and Sachdev, 2015).

On the other hand, in poor countries, the lack of access to credit and lack of safe and liquid saving methods are often policy targets. Mobile money solves these issues to some degree. This implies that the efficiency cost of taxation on mobile money transactions and stricter regulations on the mobile money industry will not be low. 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 the mobile money industry.

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The Effect of Mobile Money on Borrowing and Saving: Evidence from Tanzania

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Supplemental Information

S1 Institutional Background in Tanzania

In 2008, the Bank of Tanzania issued letters of no objection to the partner banks of Vodacom's M-PESA and Zantel's Z-Pesa (Di Castri & Gidvani, 2014), which allowed Vodacom and Zantel to start mobile money services. Following this no objection letter, in the same year, 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 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. Similarly, 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.

S2 Explanation of the Dataset

The FinScope Tanzania 2017 dataset was 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 non-governmental 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 the respondent to the interview.

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

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). This dataset is created from the detailed geographical information of the census dataset, and the resolution is 1 km. To calculate population density at each household location, we form a circle with a radius of 5 km and calculate the

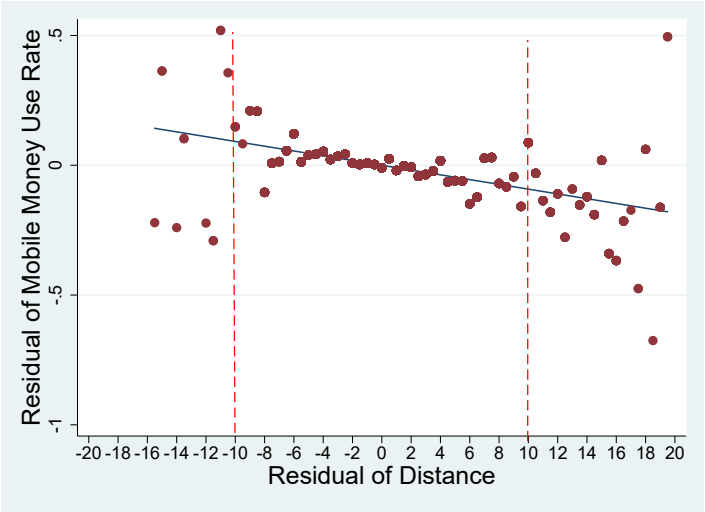
population density of each circle.

We use the night light luminosity data provided by the National Oceanic and Atmospheric Administration's National Geophysical Data Center (NOAA National Geophysical Data Center, 2019) following Henderson et al. (2012). To prevent endogeneity, namely, that mobile money affects economic activity and night light density, we use the night light luminosity data from 2007, the year before mobile money was introduced in Tanzania. The average built-up rate is created using the dataset provided by Wang et al. (2019), which was created using Landsat satellite imagery data. For both the night light luminosity data and the built-up rate data, we form a circle with a 5 km radius at the location of each household and calculate night light luminosity and the built-up rate.

S3 Relationship between the Distance to the Areas with Multiple Mobile Networks and Use of Mobile Money After Controlling for the Effect of the Control Variables

Figure S1 shows the relationship between each household's shortest distance to the areas covered by multiple mobile networks and the mobile money usage rate after controlling for the effect of the control variables. On the horizontal axis, we measure the residual from regressing each household's shortest distance to the areas covered by multiple mobile network accessibility on the control variables. On the vertical axis, we measure the residual from regressing the mobile money usage dummy on those control variables.

Figure S1: Shortest Distance to the Border of Multiple Network Areas and the Use of Mobile Money after Controlling for the Effect of the Covariates



Notes: The horizontal 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 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 the observations within [-20,20] are used.

S4 Orthogonality of a Negative Shock to the Distance from the Areas with Multiple Mobile Networks

One natural question from Figure 3 and Panel C of Table 5 is whether a household that is far away from the areas covered by 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 covered by 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 the areas covered by multiple mobile networks with several control variables using OLS. The estimated coefficients are economically and statistically insignificant. This shows that when the distance to the areas covered by 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 similar in households with different locations, suggesting that the criticism that the nature of negative shocks is different at different locations is not justified.

Table S1. Orthogonality of Negative Shocks: The Effect of Distance on Negative Shocks (OLS)

Dependent Variable	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 Luminosity		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 parentheses. Notes of Table 3 apply.

S5 Robustness Checks

S5.1 Controlling for the District Fixed Effect

In our estimation, we included 30 region dummies in addition to the population density and average night light luminosity of the area in which a household is located. The idea of including population density and average night light luminosity is to control for the difference in the economic activity of areas. One might argue, however, that controlling for the difference in economic activity using the region fixed effect, population density, and average night light luminosity is insufficient.

In this robustness check, we include 170 district dummies to control for the difference in the economic activity of areas. Tables B1–B5 show the first- and second-stage results when we include these district dummies as control variables in addition to the other control variables. The estimated coefficients and their standard errors are similar to those in Section 5. The only difference is that we use Kleibergen–Paap Rank Wald statistics to test the strength of the first stage of the 2SLS estimation. When we include all the control variables and 170 district dummies, the Kleibergen–Paap Rank Wald statistics become 9.1, which is slightly smaller than the threshold value of 10. This is likely due to the inclusion of so many control variables. However, none of the estimated coefficients or standard errors change substantially compared with those with a smaller set of control variables and 170 district dummies. This suggests that even when controlling for the district fixed effect, our results are robust.

Table B1. First-Stage Estimation Results of 2SLS :
Including District Dummies (171 Districts) as Control Variables

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:

Including District Dummies (171 Districts) as Control Variables

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 : Including District Dummies (171 Districts) as Control Variables

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.

S5.2 Endogeneity of Mobile Phone Ownership

In equation (1), we include the mobile phone ownership dummy as a control variable in x_i. Although the inclusion of this dummy follows the literature (Jack & Suri, 2014; Munyegera & Matsumoto, 2016), it 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 & Pischke, 2008). To observe how this occurs, assume that mobile phone ownership is a negative function of our instrumental variable, distance to the areas covered by 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 using mobile money increases. However, it also positively affects the probability of mobile phone ownership. 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 of mobile phone ownership) will downward bias 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 from 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 network coverage dummy) is also correlated with mobile phone ownership.[1] To address this problem, we run the 2SLS estimation without the mobile phone ownership dummy as one of the control variables and examine how the estimated coefficient of the use of mobile money is sensitive to the inclusion of the mobile phone ownership dummy. Column (1) in Tables C1–C5 shows that the estimated coefficient of mobile money use in the 2SLS estimation does not change without the mobile phone ownership dummy. This implies that the bias induced by including the mobile phone ownership dummy is unlikely to be serious.[2]

[1] 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.

[2] 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 actually negatively correlated with financial behavior. The assumption of a positive correlation between z_{1i} and financial behavior is not testable since we

S5.3 Controlling for Income

In Section 5, we included the negative shock dummy to examine the different effects of the use of mobile money. In that analysis, we did not include income as a control variable for two reasons. First, income is the outcome variable if a household that receives 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 discussed 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 downward.

On the other hand, one might argue that the instrumental variable is correlated with income, and thus 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 would be upwardly biased.

Column (2) in Tables C1–C5 shows the estimated coefficients when we control for income. We find that controlling for the effect of income does not affect the estimated coefficient. This suggests that the bias caused by excluding income from the control variables is not serious.

S5.4 Controlling for Time Distance to Financial Institutions

In Section 4, we included as a control variable the physical distance to several financial institutions such as commercial banks, community banks, and microfinance institutions. Such time distance depends on the ownership of transportation equipment (e.g., bicycle, motorcycle, and car), which is the outcome variable. A household that receives a substantial amount of remittances might purchase a motorcycle. Owing 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

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).

by controlling for the time distance instead of the physical distance. To do so, we include the ownership of transportation equipment interacted with the physical distance as the control variables. Column (3) in Tables C1–C5 show the estimation results when transportation equipment and the interaction term with physical distance are included as control variables. We find that the estimated coefficients and standard errors are similar to those in Section 4.

S5.5 Using Different Subsamples

In Section 5, we used households whose distance to the areas covered by 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 sample selection. In Column (4) of each table in Section S4.2, we use, as the sample, the households whose distance to the areas covered by multiple mobile networks is less than or equal to 7.5 km. The estimated coefficients and standard errors are similar to those obtained in Section 5. In Column (5), we use, as the sample, the households whose distance to the areas covered by multiple mobile networks is less than or equal to 15 km. Again, our estimated coefficients are similar to those obtained in Section 5. This suggests that as long as we choose the distance to the areas covered by multiple mobile networks as small as possible, the households selected are similar and our estimated coefficients change little.

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		
|Distance| ≤ 7.5km				Yes	
|Distance|≤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.

S5.6 Controlling for Social Networks and Community

Recently, several studies have pointed out the importance of social networks when adopting mobile money (Okello Candiya Bongomin et al., 2018; Okello Candiya Bongomin & Munene, 2021). Given such studies, one might have another concern for our estimation results: the shortest distance to the border of the areas covered by multiple mobile networks might be correlated with some of the characteristics of communities. More specifically, communities in which people have a strong tendency to help each other might be correlated with the shortest distance to the border of the areas with multiple mobile networks. If so, our 2SLS estimates measure not only the effect of the use of mobile money but also the effect of such communities. To examine such a possibility, we first construct a variable that measures the degree to which people in communities help each other. Then, we include this constructed index as an additional control variable in the regression.[3] Table D1 in Appendix D shows our 2SLS estimation results when we include the community index as an additional control variable. The estimated coefficient of the interaction term of the use of mobile money and adverse shock dummy changes from 0.50 to 0.49 when we include the community index. Thus, the estimated coefficient of the interaction term of the negative shock and mobile money dummy is virtually the same, even when controlling for the tendency of each community to help its members. Thus, it is improbable that the effect of community characteristics drives our results.

[3]The questionnaire of the FinScope dataset asked for agree/disagree responses to the following three statements: "You have people in the community that you can turn to for help if you need to"; "People in your community have a strong sense of involvement in the community"; and "People in your community rely on each other for support." We count the number of agrees for each respondent and standardize it so that the mean becomes zero and the standard deviation becomes one. We use this standardized value as the control variable.

Table D1. Estimation Results of the 2SLS Estimation

Estimated Coefficients of the Mobile Money Use Dummy on Borrowing by Including Community Mutual Help Index as an Additional Control Variable

Dependent variable	Borrowing Dummy				
	(1)	(2)	(3)	(4)	(5)
Use of mobile money dummy	0.0898	0.0680	0.211	0.184	0.209
	(0.152)	(0.157)	(0.180)	(0.214)	(0.249)
Mobile money × negative shock	-0.455**	-0.457**	-0.488***	-0.477**	-0.487***
	(0.194)	(0.195)	(0.187)	(0.186)	(0.187)
Negative shock	0.465***	0.466***	0.469***	0.458***	0.462***
	(0.114)	(0.115)	(0.110)	(0.109)	(0.111)
Community mutual help	0.0265***	0.0269***	0.0268***	0.0215**	0.0212**
	(0.00857)	(0.00867)	(0.00884)	(0.00836)	(0.00860)
R-squared	-0.043	-0.052	-0.015	0.003	0.006
Kleibergen-Paap Rank Wald	25.63	24.72	21.19	15.53	11.05
Control variables					
Mobile phone ownership	Yes	Yes	Yes	Yes	Yes
Population density and 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. Community Mutal Help Index is a variable that measures the degree in which the community in which each respondent reside help each other. This variable is constructed so that the mean of this variable is zero and its standard deviation is one. *** p<0.01, ** p<0.05, * p<0.1.

S5.7 Effect of the Use of Mobile Money on the Payment Method

Although this study focuses on financial behavior, mobile money can affect the payment method used. For example, using a field experiment, Aker et al. (2016) analyze the effect of utilizing mobile money as the payment method of the welfare system on consumption behavior. In Table E1, we examine whether the use of mobile money increases its use as a payment method for a type of good or service. We find that mobile money is increasingly being used as a payment method for food and utilities.

Table E1. Estimation Results of the 2SLS Estimation
Estimated Coefficients of the Use of Mobile Money Dummy on Using Mobile Money as a Payment Method for Different type of Goods and Services

Category	(1) For Food	(2) For School Fee	(3) For Medical Bill	(4) For Rent	(5) For Utility
Mobile money Dummy	0.271*	-0.0156	-0.00441	0.0489	0.270**
	(0.145)	(0.0544)	(0.00450)	(0.0379)	(0.134)
R-squared	0.162	0.011	-0.005	-0.059	0.133
Kleibergen-Paap Rank Wald	24.01	24.01	24.01	24.01	24.01
Control variables					
Mobile phone ownership	Yes	Yes	Yes	Yes	Yes
Population density and night light	Yes	Yes	Yes	Yes	Yes
Region (31 regions)	Yes	Yes	Yes	Yes	Yes
Demographic characteristics	Yes	Yes	Yes	Yes	Yes
Distance to financial institutions	Yes	Yes	Yes	Yes	Yes
N	4,127	4,127	4,127	4,127	4,127

Notes: Robust standard errors in parentheses. Notes in Table 3 apply. For each column, the dependent variable is the use of mobile money as a payment method for the category of goods or services shown under the category raw. For example, in column (1), the depedent variable is the use of mobile money dummy as a payment method for food. *** p<0.01, ** p<0.05, * p<0.1.

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