

Mobile money, food security and coping strategies in a post-conflict and fragile context: evidence from Burundi

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Abstract

Purpose – Attaining the Sustainable Development Goal 2 (SDG2) of zero hunger continues to be a challenge in most parts of Sub-Saharan Africa. However, financial inclusion is seen as a potential pathway for reducing food insecurity among poor households. Mobile money is a financial inclusion instrument that is easily accessible to poor households and has the potential to increase the level of financial inclusion. This paper contributes to the literature by examining the determinants of mobile money adoption, its effects on household food security and the choice of coping strategies in Burundi, a post-conflict and fragile country.

Design/methodology/approach – Using survey data that involved 860 households in Burundi, we adopted the Household Hunger Scale (HHS) developed under the Food and Nutrition Technical Assistance Project to measure household food security. We further employ the endogenous switching regression treatment effects model for ordered outcomes and the multivariate probit model to achieve our aims.

Findings – The results of our study reveal that the adoption of mobile money is influenced by factors such as gender, marital status, age, formal education, membership in a social network, area of residence and access to a tarred road network. Additionally, the food security status of a household was determined by marital status, formal education, social network membership, access to tarred roads, off-farm income, access to credit and land tenure security. We confirm that mobile money adoption has a significantly positive effect on the food security status of households with heterogeneity in gender and area of residence. We also find that mobile money adoption reduces the likelihood of households adopting consumption-related coping strategies.

Practical implications – The promotion of mobile money should, therefore, be included in Burundi's national food security policies.

Originality/value – This study contributes to the literature by providing empirical evidence on the effect of mobile money adoption on household food security and the choice of coping strategies in a post-conflict context.

Keywords Food insecurity, Digital financial inclusion, Endogenous switching regression, Impact, Heterogeneous effects

Paper type Research paper



1. Introduction

Food insecurity remains a challenge, especially in Sub-Saharan Africa (SSA) and other resource-poor countries, where an estimated 768 million people are said to face hunger (FAO *et al.*, 2021). Although food insecurity affects the lives of people globally, its impacts are anticipated to be protracted in conflict-affected countries (Holleman *et al.*, 2017), such as Burundi. Food insecurity manifests negative implications for health and well-being (Weaver *et al.*, 2021), children's school outcomes (Mohammed, 2023), labor productivity and earnings (Mishra and Rampal, 2020), as well as other welfare indicators. Such impacts are expected to be severe in post-conflict and fragile countries that are characterized by weakened institutions and infrastructure (Nkurunziza, 2019).

Studies demonstrate that financial inclusion plays an important role in enhancing the welfare of households (Atta-Aidoo *et al.*, 2022a, 2023a; Koomson *et al.*, 2020; Munyegera and Matsumoto, 2016). However, the adoption and use of traditional means of financial inclusion such as bank and microfinance accounts remain low globally (Atta-Aidoo *et al.*, 2023b; Demirguc-Kunt *et al.*, 2015). Over the past decade and a half, mobile money has emerged as a tool for bridging the financial inclusion gap, especially in SSA (Demirguc-Kunt *et al.*, 2015). Mobile money has proved useful, especially in connecting rural Africa to basic financial services, as the majority of households in these areas are unbanked (Demirguc-Kunt *et al.*, 2022). Mobile money involves the use of mobile phones to perform financial and banking functions (IFC, 2011). The high penetration of mobile money in SSA implies that households that ordinarily would not have had access to financial services now have access and are thus enjoying their associated benefits.

The adoption of mobile money has been on an increasing trajectory over the past decade, with significant sub-regional differences (GSMA, 2022). Eastern Africa, which comprises Burundi, has witnessed a 15% increase in registered accounts, an 8% increase in active mobile money account holders and recorded a transaction volume of US\$24 billion, which is a staggering 22% increase (GSMA, 2022). While countries in Eastern Africa, such as Kenya, continue to be the leaders in mobile money adoption, others, such as Burundi, are now catching up, albeit at a slower pace due to inherent country characteristics (Suri, 2017; World Bank, 2020). Mobile money adoption is of great concern to international development agencies because it has a significant and positive effect on the overall level of financial inclusion in the developing world (Bongomin *et al.*, 2021). It is this financial inclusion-enhancing effect of mobile money that has made it a topic of discussion among development experts. Some studies have examined the adoption process and the welfare impacts of mobile money in relatively stable SSA contexts (see; Afawubo *et al.*, 2020; Koomson *et al.*, 2022; Wieser *et al.*, 2019). Varied results have been reported in these studies across the sub-Saharan region; for example, Afawubo *et al.* (2020) report that being a client of a financial institution increases one's likelihood of adopting mobile money, in addition to the fact that households benefit from the weak ties of social groups for mobile money adoption. Wieser *et al.* (2019), on the other hand, find weak evidence to support the benefits of adopting mobile money, especially in rural areas and among vulnerable households who may not own a mobile phone. These authors therefore question the transformative effect of mobile money as heralded by several development agencies.

Additionally, a review of the empirical studies on the mobile money-food security nexus (for example, Abdul-Rahman and Abdullahi, 2022; Aker *et al.*, 2016; Jack and Suri, 2014; Jack *et al.*, 2013; Kikulwe *et al.*, 2014; Munyegera and Matsumoto, 2016; Murendo and Wollni, 2016) reveal gaps in the literature. For example, Aker *et al.* (2016) highlight the impact of mobile money cash transfer programs on household poverty in Niger. Others such as Kikulwe *et al.* (2014) examined the effect of mobile money on household income. Jack and Suri (2014) examined the effect of mobile money on consumption smoothing, Abdul-Rahman and Abdullahi (2022) examined the impact of mobile money on agricultural production input use

and farm output, while [Munyegera and Matsumoto \(2016\)](#) examined the effect of mobile money on per capita consumption. Although evidence seems to suggest that mobile money adoption can significantly improve the welfare of all, it is unclear whether the same can be said for marginalized groups such as women and rural dwellers who have to deal with the cost of securing a mobile phone to register for such services. This may be particularly true for Burundi, which has experienced high levels of poverty since the 1960s, with poverty levels being extremely high in provinces that were most affected by past conflicts ([Mercier and Verwimp, 2017](#); [Nkurunziza et al., 2012](#)). Our study addresses this gap by examining the effect of mobile money adoption on household food security and the probability of enacting coping strategies in Burundi. Our research contributes to the literature by addressing four objectives: First, we investigate the determinants of mobile money adoption in Burundi. Second, we examine the determinants of food security in Burundi and assess the effect of mobile money adoption on household food security. Third, our study recognizes the possibility of heterogeneity in the effect of mobile money adoption on food security and as such, we estimate the effect of mobile money adoption on different groups in Burundi (specifically, the effect on rural versus urban households and the effect on female-headed versus male-headed households). Lastly, we examine the effect of mobile money adoption on the choice of food insecurity coping strategies among households in Burundi.

Our choice of Burundi as the study location was informed by the following reasons. To begin with, Burundi has been engulfed in six civil wars since it attained independence in 1962 ([Nkurunziza, 2019](#)). These episodes of conflict have rendered the country fragile and characterized by weak institutions, therefore making mobile money a better alternative to the traditional banking system ([Nkurunziza et al., 2012](#)). Mobile money accounts may be better alternatives in this context because they reduce the transaction costs involved in accessing traditional financial services ([Jack and Suri, 2014](#); [Yao et al., 2023](#)), especially in a country whose infrastructure has been damaged by long periods of conflict. Also, compared to its regional peers such as Kenya, Tanzania, Uganda and Rwanda, financial inclusion in Burundi remains significantly low despite numerous government interventions ([GPFI and BRB, 2014](#)). This makes a strong case for examining the determinants of mobile money as this can be an avenue to bridge the financial inclusion gap. Furthermore, it has been estimated that the welfare-enhancing impact of financial inclusion can be greater in fragile economies. As such, providing evidence to this claim can inform policy direction that can simultaneously enhance financial inclusion and food security.

The remainder of this article is organized as follows. A review of the relevant literature is provided in [Section 2](#). [Section 3](#) covers the research methodology, while [Sections 4](#) and [5](#) entail the results and discussion and conclusion and recommendation sections, respectively.

2. Literature review

2.1 Theoretical perspectives

The theory of financial development ([King and Levine, 1993](#); [Rajan and Zingales, 1998](#)) and the theory of access ([Ribot and Peluso, 2003](#)) form the basis of this study. Development in financial systems has made it difficult to provide a succinct definition of financial inclusion. [Dimiz et al. \(2012\)](#) define financial inclusion as involving access to formal financial services at an affordable cost for all members of an economy. More broadly, [Triki and Faye \(2013\)](#) contend that financial inclusion consists of all initiatives that make formal financial services available, accessible and affordable to all members of the public.

On one hand, financial development entails the expansion of financial systems through improvements in the indicators of financial inclusion such as ownership of a bank account, microfinance account, insurance, credit access and other financial products ([Atta-Aidoo et al., 2023a, b](#); [Demirgüç-Kunt et al., 2015, 2018](#); [Koomson et al., 2020, 2022](#)). Deducing from the

theory put forward by [King and Levine \(1993\)](#) and [Rajan and Zingales \(1998\)](#), the food security status of a household can be influenced in two directions given improvements in the indicators of financial inclusion. First, financial inclusion can directly influence household food security through the provision of financial resources necessary for day-to-day food consumption needs. Second, financial inclusion can indirectly influence household food security, where resources from financial inclusion are used to acquire education and durable assets or invested in businesses, which can provide income for smoothening food consumption over time.

On the other hand, the theory of access developed by [Ribot and Peluso \(2003\)](#) argues that while people may have the right to access a resource, they may not be able to use it productively to benefit from it due to a lack of structural and relational mechanisms such as “capital, technology, labour, knowledge, authority, market mechanisms, social relations, and identity”. Although the theory’s proponents limited its application to property, it has since been broadened beyond its initial scope. For example, [Mutea et al. \(2020\)](#) applied the access theory and argued that a majority of the population faces numerous challenges, such as insufficient access to financial resources and high transaction costs due to poor infrastructure. Faced with these challenges, most people are limited in their access to productive resources and are prevented from increasing their market participation. This ultimately sinks them into poverty and causes food insecurity.

2.2 Mobile money and food security

Mobile money as an indicator of financial inclusion involves the use of a mobile phone as a channel to conduct payments, manage accounts and access financial services, such as loans and savings. Given that the majority of the world’s population remains unbanked, mobile money services have become a game changer by enabling the unbanked to register for mobile money accounts, thus providing access to financial services ([Bharadwaj and Suri, 2020](#); [Gencer, 2011](#); [Johnen et al., 2021](#)). Benefits associated with the adoption of mobile money include reduced transaction costs due to easy accessibility, convenience and reliability in delivering financial services ([Kikulwe et al., 2014](#)). Additionally, mobile money is a cheaper option for transferring and receiving money ([Donovan, 2012](#)). The advent of mobile money has also increased the range of financial services available to people who are not part of traditional financial institutions ([IFC, 2011](#)).

The benefits associated with mobile money have been documented to translate into better welfare standards for households. For example, [Murendo and Wollni \(2016\)](#) indicate that mobile money use was associated with reduced food insecurity in Uganda. Additionally, [Jack and Suri \(2014\)](#) demonstrate that mobile money use in Kenya cushioned households against consumption shocks. Mobile money can also help households manage their finances better, especially during periods of both economic and political crisis, by enabling them to send and receive money quickly and efficiently ([Mas and Morawczynski, 2009](#)). Mobile money can therefore cushion households against crisis-related consumption challenges. Mobile money access and use have the potential to double nonfarm self-employment and hence translate into a significant reduction in household food insecurity ([Wieser et al., 2019](#)). In Kenya, it was found that mobile money can enhance food security by facilitating time-sensitive money transfers, improving food production and increasing access to and consumption of diversified foods among households ([Nagarajan and Haas, 2011](#)).

2.3 The state of mobile money in Burundi

The utilization of mobile money in Burundi is less advanced compared with its East African neighbors. As of 2021, Burundi had a mobile money usage rate of 11%, compared to 45%,

54% and 69% in Tanzania, Uganda and Kenya, respectively (World Bank, 2020). This is attributable to the equally low penetration of mobile phone ownership and limited access to electricity, which is very common in SSA countries like Burundi (Bhavnani *et al.*, 2008; Mthobi and Grzybowski, 2017). Countries like Kenya, which boasts the highest number of mobile money users in East Africa, also exhibit substantial mobile phone ownership of about 93% (Afrobarometer, 2022) and electricity accessibility of about 75% (Africa Energy Portal, 2019).

However, the mobile money system in Burundi is evolving and growing with time. According to the World Bank (2020), most subscribers on mobile phones rely on the 2G network, which represents 66% of the total subscribers in the first quarter of 2020. The report further indicated that mobile money was the second most used function of mobile phones in the country, an indication that the use of mobile money is on the rise. Despite this, the penetration rate of mobile phones in Burundi is criticized as being low, but some noticeable progress should be recognized as it has moved from 28% in 2012 to 36.8% in 2020 (Bank of the Republic of Burundi, 2012 [1]; World Bank, 2020). The number of electronic money transactions conducted using mobile money services represented 96.1% of the total electronic money transactions made in 2018 (Bank of the Republic of Burundi, 2018) [2]. In addition to Kenya, Rwanda, Tanzania and Uganda, Burundi is home to 49 out of the 111 digital financial services targeted at agriculture (GSMA, 2022). Such successes point to the fact that Burundi is gradually catching up in terms of mobile money adoption and usage. However, there is a stark rural-urban divide in terms of mobile network coverage, making it difficult for rural residents to fully take advantage of the mobile money revolution (World Bank, 2020).

3. Research methodology

3.1 Study area and data

The data used for this study are derived from a household survey in Burundi conducted from October to November 2021 for an African Economic Research Consortium project that aimed to examine the impact of financial inclusion on household welfare. A total of 860 households were sampled in five provinces, representing approximately 30% of 18 provinces. Purposive sampling of provinces was conducted based on two criteria: first, the level of growth of SMEs and proximity to neighboring countries where the adoption of mobile money is expected to be higher. The provinces selected were Ngozi, Bujumbura Rural, Bujumbura Mairie, Rumonge and Kayanza. The selected provinces were further stratified into rural and urban areas, leading to the random selection of one urban commune and one rural commune within each selected province. This made up a total of ten communes selected for the study. Further, a random walk approach was used to select the households involved in the study. Table A1 in Appendix 1 shows the distribution of sampled households from each province.

The process of determining the sample size was influenced by the availability of resources and timeline constraints, as observed in most social science research. The methods proposed by Roscoe (1975) and Green (1991) were consulted to establish the sample size. Roscoe (1975) recommended that the minimum sample size should be 10 times higher than the number of independent variables, a guideline confirmed by Rahman (2023). On the other hand, Green (1991) suggested a procedure where the sample size should be $N \geq 50 + 8*m$ (where m equals the number of independent variables). Based on these methods, a minimum sample size of 500 was determined and evenly distributed across the five provinces. Discrepancies in sample sizes among provinces were attributed to the availability of respondents.

3.2 Measurement of household food security

We adopted the Household Hunger Scale (HHS), developed under the Food and Nutrition Technical Assistance Project (FANTA) as a measure of household food security. The HHS is a simple but effective measure of household hunger in food-insecure areas. The distinguishing feature of the HHS is that it was specifically developed and validated for cross-cultural use (Ballard *et al.*, 2011). This measure of household food security is capable of producing valid and comparable results across cultures and settings, so that the status of different population groups can be described in a meaningful and comparable way. This measure of household food security has been successfully utilized in studies in Ghana and Zambia (see Nkegbe *et al.*, 2017; Nkomoki *et al.*, 2019).

In soliciting a household's hunger situation, a four-week (one month) recall period is set as a standard in the data collection period. The three questions under the HHS module are: (1) Was there ever no food at all in your household because there were no resources to get more? (2) Did you or any household member go to sleep at night hungry because there was not enough food? (3) Did you or any household member go a whole day and night without eating anything because there was not enough food? The responses to the questions are categorized as rare = 0 (twice a month), sometimes = 1 (3–10 times) and often = 2 (more than 10 times). The values are then added up for the three questions, and the scores obtained range from 0–6. The HHS categories are as follows: little or no hunger (scores 0–1), moderate hunger (scores 2–3) and severe hunger (scores 4–6) (Leroy *et al.*, 2015). Table A2 in Appendix 1 shows the food security status of sampled households in Burundi as measured using the HHS.

3.3 Estimation technique for the impact of mobile money adoption on food security

Based on the ordered outcome variable (food security; HHS), the endogenous switching regression treatment effects model for ordered outcomes as developed by Gregory (2015) is the appropriate impact evaluation estimation method for this study. The underlying assumption of the model is that the treatment (adoption of mobile money) and the outcome (food security) are endogenous and thus partition individuals into two regimes based on household food security of those who have adopted mobile money and those who have not adopted mobile money.

Based on this assumption, the selection equation, which represents the treatment model measuring the factors influencing the adoption of mobile money, is specified as

$$MomoAdopt_i = \begin{cases} 1 & \text{if } MomoAdopt_i^* = \alpha X_i + \eta Z_i + \mu_i > 0 \\ 0 & \text{if } MomoAdopt_i^* = \alpha X_i + \eta Z_i + \mu_i \leq 0 \end{cases} \quad (1)$$

where $MomoAdopt_i$ is mobile money adoption (1 if the household head is a mobile money adopter and 0 otherwise); X_i is the explanatory variables that influence mobile money adoption, Z_i is an instrument defined to influence household food security only through mobile money adoption and μ_i is the error term.

Based on the selection Equation (1), the outcome (household food security) function is specified as

$$HFS_{0i} = \begin{cases} 1 & \text{if } -\infty < \beta_0 X_{0i} + \varepsilon_{0i} \leq e_{01} \\ 2 & \text{if } e_{01} < \beta_0 X_{0i} + \varepsilon_{0i} \leq e_{02} \\ 3 & \text{if } e_{02} < \beta_0 X_{0i} + \varepsilon_{0i} \leq \infty \end{cases} \quad (2)$$

For mobile money non-adopters regime and

$$HFS_{1i} = \begin{cases} 1 \text{ if } -\infty < \beta_1 X_{1i} + \varepsilon_{1i} \leq e_{11} \\ 2 \text{ if } e_{11} < \beta_1 X_{1i} + \varepsilon_{1i} \leq e_{12} \\ 3 \text{ if } e_{12} < \beta_1 X_{1i} + \varepsilon_{1i} \leq \infty \end{cases} \quad (3)$$

For mobile money adopters' regime for the three ordered outcomes.

HFS_{1i} is household food security and X_i is as defined earlier. Equations (1)–(3) were implemented using the “switchprobit” written by Gregory (2015) in STATA. The command simultaneously estimates the three equations using a maximum likelihood approach under the assumption that the unobservable errors in the treatment and the outcome equations have a bivariate normal distribution and that outcomes for the treated and untreated groups are distinct. Simultaneously estimating the equations ensures that consistent standard errors are estimated leading to the correction of selectivity bias and endogeneity in the estimates.

Following the estimation of Equations (1)–(3), the ATT is specified as

$$ATT_{kj} = \frac{1}{N} \frac{1}{S} \sum_{i=1}^N \frac{1}{E\{\Phi(\alpha X_{ik})\}} \left[\sum_{s=1}^S \sum_{\theta=0}^{\theta=1} \{I x (FI_{ik} = \theta)\} \Phi(\alpha X_{ik} + \eta_{is}) x \langle \Phi\{\varepsilon_{1j} - (\beta_1 X_{1ik} + \mu_{1k} \eta_{is})\} - \Phi\{\varepsilon_{1j-1} - (\beta_1 X_{1ik} + \mu_{1k} \eta_{is})\} - \Phi\{\varepsilon_{0j} - (\beta_0 X_{0ik} + \mu_{0k} \eta_{is})\} - \Phi\{\varepsilon_{0j-1} - (\beta_0 X_{0ik} + \mu_{0k} \eta_{is})\} \right] \quad (4)$$

ATT is the average treatment effect on the treated (which measures the effect of mobile money adoption on household food security for those who have adopted mobile money).

3.4 Instrumental variable

To overcome the potential problem of endogeneity in estimating the treatment effect model, it is appropriate to include at least one instrument that affects mobile money adoption but not household food security. The instrumental variable we employ in our study is whether the sampled household has any family relatives or acquaintances outside their home (i.e. non-household members) who have a mobile money account. This was adapted from the study of Liu *et al.* (2021), who used the number of acquaintances who were known by each sample household to be using e-commerce to sell goods. The intuition behind the choice of this instrument is that knowing that a family relative or acquaintance has a mobile money account will directly influence the decision of the household head to also register for a mobile money account. On the contrary, knowing that a relative or acquaintance has a mobile money account is not expected to directly influence food insecurity unless it indirectly goes through the adoption of a mobile money account. The falsification test as suggested by Di Falco *et al.* (2011) and used by other studies (e.g. Liu *et al.*, 2021) was used to check the validity of our instrument. The falsification test involves regressing the outcome variable(s) on a set of original regressors now including the excluded instrument but using only the subsample of the non-adopters. A valid instrument in this case should be one that significantly correlates with households' adoption of mobile money but hardly has any direct effect on the food insecurity status of the household. Table A3 in Appendix 1 provides evidence of this effect. The results show that our instrumental variable significantly increases the likelihood of adopting mobile money, but it has no significant effect on our outcome variable (i.e. household food insecurity) for the subsample of households who had not adopted mobile money. This confirms the validity of the instrumental variable used.

3.5 Food insecurity coping strategies

The data contained information on 12 food insecurity coping strategies [3] employed by sampled households during the past year. We retained the 5 most used strategies (based on frequency) for compensating shocks to food access. These were (1) reducing diet quality, (2) reducing the portion of adults' food to favor children, (3) reducing the portion of food for all household members, (4) seeking community assistance and (5) skipping meals. For each of these strategies, we created a dummy variable equal to 1 if the household reported using that coping strategy during the year before the survey and 0 otherwise.

3.6 Estimation technique for the effect of mobile money adoption on the choice of coping strategy

We employ the multivariate probit model to examine the effect of mobile money adoption on the choice of coping strategies by the sample households. The multivariate probit model was used due to its ability to simultaneously analyze the causal effect of mobile money adoption on each coping strategy while allowing for the potential correlation between the unobserved errors and the relationship between the utilization of the different coping strategies (Belderbos *et al.*, 2004). Greene (2012) demonstrates that the use of a multivariate probit model, unlike using univariate probit/logit models, in modeling the simultaneous adoption of several alternatives yields unbiased and efficient estimates. This is because the multivariate probit model can capture the unobserved factors and the interrelationship among the utilization of the various coping strategies available to households. The error terms of the multivariate probit model are known to jointly follow a multivariate normal distribution with a zero conditional mean and with the variance normalized to unity. Therefore, it produces a symmetric covariance matrix, with the non-zero off-diagonal elements representing the unobserved correlation between the stochastic components of the different coping strategies. The positive coefficients of the resultant matrix establish complementarity between the pair of coping strategies, while the negative coefficients indicate that the pair of coping strategies are substitutes.

4. Results and discussion

4.1 Sample characteristics

The descriptive statistics of the variables used in the study are presented in Table A4 in Appendix 1. About 65% of the 860 study respondents had mobile money accounts. The average age of respondents was about 44 years, indicating that household heads were relatively young and productive. This is consistent with the latest population estimates of Burundi, which indicate that the country is largely a youthful one (United Nations Population Fund [UNFPA], 2012). The majority of household heads (53.02%) interviewed were females, while about 68% of respondents reported being married. This resonates with the latest population estimates of Burundi, which indicate that 50.3% of the country's population is female (World Bank [WB], 2022). Although most female respondents had earlier listed their husbands as the head of their households, further interrogation revealed that most husbands lived in different locations due to their employment and as such the females had to assume such roles. The average farm size of respondents who reported being engaged in agriculture was about 1.4 acres. This implies that the majority of farm households were smallholder in nature. The test of mean differences revealed that there were significant differences between households that had mobile money accounts and those without mobile money accounts in all variables except their farm sizes. As expected, the mean of the instrumental variable is significantly higher for households that have mobile money accounts than for those that do not have accounts.

4.2 Frequency distribution of food security status of sampled households

Figure A1 in Appendix 2 presents the percentage frequency distribution of the food security status of sampled households categorized by their adoption of mobile money in Burundi. About 18% of households were classified as encountering no or light hunger, which is to say they are relatively food secure compared to their compatriots. About 12% of households fall under the severe hunger category, implying that they were the most food insecure within the sample. About 70% of the sampled households experienced moderate hunger, indicating that they were moderately food insecure. The observed trend in household food security resonates with the findings of Desiere *et al.* (2015), who indicate that most Burundian households may be categorized as moderately food insecure because, even though food production may be declining, they always assess their food security status in comparison with other, which always makes them perceive that they are better off. Although a large section of both adopters and non-adopters experienced moderate hunger, the extremes reveal a different story. About 23% of mobile money adopters fall within the no or light hunger category compared to about 9% of non-adopters. Conversely, about 18% of non-adopters are categorized as experiencing severe hunger compared with about 8% of mobile money adopters.

4.3 Determinants of mobile money adoption and household food insecurity

4.3.1 Model diagnostics. Table 1 presents the estimates of the determinants of mobile money account adoption and household food insecurity. The relationship between the mobile money

Variable	Mobile money	Household food insecurity	
		Mobile money non-adopters (n = 287)	Mobile money adopters (n = 534)
Relative mobile money account	1.254*** (0.112)		
Gender (1 = male)	0.266** (0.110)	-0.560*** (0.169)	-0.376*** (0.080)
Married (1 = married)	0.232*** (0.043)	-0.149* (0.087)	0.081 (0.136)
Age	0.069*** (0.025)	0.008*** (0.003)	0.002*** (0.005)
Formal education (1 = yes)	0.602*** (0.128)	-0.377* (0.194)	-0.151 (0.161)
Social network (1 = yes)	0.385*** (0.117)	-0.926* (0.541)	0.115 (0.195)
Area (1 = urban)	0.794*** (0.153)	-0.328 (0.298)	-0.169 (0.153)
Farm size	-0.057 (0.063)	-0.320*** (0.093)	-0.131** (0.061)
Main income source (1 = off-farm)	0.209 (0.142)	-0.217 (0.234)	-0.341** (0.139)
Access to credit (1 = yes)	0.166 (0.130)	0.153 (0.209)	-0.213* (0.121)
Tarred road network (1 = yes)	-0.345*** (0.095)	0.299** (0.118)	-0.112 (0.114)
Household emigration (1 = yes)		-0.161*** (0.042)	-0.338** (0.162)
Land tenure (1 = secured)		0.088 (-0.065)	-0.146** (0.065)
Constant	-3.604*** (0.548)		
Rho0	-0.0311 (0.226)		
Rho1	0.717*** (0.247)		
Number of observations	820		
Wald χ^2	247.10***		
Log pseudo like	-930.749		
Test of distinct regimes	5.26**		

Note(s): Robust standard errors in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Source(s): Authors' own creation

Table 1. Determinants of mobile money adoption and household food insecurity levels

adoption model and the household food insecurity model, as measured by the ρ parameter, is statistically significant. By implication, a separate estimation of the two models is likely to yield biased and inconsistent results. Additionally, the statistical significance of the Wald chi-square value indicates that the model fits the data reasonably well. The likelihood ratio test for distinct regimes is significant at 5%, indicating that mobile money adoption affects household food insecurity.

4.3.2 Determinants of mobile money adoption. The second column of [Table 1](#) presents the estimates of the determinants of mobile money adoption among households in Burundi. Respondents who had relatives with mobile money accounts were 125% more likely to adopt a mobile money account of their own. Relatives play an important role in the adoption behavior of individuals by exerting pressure from the social environment. An increasing number of studies (e.g. [Atta-Aidoo et al., 2022b](#); [Conci et al., 2009](#)) have acknowledged the role of social pressure mainly exerted by relatives on influencing people's intention to adopt and their actual adoption behavior.

Socioeconomic factors such as gender, marital status, age and formal education significantly influence the adoption of mobile money. We observed that males were about 27% more likely to adopt mobile money accounts. This reflects the general trend of financial inclusion in Burundi, where females are reported to be relatively financially excluded compared to sub-regional peers ([Atta-Aidoo et al., 2022a, 2023b](#)). This can be attributed to the long periods of conflicts that characterized the country leading to mistrust and a feeling of insecurity, particularly among women who mostly suffer disproportionately during conflicts. Additionally, women tend to be disadvantaged immensely in such fragile states in terms of income and literacy, hence their low adoption rate. Married individuals were about 23% more likely to adopt mobile money than the unmarried. This is because mobile money has become a common means of money transfer which people use to send and receive remittances from their spouses who happen to be working in different regions of the country.

The adoption of mobile money is positively influenced by the age of the individual. We estimate that older people are about 7% more likely to adopt mobile money than younger individuals. This goes against our intuition that younger people are more receptive to new technologies. However, this result is consistent with those of [Afawubo et al. \(2020\)](#) and [Mbiti and Weil \(2015\)](#). This may likely be the case that older people in Burundi have more financial resources and are therefore capable of adopting mobile money than the younger generation. Individuals with some form of formal education are estimated to be 60% more likely to adopt mobile money than the uneducated. This is because the educated populace is better informed about financial products. Again, the ability to read and write enhances one's ability to use mobile phones more easily ([Terrade et al., 2009](#)). These factors combine to enhance the adoption of mobile money among the educated populace. This result is consistent with those of [Afawubo et al. \(2020\)](#), who indicated that education is a positive determinant of mobile money usage in Togo and [Abdul-Rahaman and Abdulai \(2022\)](#), who indicated that education helps people make informed decisions such as technology adoption.

Membership in a social network, area of residence and access to tarred roads significantly influence the adoption of mobile money among Burundian households. Social networks positively enhance the adoption of mobile money among Burundian households. This is attributable to the fact that group membership helps to overcome information asymmetries and transaction costs associated with new technologies ([Munyegera and Matsumoto, 2016](#)). This result is consistent with that of [Abdul-Rahaman and Abdulai \(2022\)](#), who has indicated that membership in social networks exerts a significant positive effect on the adoption of mobile money. Individuals living in urban areas are estimated to be 79% more likely to adopt mobile money than their rural counterparts. This is because urban residents are more prone to mobile money vendors than rural residents. Our result is consistent with that of [Afawubo et al. \(2020\)](#), who indicated that people in urban areas are more likely to test mobile money

services. Our results further reveal that people with access to tarred road networks are less likely to adopt mobile money. This may be the case because access to tarred road networks enhances easy transportation between communities and as such, people will rather maintain accounts with traditional financial institutions that they can easily access.

4.3.3 Determinants of household food security. We found differences between the factors affecting the food security status of households that have adopted mobile money and those that have not adopted mobile money. Columns 3 and 4 of [Table 1](#) present the estimates of the drivers of food security among mobile money adopters and non-adopter households in Burundi. The estimates show some semblance of homogenous behavior between mobile money adopter households and non-households, albeit differences in the magnitude of the estimates.

Gender of the household head, age, farm size and having a member of the household migrating in the past year influenced the food security of a household regardless of that household's mobile money adoption status. We estimate that male-headed households are less likely to be food insecure regardless of their adoption of mobile money. This may be due to the inherent inequality in resource distribution among males and females, which is protracted in post-conflict contexts. This may imply that males have access to more resources than their female counterparts and are thus able to allocate more resources to food expenditure. This result is similar to the findings of [Otegunrin et al. \(2021\)](#), who indicate that male-headed households are more likely to be food secure. Contrary to the findings of [Otegunrin et al. \(2021\)](#) and [Oduniyi and Tekana \(2020\)](#), we find that the age of a household head is positively related to household food insecurity. That is, households with older heads are more likely to be food insecure. This may be the case in Burundi because people become less productive, particularly since most households are agricultural in nature. This means that the household heads are not able to produce enough for their households as they advance in age and become weaker.

Households with larger farm sizes are less likely to be food insecure regardless of their mobile money adoption status. Since most households in Burundi are agricultural households and subsistence in nature, any increase in their farm size invariably translates into larger food sources from which to feed their members. It is therefore implied that households regardless of their mobile money status can get access to more food for their members as they cultivate larger tracts of land. Our finding is consistent with that of [Otegunrin et al. \(2021\)](#) who reported that the food security of Nigerian households improved as they increased their farm size and [Bogale and Shimelis \(2009\)](#) who found that food insecurity risk is lower for households with large farm size in rural Ethiopia.

Having a member of one's household migrate in the past year improved the food security status of the household. This may be the case because households now have fewer mouths to feed meaning that the existing household members will have adequate food to consume all other things being equal. The magnitude of the coefficients was greater for households who have adopted mobile money. We infer that this may be so because there is a likelihood that the member who migrated may start earning income if he/she migrated for employment reasons and is likely to send remittances back home through mobile money services. This highlights the importance of mobile money to remittances since it is a cheaper way of sending and receiving money compared to traditional means. Our finding confirms those of [Moniruzzaman \(2022\)](#) and [Regmi and Paudel \(2016\)](#), who found a positive relationship between remittances and food security as remittances tend to provide choices to counterbalance food-related shocks and uncertainty.

On the other hand, factors such as marital status, education level, membership in a social network and access to tarred road networks influenced the food security status of households who have not adopted mobile money. We estimate that household heads that are married are about 15% less likely to be food insecure. This is likely because married couples tend to have

more resources since they pool their resources together than unmarried individuals. Additionally, household heads who are formally educated are about 38% less likely to be food insecure. We anticipate that educated household heads are engaged in higher-paying economic activities and as such can afford adequate amounts of food for the household. Our results are consistent with those of [Koomson et al. \(2022\)](#), who reported that households with married and/or educated heads are less likely to experience food insecurity. Moreover, [Otegunrin et al. \(2021\)](#) also estimated that the education level of the head of a household reduces the probability of a household being food insecure.

The head of a household being a member of a social network reduces the likelihood of the household being food insecure. [Claasen and Lemke \(2019\)](#) observed that social networks serve as an important coping strategy for households in the face of food insecurity. The food security-enhancing nature of social networks plays out in two mechanisms; first, knowledge sharing and; second, product sharing ([Nosratabadi et al., 2020](#)). Social networks help improve the food security of a household by either sharing knowledge relevant to ensuring food security or sharing food and other products with members who are food insecure. Households with access to tarred roads are also less likely to be food insecure. This is because having access to tarred roads reduces the time and cost of transport to market centers either to purchase or sell food products, which are both important for ensuring food security.

Mobile money adopter households with an off-farm source of income, access to credit and secured land tenure arrangements are less likely to be food insecure. Our results indicate that household with a head whose main source of income is from an off-farm source are less likely to be food insecure. This is because such households are not exposed to the seasonal fluctuations associated with agriculture and on-farm income. Such households are therefore able to secure adequate food throughout the year with little or no difficulty. We further postulate that off-farm income plays a crucial role in mobile money adopter households because such households are likely to be well off and therefore enjoy all the benefits associated with being financially included through mobile money. Our result is consistent with that of [Dzanku \(2019\)](#) and [Regmi and Paudel \(2016\)](#), who indicated that off-farm income positively influences the food security of households. However, such impact has some gender dynamics; for example, [Dzanku \(2019\)](#) contends that the impact of off-farm income is greater among female-headed households, whereas [Regmi and Paudel \(2016\)](#) reported the contrary.

Additionally, access to credit reduces the likelihood of being food insecure among mobile money adopter households. It is expected that households who have access to credit can smoothen their consumption in times of difficulty and as such are less prone to be food insecure. The influence of access to credit on household food insecurity is particularly pronounced in households that have adopted mobile money. This is because adopters of mobile money have a greater chance of accessing lending opportunities. Our result is consistent with that of [Bidisha et al. \(2017\)](#) who indicated that access to credit tends to improve food security and also allows households to achieve greater dietary diversity. Furthermore, secured land tenure arrangements reduced the likelihood of a household being food insecure. [Corsi et al. \(2017\)](#) argue that secure land tenure is essential for enhanced market access, which translates into greater income levels and improved food security. [Antwi-Agyei et al. \(2023\)](#) further indicated that secured land tenure enhances farm investment, which can translate into improved farm output and subsequently better food access.

4.3.4 Effect of mobile money adoption on household food security. [Table 2](#) presents the treatment effect on the treated for all three levels of household food security. We followed the approach of [Liu et al. \(2021\)](#) to compute the impact of mobile money adoption percentage-wise. The results indicate that mobile money adoption increases the likelihood of a household experiencing no or light hunger by about 23 folds and decreases the likelihood of a household falling into the moderate hunger and severe hunger categories by about 5 and 11 folds, respectively. These estimates indicate that mobile money adoption enhances the food

security status of households. This finding is consistent with earlier studies on the impact of financial inclusion in general and mobile money in particular on household food security. For example, [Murendo and Wollni \(2016\)](#) observe that mobile money adoption improves the food security level of households in Uganda. Thus, mobile money adoption improves the commercial activities of households and leads to higher income levels that allow a household to purchase adequate food for the household. Additionally, the adoption of mobile money can positively impact household income through remittances and it can also enhance the resilience of households in case of shocks. [Yao et al. \(2023\)](#) and [Munyegera and Matsumoto \(2016\)](#) indicate that mobile money adopters have an advantage compared to non-adopters mostly in terms of remittances, which gives them the capacity to withstand food security shocks.

4.3.5 Heterogenous effect of mobile money adoption on food security by gender and location. [Table 3](#) presents the results of the heterogeneous effects of mobile money adoption on household food insecurity. Unlike previous studies, we hypothesize that the effect of mobile money on household food insecurity is not homogenous among different groups of households. We therefore examine the effect of mobile money adoption based on gender (i.e. male vs female) and area of residence (i.e. urban vs rural). Our findings show that male-headed households that experience no or light hunger and severe hunger stand to benefit more from the adoption of mobile money than female-headed households. On the other hand, mobile money adoption has a greater impact among female-headed households in the category of moderate hunger. This is likely because female heads of households that face

Table 2.
Estimates of the effect of mobile money use on household food insecurity

Food security status	Predicted mean outcome		ATT	Change (%)
	Users	Non-users		
No or light hunger	0.294	0.016	0.375***	2,344
Moderate hunger	0.181	0.048	-0.242***	504.2
Severe hunger	0.101	0.028	-0.331***	1,182

Note(s): ATT is the average treatment effect for the treated. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Source(s): Authors' own creation

Table 3.
Heterogenous effect of mobile money use on household food insecurity

Food security status	Food security status	Predicted mean outcome		ATT	Change (%)
		Users	Non-users		
Males	No or light hunger	0.266	0.094	0.143***	152.1
	Moderate hunger	0.135	0.039	-0.123	315.4
	Severe hunger	0.075	0.013	-0.049***	376.9
Females	No or light hunger	0.313	0.138	0.065	47.1
	Moderate hunger	0.225	0.060	-0.261***	435.0
	Severe hunger	0.148	0.097	-0.139***	142.3
Urban	No or light hunger	0.358	0.247	0.101	40.9
	Moderate hunger	0.311	0.143	-0.148**	103.5
	Severe hunger	0.276	0.085	-0.064**	75.3
Rural	No or light hunger	0.187	0.079	0.088***	111.4
	Moderate hunger	0.113	0.040	-0.072***	180.0
	Severe hunger	0.057	0.021	-0.053**	252.4

Note(s): ATT is the average treatment effect for the treated. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Source(s): Authors' own creation

hunger are more prone to using any money received via such channels for food purposes. In terms of the heterogeneity in the area of residence, we find that mobile money adoption has a greater impact on reducing the food insecurity of rural households than urban households in all the categories of food security status. This is because mobile money enhances the access of rural households to financial services that may otherwise not be available. The adoption of mobile money, for example, reduces the cost of receiving remittances from relatives who live in other parts of the country. The impact among urban households tends to be lower because urban residents already benefit from the availability of other financial products and may not depend so much on mobile money.

4.3.6 Mobile money adoption and coping strategies. Table 4 presents the results of the multivariate probit model. The Log-likelihood value of -421.54 and the Wald chi-square value of 119.41 ($p < 0.01$) are indications of a good model fit, implying that the independent variables significantly explain the variations in the dependent variables (i.e. the five coping strategies). The test of independence between the choices of coping strategies is given by the likelihood ratio test ($\rho_{21} = \rho_{31} = \rho_{41} = \rho_{51} = \rho_{32} = \rho_{42} = \rho_{52} = \rho_{43} = \rho_{53} = \rho_{54} = 0$). The results show statistical significance at the 1% level and confirm the goodness of fit of our model. This shows that there are differences in the choice of coping strategies to address household food insecurity among the sampled households.

Our results further show the presence of a correlation between the various coping strategies which is given by the ρ_{ij} . We found a positive relationship between each pair (a total of 10 pairs), indicating that the coping strategies were used to complement one another, albeit insignificant in two cases (i.e. ρ_{41} – reduced quality and community assistance; ρ_{51} – reduced quality and skip meals). This result resonates with that of Abebe (2021), who indicated that households tend to adopt several consumption-related coping strategies to address food insecurity shocks.

We also find that mobile money adoption reduces the likelihood of adopting any of the five most used food insecurity coping strategies, albeit insignificant in the case of *reducing the portion of meals for all household members* and *skipping meals*. Specifically, we find that the adoption of mobile money reduces the probability of households *reducing the quality of meals*, *reducing the portion of adults share of food in favor of children* and *seeking community assistance* as ways of addressing food insecurity. These results support the assertion that mobile money adoption makes households more resilient to shocks that might otherwise expose their members to food insecurity (Afawubo *et al.*, 2020). Additionally, the adoption of mobile money facilitates the receipt of additional income to support food expenditures (Murendo and Wollni, 2016) while also reducing the likelihood of a household being too poor to meet its food expenditures (Djahini-Afawoubo *et al.*, 2023). We, therefore, contend that the adoption of mobile money prevents households from adopting any consumption-related food insecurity coping strategy in a post-conflict and fragile context. This is contrary to the findings of Swesi *et al.* (2020), who indicate that households in conflict-affected areas mostly use food-compromising strategies such as reducing quality and portions to address their food insecurity.

5. Conclusion and policy implications

Our study investigates the effect of mobile money adoption on household food security, as measured by the household hunger scale. We find that gender, marital status, age, formal education, membership in a social network and area of residence positively influence mobile money adoption, while access to tarred roads decreases the probability of adopting mobile money. We further observe that gender, age, farm size and household migration influenced the food security status of a household regardless of their mobile money adoption status. Other factors, such as marital status, formal education, social network membership and

Variable	(1) Reduce quality (n = 305)	(2) Reduce the portion of adults (n = 221)	(3) Reduce the portion of all members (n = 253)	(4) Community assistance (n = 195)	(5) Skip meals (n = 190)
Mobile money account	-1.110*** (0.257)	-0.890*** (0.263)	-0.362 (0.233)	-0.584** (0.266)	-0.169 (0.516)
Gender (1 = male)	-0.273 (0.229)	0.361 (0.228)	0.050 (0.210)	0.177 (0.241)	0.297 (0.233)
Married (1 = married)	0.300 (0.246)	0.174 (0.245)	0.068 (0.225)	-0.012 (0.251)	0.158 (0.250)
Age	0.021** (0.009)	0.016* (0.008)	0.008 (0.008)	0.007 (0.009)	0.023** (0.009)
Formal education (1 = yes)	-0.066 (0.284)	0.199 (0.282)	-0.257 (0.257)	0.044 (0.297)	0.343 (0.303)
Social network (1 = yes)	0.807** (0.380)	0.764** (0.368)	0.428 (0.335)	0.405 (0.390)	0.012 (0.419)
Area (1 = urban)	0.012 (0.317)	0.193 (0.301)	0.226 (0.293)	0.446 (0.330)	0.765** (0.327)
Farm size	-0.040 (0.093)	-0.161 (0.099)	-0.076 (0.089)	-0.324*** (0.119)	-0.260** (0.116)
Main income source (1 = off-farm)	-0.510* (0.285)	-0.333 (0.308)	-0.616** (0.277)	-0.564 (0.349)	-0.756** (0.359)
Access to credit (1 = yes)	0.181 (0.246)	-0.215 (0.244)	-0.074 (0.222)	-0.589** (0.274)	-0.628** (0.275)
Tarred road network (1 = yes)	-0.039 (0.228)	0.137 (0.225)	-0.159 (0.212)	0.109 (0.241)	0.204 (0.236)
Household emigration (1 = yes)	-0.680* (0.369)	-0.492 (0.365)	-0.314 (0.341)	-0.295 (0.406)	-0.122 (0.421)
Land tenure (1 = secured)	-0.151 (0.224)	-0.323 (0.221)	-0.120 (0.205)	-0.586** (0.234)	-0.753*** (0.231)
Constant	-0.199 (0.442)	-0.877* (0.476)	-0.007 (0.418)	0.094 (0.482)	-1.259** (0.503)
rho21	0.509***	(0.102)			
rho31	0.580***	(0.098)			
rho41	0.210	(0.137)			
rho51	0.216	(0.143)			
rho32	0.643***	(0.089)			
rho42	0.404***	(0.126)			
rho52	0.583***	(0.105)			
rho43	0.517***	(0.115)			
rho53	0.510***	(0.109)			
rho54	0.864***	(0.050)			

Table 4. Mobile money effect on the probability of adopting coping strategies (MVP)

Note(s): Standard errors in parentheses; Number of observations = 191; Wald χ^2 (65) = 119.41***; Log likelihood = -421.54; Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0: χ^2 (10) = 161.235***; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Source(s): Authors' own creation

access to tarred roads, influence the food security status of households that have not adopted mobile money. Off-farm income, access to credit and land tenure security also influence the food security of households that have adopted mobile money. Most importantly, we observe

that the adoption of mobile money significantly enhances the food security status of households with some heterogeneity. We further found that the adoption of mobile money significantly reduced the likelihood of households adopting any consumption-related food insecurity coping strategies. We therefore conclude that the adoption of mobile money holds significant potential for enhancing food security in fragile economies.

Important policy-relevant insights can be drawn from our findings. First, our results show gender disparities in terms of mobile money adoption and its impact on household food security. This therefore calls for guidelines that promote inclusivity in the adoption of mobile money, including targeted awareness initiatives, financial education campaigns and incentives to address gender-specific barriers. By ensuring an equitable approach that benefits both men and women, policymakers can enhance the positive impact of mobile money on food security. Secondly, our results underscore the importance of social networks. Therefore, it will be prudent on the part of policymakers to encourage and support social networks within communities. Given that membership in social networks influences both the adoption of mobile money and food security, policies that strengthen community bonds and networks can enhance the positive outcomes highlighted in this study. Additionally, policymakers must ensure the integration of mobile money services into broader strategies for financial inclusion, building on the observed positive correlation between mobile money adoption and food security. This may involve creating a supportive regulatory framework, promoting healthy competition among mobile money service providers and ensuring that financial services are accessible to marginalized populations. We further recommend that the promotion of mobile money must be incorporated into national food security policies since it has proven to be an effective food security-enhancing instrument. This will ensure that households will become financially included while simultaneously achieving food security. Moreover, the government of Burundi should collaborate with mobile money operators (i.e. telecommunication networks) to expand access to credit, possibly through their mobile money platforms. This is because access to credit proved to be a food security-enhancing instrument, particularly among mobile money adopting-households.

A major limitation of our study is the inability to establish pathways through which mobile money impacts household food security. This may be due to data limitations that could not permit the current study to explore potential pathways of impact. Future studies should therefore be designed to be able to capture potential pathways through which the adoption of mobile money can impact the food security status of households. This will enhance the conceptualization of the mobile money and food security nexus and also bring more insights to policymakers for the design and implementation of more targeted interventions to address food insecurity.

Notes

1. <https://www.brb.bi/en/node/6976>
2. https://www.brb.bi/sites/default/files/Financial%20stability%20report_2018.pdf
3. The dataset lists the following coping strategies: reducing diet quality; reducing the portion of adults' food in favor of children; reducing the portion of food for all household members; buying food on credit; sending children to eat elsewhere; sending children to work for income; asking for help from community members; skipping meals; migrating elsewhere; withdrawing children from school; selling household assets; begging for food.

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Appendix 1
Descriptive statistics of the sample and results of the falsification test

Table A1.
Distribution of samples in provinces

Provinces	Frequency	Percentage
Bujumbura Mairie	193	22.44
Bujumbura Rural	129	15.00
Ngozi	197	22.91
Rumonge	116	13.49
Kayanza	225	26.16
Total sample	860	100

Source(s): Authors' own creation

Table A2.
Food security status of households in Burundi

Household hunger scale	Code	Frequency	Percentage
No or light hunger	1	157	18.26
Moderate hunger	2	598	69.53
Severe hunger	3	105	12.21
Total		860	100

Source(s): Authors' own creation

Table A3.
Results of the falsification test on the instrumental variable

	Mobile money adoption	Household food insecurity
IV	0.364*** (0.030)	-0.115 (0.661)
Constant	0.278*** (0.061)	2.383*** (0.124)
Household controls	YES	YES
R-squared	0.389	0.126
F-statistic	46.79***	3.61***
Observations	820	287

Note(s): Standard errors in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Source(s): Authors' own creation

Variable	Measurement	Means		Mean difference	Overall mean	Standard deviation
		Non-adopter	Adopter			
<i>Dependent variable (household food security)</i>						
Household hunger scale	Ordinal: 1 = no/light hunger; 2 = moderate hunger; 3 = severe hunger	2.087	1.854	0.233***	1.940	0.549
<i>Independent variables</i>						
Mobile money account	Dummy: 1 = owns a mobile money account; 0 = otherwise				0.650	0.477
IV	Dummy: 1 = relative/ neighbour owns a mobile money account; 0 = otherwise	0.317	0.815	-0.497***	0.632	0.483
Gender	Dummy: 1 = male; 0 = female	0.397	0.52	-0.123***	0.470	0.499
Married	Dummy: 1 = married; 0 = otherwise	0.620	0.714	-0.093***	0.677	0.468
Age	Number of years	43.575	38.307	5.268***	40.257	13.451
Formal education	Dummy: 1 = has formal education; 0 = otherwise	0.467	0.824	-0.357***	0.691	0.462
Social network	Dummy: 1 = member of any social network/ organization; 0 = otherwise	0.199	0.461	-0.262***	0.370	0.483
Area	Dummy: 1 = lives in an urban area; 0 = rural	0.094	0.395	-0.301***	0.283	0.451
Farm size	Number of acres	1.223	1.504	-0.28	1.393	1.192
Main income source	Dummy: 1 = off-farm job as the main source of income; 0 = otherwise	0.167	0.485	-0.318***	0.365	0.482
Access to credit	Dummy: 1 = access to credit for economic activities; 0 = otherwise	0.171	0.341	-0.17***	0.279	0.449
Tarred road network	Dummy: 1 = has access to tarred roads in community; 0 = otherwise	0.509	0.392	0.118***	0.423	0.494
Household emigration	Dummy: 1 = household member has migrated in past year; 0 = otherwise	0.177	0.371	-0.193***	0.305	0.461
Land tenure	Dummy: 1 = has secured land tenure arrangement; 0 = otherwise	0.425	0.58	-0.155***	0.511	0.500
<i>Coping strategies</i>						
Reduce quality	Dummy: 1 = if reduce food quality; 0 = otherwise	0.532	0.271	0.262***	0.364	0.482
Reduced portion of adults	Dummy: 1 = if reduce portion of food for adults to favor children; 0 = otherwise	0.393	0.187	0.206***	0.262	0.440

(continued)

Table A4.
Description,
measurement and
statistics of variables

Variable	Measurement	Means		Mean difference	Overall mean	Standard deviation
		Non-adopter	Adopter			
Reduce the portion of all members	Dummy: 1 = if reduce food of all household members; 0 = otherwise	0.438	0.227	0.210***	0.301	0.459
Community assistance	Dummy: 1 = if relies on community assistance for food; 0 = otherwise	0.352	0.170	0.183***	0.231	0.422
Skip meals	Dummy: 1 = if skips meals on some occasions; 0 = otherwise	0.323	0.181	0.142***	0.228	0.420

Note(s): * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Source(s): Authors' own creation

Table A4.

Appendix 2

Distribution of households across the three food security categories

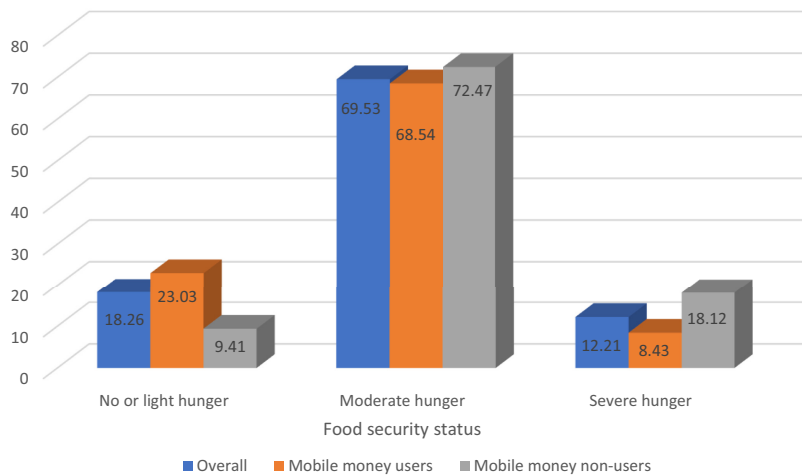


Figure A1. Percentage frequency distribution of food security status of households

Source(s): Authors' own creation

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