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Financial inclusion, mobile money, and individual welfare: The case of Burkina Faso

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ABSTRACT

Access to financial services promotes investment and facilitates consumption smoothing by enhancing resource mobilization. Over 60 percent of Burkinabe adults are excluded from financial services by banks and other nonbank financial institutions, so mobile money is expected to bridge this gap. Accounting for the importance of financial inclusion with the rapid prevalence of mobile money, this paper assesses the effects of financial inclusion and mobile money use on an individual's nonmonetary welfare in Burkina Faso by applying matching methods. The results confirm the significant role of financial inclusion in alleviating poverty. More importantly, our analysis shows that once individuals access financial services through mobile money, such favorable effects on poverty alleviation become more substantial. Financial regulators in Burkina Faso should promote financial inclusion with mobile money to ensure the efficient enhancement of individual welfare with poverty reduction.

1. Introduction

The promotion of financial inclusion has been emphasized, particularly for poor people. Financial accessibility is crucial for economic growth.[1] Demirgüç-Kunt and Klapper (2012) suggest an integral role of financial inclusion in poverty reduction by facilitating saving and borrowing, which empowers poor individuals to help smooth consumption and insure themselves against vulnerabilities in their lives. However, the unfulfilled demand for financing is still substantial around the world, so that the lack of financial inclusion remains a far-reaching problem even though microcredit institutions have prevailed in many developing countries (Chaia et al., 2009). Indeed, adults without access to the banking system amount to 1.7 billion in 2017, representing almost 40 percent of adults worldwide (Grohmann, Klühs, & Menkhoff, 2018). Traditional financial institutions, such as banks and nonbank financial institutions, have failed to provide enough financial services or financial access for low-income people who need financial credit in developing countries (Diniz, Birochi, & Pozzebon, 2012).

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[1] See, e.g., King and Levine (1993), Rajan and Zingales (1998), Beck, Levine, and Loaayza (2000), Levine, Loayza, and Beck (2000), Khan (2001), Claessens (2006), Demirguc-Kunt et al. (2008), and Ghosh (2016).

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The emergence of mobile money or mobile financial services is expected to resolve issues related to the difficulty in financial access to traditional financial institutions and to promote the financial inclusion of poor people in developing countries. Several studies, such as Jack and Suri (2014) and Munyegera and Matsumoto (2016), suggest that mobile money can be the best tool for individual financial inclusion because it allows individuals, especially among the financially excluded rural communities in many developing countries, to transfer purchasing power by simple Short Messaging Service (SMS) technology with the low cost of sending money across vast distances. Recently, mobile money, or rather interoperability, which is the association of mobile money and external parties such as traditional financial services, has prevailed due to rapid progress in telecommunication technology and the regulatory efforts of financial regulators. However, the penetration rates of mobile money differ substantially among developing countries. In fact, some of the least-developed countries in Africa still have a low penetration of mobile money due in part to deficiencies in the telecommunication infrastructure. For example, only 16 percent of adults are registered with mobile money services in Burkina Faso. Given these arguments, this study attempts to evaluate the roles of financial inclusion and mobile money in improving individual welfare and contributing to poverty reduction in a landlocked sub-Saharan country, Burkina Faso, one of the poorest countries in the world.

Many studies have discussed the linkage of financial inclusion with welfare and poverty. Demirguc-Kunt et al. (2017) show that financial inclusion alleviates poverty and inequality through investment in the future, consumption smoothing, and financial risks management. Burgess and Pande (2005) show that a state-led rural branch expansion is associated with poverty reduction in India. Bruhn and Love (2014) state that more access to financial services promotes income growth for low-income people by enabling informal business holders to maintain their businesses functional and thus creates an overall increase in employment. Moreover, Brune, Giné, Goldberg, and Yang (2016) assess that offering financial access to individual savings accounts not only increases banking transactions but also improves measures of household welfares, such as investments in inputs and subsequent agricultural yields, profits, and expenditures. Furthermore, Klapper, El-Zoghbi, and Hess (2016) sum up the advantages of financial inclusion by showing how it can help achieve Sustainable Development Goals (SDGs).

At the same time, there has been a growing literature on the effects of mobile money on poverty, particularly in the context of poor countries. The report of the Global System for Mobile communications Association (GSMA) (2017a) states that mobile money contributes to 11 of the 17 United Nations SDGs, decreasing inequality by enabling households to lift themselves out of poverty and empowering underserved segments of the population. Suri and Jack (2016) find that access to the Kenyan mobile money system M-PESA[2] increased per capita consumption and lifted 194,000 households, or two percent of households, out of poverty. In addition, Munyegera and Matsumoto (2016) reveal a positive effect of mobile money access on household welfare in Uganda. Moreover, Riley (2018) finds that after a village-level rainfall shock, users of mobile money could prevent a drop in their consumption in Tanzania. Furthermore, Danquah and Iddrisu (2018) show that mobile money access leads to higher sales revenues for nonfarm enterprises and households and improves the chances of not being in poverty in Ghana.

This paper makes three main contributions to the existing literature. First, we estimate the effects of mobile money use on an individual's poverty indicators of nutrition, health, and education, which would reflect basic needs as proxies of welfare, rather than monetary poverty measures such as income and savings, which are known as one-dimensional poverty (Batana, Agbodji, & Ouedraogo, 2013). Second, we analyze the role of the combination of financial inclusion and mobile money in determining poverty reduction at the individual level, unlike other studies that focus separately on financial inclusion and mobile money (Munyegera & Matsumoto, 2016; Riley, 2018; Danquah & Iddrisu, 2018). Third, our study fills the gap in empirical studies on mobile money and poverty reduction in low-income countries, such as members of the West African Economic and Monetary Union (WAEMU),[3] where mobile money is at an early stage, and the penetration rate is low. Although some studies evaluate the effects of mobile money in Africa (Munyegera & Matsumoto, 2016; Riley, 2018), most of their targeted countries are at a more matured stage of mobile money systems in the East African Community (EAC),[4] which differ from the financial conditions of WAEMU members in terms of mobile money penetration. One of the closest studies related to our work is Ky and Rugemintwari (2015). However, their study on Burkina Faso contexts examines the relationship between mobile money and savings without taking poverty reduction into account. Thus, examining the case of a low-income country with low mobile money penetration, Burkina Faso, would enable us to discuss the role of financial inclusion and mobile money at the early stage of mobile money systems.

This study evaluates the effects of financial inclusion and mobile money use on an individual's poverty status using data on 5066 individuals in Burkina Faso taken from the Finscope Consumer Survey (2016). The survey primarily aims to describe the levels of financial inclusion, to describe the landscape of financial access, to identify the drivers of and barriers to financial access, to stimulate evidence-based dialogue and to create a baseline for financial inclusion in the country. The survey data include three measures of multidimensional poverty status: (i) nutrition, (ii) healthcare, and (iii) education, which are among the main Millennium Development Goals (MDGs) agreed upon by 189 heads of state in 2000; they are known today as the SDGs goals and have been designated as basic needs by Beck, Demirguc-Kunt, and Peria (2007). Moreover, our three measures are widely used in comparative analysis in Sub-Saharan Africa (SSA) for practical, theoretical, and methodological reasons (Batana, 2013).

One critical challenge is that our treatment variable representing individuals' choice of financial inclusion and mobile money use is

[2] M-PESA: "M" is for mobile and "PESA" means money in Swahili (the local language of Kenya).

[3] The WAEMU comprises Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo. They use FCFA as currency, which is pegged on the euro. 1€≈656 FCFA, and they are listed in the worst ranked countries based on the United Nations Development Programme (UNDP)'s (2016) Human Development Index; Burkina Faso ranks 185th out of 188 countries, and Niger ranks 187th.

[4] The EAC comprises six countries in the African Great Lakes region in eastern Africa: Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda. In the EAC, over 40 percent of the adult population use mobile money on an active basis (90-day) (GSMA, 2017a).

not random and may have possible relationships with their characteristics, which would cause selection biases. To mitigate such an endogeneity problem, this study estimates the treatment effects by applying two matching methodologies: propensity score matching (PSM) and inverse-probability-weighted regression adjustment (IPWRA). The main results reveal that financial inclusion reduces poverty at the individual level. More importantly, once individuals access financial services through mobile money, such favorable effects on poverty alleviation become more substantial, so that policy makers in low-income countries, such as Burkina Faso, should emphasize the promotion of mobile money in their financial inclusion programs to enhance individual welfare. Our results also support the 'interoperability' of financial services and mobile money to encourage financial institutions to provide swift financial transactions for people anywhere, which would engender a deep sense of financial inclusion (GSMA, 2017b; Peric, Abel, & Bohan, 2018). In addition, financial regulators should create a sound environment for the prevalence of mobile money through financial regulations with supply- and demand-side considerations, as suggested by the International Monetary Fund (IMF) (2019).

The rest of the paper is organized as follows. In Section 2, we provide a selective review of the literature on financial inclusion, mobile money, and poverty reduction. Section 3 explains the overview of financial conditions and poverty in Burkina Faso. Section 4 deals with the empirical analysis of financial inclusion and poverty reduction, and Section 5 incorporates the role of mobile money in our empirical analysis. Section 6 concludes with some policy discussions.

2. Literature review

2.1. Financial inclusion and poverty reduction

The primary objective of financial inclusion is the pursuit of making financial services accessible at affordable costs to all individuals and businesses (Diniz et al., 2012), and it is expected to be a key driving force in reducing poverty and boosting prosperity (Beck et al., 2007; Bruhn & Love, 2014; Han & Melecky, 2013). The importance of financial inclusion was first recognized by the United Nations Capital Development Fund (UNCDF) in the late 1990s through the support of microcredit institutions including poor people in financial systems. This has been widely acknowledged as a crucial agenda to be achieved in many developing countries.

Many studies have shown that financial inclusion by traditional financial institutions (banks and nonbanks) helps to decrease rural poverty and improve various economic and financial conditions, such as credit, employment, insurance, and savings (Sapienza, 2004; Bruhn & Love, 2014; Cai, Chen, Fang, & Zhou, 2015; Dupas & Robinson, 2013; Kaboski & Townsend, 2011, 2012). Sapienza (2004), using a panel data during the period 1991 to 1995, shows that state-owned banks help firms located in depressed areas, which mitigates rural poverty in Italy. Kaboski and Townsend (2011, 2012) describe the favorable impacts of microcredit loans in the context of Thailand's Million Baht Village Fund Program, where every village received 1 million Baht (about $24,000) to initiate a village bank that provided funds available to villagers. Bruhn and Love (2014) find that reaching low-income individuals by financial access, with over 800 branches opening almost overnight in 2002, has a considerable positive effect on economic activity through the labor market (employment) in the case of Banco Azteca in Mexico. Cai et al. (2015) conduct field experiments in China and show that promoting the adoption of insurance significantly increases farmers' sow production, and this effect seems to persist in the long run. Dupas and Robinson (2013) show that having access to savings accounts encourages women to economize and to increase the size of their business in Kenya.

On the other hand, some studies fail to show clear evidence supporting the favorable effect of financial inclusion on poverty reduction. In summarized studies in Uganda, Malawi, and Chile, Dupas, Karlan, Robinson, and Ubfal (2016) find no evidence that reaching basic bank accounts for the rural poor results in improving welfare or reducing poverty. Their study comments that accounts not geared to particular needs and expensive costs due to the use of accounts are the main hindrances to overall increases in savings or to improvements in developmental outcomes such as consumption, schooling, and health. Banerjee, Karlan, and Zinman (2015a) summarize results across studies and mention unclear evidence of financial inclusion by revealing a merely positive, but not transformative, effect of microcredit on poverty reduction under different specifications in Europe with the case of Bosnia and Herzegovina (Augsburg, De Haas, Harmgart, & Meghir, 2015), Africa with the case of Ethiopia (Tarozzi, Desai, & Johnson, 2015), and Morocco (Crepon, Devoto, Duflo, & Parienté, 2015), Asia with the case of India (Banerjee, Duflo, Glennerster, & Kinnan, 2015b) and Mongolia (Attanasio, Augsburg, De Haas, Fitzsimons, & Harmgart, 2015), and America with the case of Mexico (Angelucci, Karlan, & Zinman, 2015). They generally suggest that though businesses can obtain profit from loans, it is less clear that this profit is translated into developmental impacts, such as increased incomes and broader welfare benefits for individuals. Such unfavorable evidence is consistent with the argument of Demirguc-Kunt et al. (2015), who claim that over 40 percent of adults worldwide remain financially excluded due to various barriers, such as physical access, affordability, and eligibility. Owing to the limited traditional financial access, particularly in rural areas, associated with low infrastructure levels in developing countries, it has widely been acknowledged that financial institutions should make use of advanced telecommunication technology, such as mobile phones, to enhance financial accessibility, especially for poor people (Claessens, 2006; He et al., 2017; Mas & Kumar, 2008).

2.2. Mobile money and poverty reduction

Mobile money is a financial innovation through Short Message Service (SMS) technology with a commission system to remunerate the providers of the different services (Jack & Suri, 2014). Through a mobile phone, mobile money enables people to use various financial services, including (1) person-to-person transfer of funds, including domestic and international remittances, (2) person-to-business payments for sales and purchases of goods and services, and (3) mobile banking, through which customers can access their bank accounts to pay bills or deposit and withdraw funds (Dolan, 2009; Riley, 2018). On the one hand, several studies have

examined the effects of mobile money on welfare in the context of poor countries. Among them, GSMA (2017a) states that mobile money contributes to eleven (including the three proxies in this study) of the seventeen UN SDGs by enabling households to lift poor people out of poverty and by empowering underserved segments of the population. Suri and Jack (2016) show that mobile money enables two percent of households to escape from extreme poverty and its impacts are more pronounced for female-headed households in Kenya. Munyegera and Matsumoto (2016) also find a positive effect of mobile money access on household welfare, measured by real per capital consumption, in Uganda using a combination of household fixed effects, instrumental variables, and matching methods. Riley (2018) reveals that after a village-level rainfall shock in Tanzania, only users of mobile money can prevent a drop in their consumption by applying difference-in-difference specification. Danquah and Iddrisu (2018) find that mobile money improves the chances of not being in poverty by leading to higher sales and revenues for nonfarm enterprises and households in Ghana.

On the other hand, a few studies have cast doubt on the positive effects of mobile money on poverty reduction by revealing some risks stemming from the use of mobile money, which may diminish the positive effects and renew the debate around this relationship for researchers at the Consultative Group to Assist the Poor (CGAP) (2017). There is a growing interest in possible win-to-win collaboration or interoperability between mobile money and external parties, such as bank and nonbank services. Indeed, mobile money covers two distinct industries (telecommunication and banking) with separate business models, so that the development of the necessary cross-sectoral partnership must include bridging cultures and regulations (World Bank, 2012). Such complex social and business forms could be difficult, and often risky, to manage for both providers and users. In addition, profitability in this industry needs a large scale, and business operators are faced with the trade-off between higher costs to recoup their investments and lower costs to build a mass market with a large scale (Mas & Radcliffe, 2010). Moreover, the Consultative Group to Assist the Poor (CGAP) (2017) reveals that mobile financial services could become a conduit for fraud and other criminal activities, as explained in more detail in a document related to financial crimes on mobile money (Chatain, Zerzan, Noor, Dannaoui, & Koker, 2011). Furthermore, Raphael (2016) reveals the risks and barriers for mobile money users in mobile money transactions (MMT) and the frequencies of their incidences using primary data collected in a survey conducted in Ilala district, Tanzania.

3. Financial inclusion and mobile money in Burkina Faso

Financial inclusion is expected to play an integral role in reducing poverty and insuring poor people against several vulnerabilities in their lives (Demirgüç-Kunt & Klapper, 2012). Burkina Faso is a landlocked Sahel country between the Sahara desert and the Gulf of Guinea and shares borders with six nations (Mali, Niger, Benin, Togo, Ghana, and Côte d'Ivoire). In the country, a large portion of people remains financially excluded, despite ongoing efforts by the new government. Indeed, the country's report no. 19/16 of the International Monetary Fund in 2019 on Burkina Faso states that less than 25 percent of the population owns an account at financial institutions, and among them, less than 10 percent have accessed loans from financial institutions. In addition, the 2019 World Bank's Doing Business Report argues that access to credit in Burkina Faso is difficult and broadly comparable to its WAEMU peers. Financial accessibility is generally constrained in rural areas, particularly for lower-income women. There are also substantial informational and collateral barriers to affordable credit for small and medium sized enterprises (SMEs), which also hampers private sector-led development in dealing with poverty reduction. Although the government prioritizes the development of microfinance institutions, microfinance remains relatively underdeveloped due to a lack of information technology infrastructure, a shortage of scale economies, and fragility in business operations. Thus, the prevalence of mobile money is more imminently needed in Burkina Faso to alleviate poverty.

Mobile money use started increasing in Burkina Faso at the same time as its WAEMU peers, ever since instruction N^0 01/2006/SP DU 31 JUIL. 2006 (Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO) (2006), which enables a nonfinancial entity (mostly telecommunication companies) to issue mobile money services in the WAEMU under the agreement of BCEAO. The two pioneers of mobile money in Burkina Faso are Airtel and Telmob. Both are telecommunication companies, and they launched mobile money services in 2012 and 2013, respectively. Airtel money was launched further to a partnership between Airtel Burkina and Ecobank Bank in 2012 and later became Orange money. In 2013, a partnership between Telmob and BICIA-Burkina (a subsidiary of BNP Paribas) gave rise to mobicash, which is the second mobile payment service (money transfers and bill payments) in Burkina Faso. Currently, the evolution of the mobile payments market is impressive, such that they compete with traditional banks at some locations. In addition, BCEAO (2016) revealed that the flow of mobile money transactions in 2016 in Burkina Faso reached 2415 billion FCFA ($4,488,847,584 USD) but still recognized that it still has a huge potential of growth, which can be seen in the economic literature. Indeed, according to Mothobi and Grzybowski (2017), mobile phone users who live in areas with poor infrastructure tend to rely on mobile phones to make financial transactions than individuals living in areas with better infrastructure. Ky and Rugemintwari (2015) find that using mobile money services increases the ability of individuals to save for health emergencies in the case of Burkina Faso, but they did not rely directly on poverty reduction in their study.

4. Financial inclusion and poverty reduction

This study first assesses the effects of financial inclusion on poverty status at the individual level and then evaluates the role of mobile money in accelerating financial inclusion in a later section. We took the data at the individual level in Burkina Faso from the Finscope Consumer Survey (2016). The survey primarily aims to describe the degrees of financial inclusion, to describe the landscape of financial access, to identify the drivers of and barriers to financial access, to stimulate evidence-based dialogue, and to create a baseline for financial inclusion in the country. The survey targeted adults who are 15 years old or older in a comprehensive listing of 675 enumeration areas within the 13 regions of Burkina Faso with 85,513 eligible households, and face-to-face interviews were

conducted by an international study group during the period from May 2016 to September 2016. The sample was randomly drawn by the Institut National de la Statistique et de la Démographie (INSD). The sampling method broadly resembled a stratified multistage random sampling with confirmation of quality control and data validation.[5] After removing observations with missing variables, our sample comprises 5066 individuals, which includes demographic, socioeconomic, and geographic characteristics.

Monetary-based poverty measures (such as income) have widely been used to examine the poverty status. However, several studies have emphasized the argument that in addition to these money-metric poverty measures, other dimensions of poverty, such as education and health conditions, should be incorporated to examine the poverty status. In fact, obtaining the precise information of income and expenditures are often difficult in developing countries, especially in Sub-Saharan Africa which is generally regarded as having the highest levels of poverty and extreme poverty (Batana, 2013). Moreover, monetary-based poverty measures do not capture all forms of deprivation. For example, although South Asian countries have reduced monetary-based poverty at an impressive pace over the past decade, the region lags in the non-monetary dimensions of the poverty status (World Bank, 2018). Accounting for the multidimensional concept of poverty (Sen, 1976), this study focuses on three outcome variables related to poverty status: (i) lack of nutrition (skipped a meal because of lack of food, LON), (ii) lack of healthcare (stayed without medical treatment or medicine because of lack of money, LOH), and (iii) lack of education (not been able to send children to school because of lack of money, LOE), using a four-point Likert-type scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often). Financial inclusion and exclusion at the individual level are captured by the dummy variable (FI), which equals one if an individual uses financial access provided by financial institutions (banks or nonbank financial institutions) and zero otherwise. Our specification implies that individuals with FI = 1 are financially included, while those with FI = 0 are financially excluded.

4.1. Methodology

This study first measures the effects of financial inclusion on individual poverty status to verify the conventional wisdom that financial inclusion improves welfare in the case of Burkina Faso. The reasons for using financial services could reflect individuals' characteristics related to their level of poverty status, so that linear regression models may be biased due to potential endogeneity problems.[6] Past literature suggests various methods to address such a selection bias issue. Among them, many studies employ instrumental variables (IVs). However, finding valid instruments is a challenge for many empirical studies. To mitigate potential endogeneity, our study uses matching methods. Our analysis is based on the idea that the use of financial services or financial inclusion represents a treatment, where individuals using financial services comprise the treatment group, while nonusers represent the counterfactual group (control group). Our measure of interest is the average treatment effect on the treated (ATT).[7]

In nonexperimental analysis, the treatment is nonrandom (De Janvry, Dustan, & Sadoulet, 2010; Heckman & Vytlacil, 2007). In the case of nonrandomized assignments, observed and unobserved backgrounds of individuals may influence treatments as well as dependent variables so that selection bias can be persistent. The concept of matching methods is to imitate randomization regarding the assignment of the treatment. The unobserved counterfactual dependent variable is imputed by matching the treated individuals with untreated individuals that are as close as possible regarding all pretreatment characteristics. The estimate of the ATT is described as follows:

$$\mathrm{ATT}(\mathrm{x}) = \mathrm{E}[\mathrm{Y}_1|\mathrm{D}=1, \mathrm{X}=\mathrm{x}] - \mathrm{E}[\mathrm{Y}_0|\mathrm{D}=0, \mathrm{X}=\mathrm{x}],$$

where x is a set of relevant pretreatment characteristics, $\mathrm{E}[\mathrm{Y}_1|\mathrm{D}=1, \mathrm{X}=\mathrm{x}]$ is the expected outcome for the units that received treatment, and $\mathrm{E}[\mathrm{Y}_0|\mathrm{D}=0, \mathrm{X}=\mathrm{x}]$ is the expected outcome for the treated units' best matches. This study first estimates the ATT by applying the propensity score matching (PSM) method, which could mitigate selection bias issues. Once the treated units are matched,

[5] See the Finscope Consumer Survey (2016) for the details.

[6] The standard ordinary least squares (OLS) estimation of the model with poverty status as the outcome and the decision to use financial inclusion as the independent variable creates the issue of self-selection bias, because the decision could be affected by unobservable characteristics, such as an individual's knowledge, that are already part of the error term. The literature applies several empirical procedures to fix the selection bias. Among them, many studies employ the instrumental variables (IV) method.

[7] Following Imbens and Wooldridge (2009), the ATT is described as $\mathrm{ATT} = \mathrm{E}[\mathrm{Y}_1|\mathrm{D}=1] - \mathrm{E}[\mathrm{Y}_0|\mathrm{D}=1]$, where D is the financial inclusion dummy; Y_1 and Y_0 are potential outcomes of the users and nonusers (two counterfactual situations), respectively; $\mathrm{Y}_0|\mathrm{D}=1$ is the value of the outcome of our interest that would have been observed if the individual had not chosen to use financial services (counterfactual outcome); and $\mathrm{Y}_1|\mathrm{D}=1$ is the value of the outcome that is actually observed for the same individual. A fundamental problem is the difficulty in estimating the ATT because the counterfactual outcome is the unobservable value of $\mathrm{E}[\mathrm{Y}_0|\mathrm{D}=1]$. When an individual's choice of financial inclusion is random, the average outcome of individuals not exposed to treatment, $\mathrm{E}[\mathrm{Y}_0|\mathrm{D}=1]$ is an adequate substitute, meaning that the ATT can be obtained from the differences in the sample means of the outcome variable between the treatment and the control groups. However, the choice of financial inclusion can be endogenous.

the PSM assumes no systematic differences in unobservable characteristics between treated and untreated units. Given the estimated propensity scores P(x) under the main assumptions, i.e., conditional independence, the independent and identically distributed observations, and the common support assumptions, the ATT can be computed as follows[8]

$$ATT = E[Y_1|D = 1, P(x)] - E[Y_0|D = 0, P(x)].$$

In the matching process, a sufficient overlap is assumed to exist between the control and treatment groups (i.e., common support). Furthermore, even when the overlap assumption is satisfied, there may be a large gap between the propensity scores of the two closest individuals available for match, leading to poor matches. To avoid this situation, this study uses the caliper restriction (Caliendo & Kopeinig, 2008), which imposes a threshold for the maximum distance between matched units. If the distance is above this threshold, the treated observation is dropped to avoid obtaining biased estimates. In this study, common practice is applied with a caliper of 0.05.

However, the ATT estimated from PSM can still suffer from biased results in the presence of misspecification in the propensity score model (Robins, Sued, Lei-Gomez, & Rotnitzky, 2007; Wooldridge, 2007, 2010).

One potential remedy for such a problem is to apply inverse-probability-weighted regression adjustment (IPWRA) estimation methods (Imbens & Wooldridge, 2009). IPWRA estimators use weighted regression coefficients to calculate averages of treatment-level predicted outcomes, where the weights are the estimated inverse probabilities of treatment.[9] Unlike PSM, IPWRA has a double robust property that ensures consistent results, as it allows the outcome and the treatment models to account for misspecification. PSM will provide inconsistent estimates if the treatment model is mis-specified. Moreover, with IPWRA, if the treatment model is misspecified, the estimates of the treatment effect can still be consistent if the outcome model is not misspecified. In addition, if the treatment model is not misspecified, IPWRA can also provide consistent estimates even when the outcome model is misspecified. That is why IPWRA estimates are consistent in the presence of misspecification in the treatment or outcome model, but not both (Imbens & Wooldridge, 2009; Wooldridge, 2010).[10] To estimate treatment effects using IPWRA, we start by estimating the parameters of the treatment model and derive inverse-probability weights. By using the estimated inverse-probability weights, we fit weighted regression outcome models for each treatment level and obtain the treatment-specific predicted outcomes for each subject. At the end, we compute the means of the treatment-specific predicted outcomes so that the contrasts of these averages provide the estimates of the average treatment effects.

This study evaluates the effects of financial inclusion on three measures of an individual's poverty status related to lack of nutrition, healthcare, and education (LON, LOH, and LOE). To construct a control group of untreated units that is as similar as possible to the treatment group, we need to select appropriate covariates representing the pretreatment an individual's characteristics. Following the studies by Ogutu, Okello, and Otieno (2014) and Barnett, Hu, and Wang (2019), we select relevant pretreatment individual characteristics, including the age of the respondent in years (AGE), a gender dummy (FEMALE) that is equal to one if the respondent is female and zero otherwise, the family size or the number of household members (HSIZE), a distance dummy (TTM) that indicates the time to reach the market by using a six-point Likert-type scale (1 = less than 10 min; 2 = 11–20 min; 3 = 21–30 min; 4 = 31–60 min; 5 = 61 minutes-2 hours; 6 = more than 5 h), and a mobile phone dummy (MP) that equals one if the respondent owns a mobile phone and zero otherwise. We also control for the primary education attendance of each respondent by including a dummy (PEDUC) which equals one when the respondent attended primary education and zero otherwise, the land (hectares) owned by each respondent (LSIZE) and an area dummy (RURAL) which equals one when the respondent lives in a rural area and zero otherwise.[11] Table 1 displays the descriptions of variables used in this study.

4.2. Results

Table 2 shows the summary statistics of the variables. The sampled individuals are divided into the treatment (financial inclusion)

[8] As underlined in several studies, such as Rosenbaum and Rubin (1985) and Heinrich, Laurence, and Brinton (2010), PSM approaches work under the following assumptions. The first assumption is the conditional independence assumption (CIA) or confoundedness. This assumption states that no unobservable variable affects both the likelihood of treatment and the outcome of interest after conditioning on covariates. CIA is the strong assumption and does not consider any unobservable differences. The second assumption is the independent and identically distributed observations assumption, which requests the potential outcomes and treatment status of each unit to be independent of the potential outcomes and treatment status of all other units in the sample. The third assumption is the common support or overlap requirement, which suggests that every observation comes with a positive probability of being both treated and controlled. In addition, the PSM should satisfy the balancing property, i.e., the mean value of covariates between treatment and control groups should be similar after matching.

[9] The use of IPWRA also requires several assumptions, such as the conditional independence, the independent and identically distributed observations, and the overlap assumptions.

[10] In addition to the misspecification issue, IPWRA improves on PSM in two ways. The first one is the inclusion of controls for the observation's baseline characteristics in the outcome model. Both IPWRA and PSM must satisfy the conditional independence assumption, which states that no unobservable variable affects both the likelihood of treatment and the outcome of interest after conditioning on covariates. Since IPWRA includes more covariates in the outcome model than PSM, which includes only the covariates in the treatment model, this assumption is more likely to hold with IPWRA than with PSM. The second improvement is that, unlike PSM, which compares each treatment observation to control observations that have a similar likelihood of being treated in a restrictive way, IPWRA implicitly compares every unit to every other unit while placing higher weights on observations that have a similar likelihood of being treated and lower weights on observations that are dissimilar.

[11] In Burkina Faso, most of the total adult population (76%) live in rural areas. The definition of the rural area is decided by the Institut National de la Statistique et de la Démographie (INSD. The rural area is an area where there is less than 5000 people living further than 2 km from a rood in good or fair condition (World Bank, 2019a, 2019b).

Table 1
Description of variables.

variables	Description
Dependent variables	
LON	Lack of nutrition (skipped a meal because you did not have food (1 = Never/2 = Rarely/3 = Sometimes/4 = Often))
LOH	Lack of healthcare (stayed without medical treatment or medicine because you did not have money (1 = Never/2 = Rarely/3 = Sometimes/4 = Often))
LOE	Lack of education (not been able to send children to school because of lack of money for transport or uniform or other school costs (1 = Never/2 = Rarely/3 = Sometimes/4 = Often))
Treatment variables	
FI	Use of financial services (1 for formal financial access and 0 for otherwise)
MM	Use of mobile money (1 for mobile money use and 0 for otherwise
Covariates	
AGE	Age of respondent (years)
FEMALE	Dummy for gender of respondent (1 = female/0 = male)
HSIZE	Household size
TTM	Dummy for Time to Market (1 = "Less than 10 min"/2 = "11–20 min"/3 = "21–30 min"/4 = "31–60 min"/5 = "61 min - 2 h"/6 = "More than 5 h")
MP	Dummy for Mobile Phone (1 = own a Mobile Phone; 0 = Otherwise)
PEDUC	Dummy for Primary Education (primary school (1 = No formal schooling or Preschool or Primary/0 = Otherwise))
LSIZE	Land size (hectares)
RURAL	Dummy for area (1 = Rural; 0 = Otherwise)

group with 1148 individuals (29.8 percent) and the control (financial exclusion) group with 2703 individuals (70.2 percent). There are significant differences in means for poverty status measures and pretreatment variables between financially included and excluded groups. Financially excluded individuals tend to be poorer than financially included individuals in terms of nutrition, healthcare, and education. The process in this study begins with the estimation of propensity scores for the treatment variable by applying a logistic regression model, where the probability of financial inclusion is regressed on our individual characteristics. Table 3 displays the estimated results of the logistic regression. The results confirm that female, young, and less educated people are more likely to be financially excluded. In addition, people in rural regions tend to be financially excluded. Moreover, people without assets, such as a mobile phone and land, are more likely to be financially excluded. In the matching process, sufficient overlap exists between the control and treatment groups, i.e., common support (Caliendo & Kopeinig, 2008). In addition, large gaps may exist between the propensity scores of the closest individuals available for match, which leads to poor matches. To mitigate this issue, we implement a restriction of a 0.05 caliper. Moreover, the density distribution of the propensity scores in the treatment and control groups confirms that differences in the density distributions prior to the matching have been removed. The balancing property in Table 4 shows that the p-values related to the differences in means of covariates between the two groups after matching are insignificant, indicating that our matching achieves appropriate balancing properties.

Table 5 displays the estimated ATTs of financial inclusion on our three proxies of individual welfare related to lack of nutrition, healthcare, and education (LON, LOH, and LOE) under the PSM and IPWRA frameworks. The results present clear evidence supporting that financial inclusion guided by financial services induces poverty reduction at the individual level. Once an individual is financially included, the three measures of poverty status (LON, LOH, and LOE) are reduced by 0.16–0.20, 0.17–0.24, and 0.24–0.30 points, respectively. For robustness checks, we also conduct ordinary least squares (OLS) regressions (Table A1 in the appendix). The coefficients of LON, LOH, and LOE are significantly negative, which support the PSM and IPWRA results.[12] Our results in the case of Burkina Faso are consistent with the conventional relationship between financial inclusion and poverty reduction (Burgess & Pande, 2005; Demirguc-Kunt et al., 2017). Enabling people to access financial services would help achieve poverty reduction, which is emphasized in the Sustainable Development Goals (SDGs). Since limited capital or credit is the main hindrance for entrepreneurs to access inputs and high-end markets for their output (Okello, 2010) and for households to smooth consumption (Demirgüç-Kunt & Klapper, 2012), financial services could help eliminate extreme poverty. Deepening financial inclusion can induce favorable welfare effects that extend beyond benefits in the financial realm to the real economy (Grohmann et al., 2018).

5. Incorporating the role of mobile money

This section extends the analysis to evaluate how an individual's welfare is affected by the introduction of mobile money. In the previous section, we consider two categories based on whether or not an individual has financial accounts in financial institutions (FI): financially included individuals (treatment group) (FI = 1) and financially excluded individuals (control group) (FI = 0). A mobile money user is captured by the dummy variable (MM) which equals one if an individual uses mobile money and zero otherwise. To

[12] Recently, matching techniques have moved away from the PSM towards other matching techniques. King and Nielsen (2019) emphasize the weakness of the PSM, which often suffers from increasing imbalance, inefficiency, model dependence, and bias, and they suggest other matching methods, such as Mahalanobis Distance Matching (MDM) and Coarsened Exact Matching (CEM), which approximate a fully blocked experimental design. Thus, in addition to the PSM, we also conduct the robustness checks by applying two alternative matching methods, (i) kernel matching and (ii) 2-nearest neighbor matching. Table A2 in the appendix shows the estimated ATTs of these two methods, which confirm the results of the PSM and IPWRA.

Table 2
Descriptive statistics.

	Whole sample (1)		Financial inclusion (2)		Financial exclusion (3)		Mean diff (3)–(2)
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev	Mean
LON	1.8886	1.0692	1.7247	1.0130	1.9582	1.0849	0.2334***
LOH	1.8489	1.0482	1.6881	0.9732	1.9171	1.0714	0.2290***
LOE	1.6964	1.0566	1.5174	0.9171	1.7725	1.1019	0.2550***
FI	0.2981	0.4575	–	–	–	–	–
MM	0.1898	0.3922	–	–	–	–	–
AGE	34.8169	14.8407	37.3850	14.5673	33.7262	14.8240	−3.6588***
FEMALE	0.4827	0.4998	0.3606	0.4804	0.5346	0.4989	0.1740***
HSIZE	8.8437	4.7546	9.4347	5.0114	8.5927	4.6193	−0.8420***
TTM	2.4025	1.0959	2.3545	1.0908	2.4229	1.0977	0.0683*
MP	0.8250	0.3800	0.8841	0.3202	0.7998	0.4002	−0.0843***
PEDUC	0.8873	0.3163	0.8632	0.3437	0.8975	0.3033	0.0343***
LSIZE	5.0321	4.6823	6.0233	6.7015	4.6111	3.4030	−1.4121***
RURAL	0.9182	0.2741	0.8615	0.3456	0.9423	0.2332	0.0808***
No of obs.	3851		1148		2703		

Note: ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table 3
Logistic regression.

	Coefficient
AGE	0.0182*** (0.0026)
FEMALE	−0.6640*** (0.0762)
HSIZE	0.0110 (0.0082)
TTM	−0.0162 (0.0342)
MP	0.6361*** (0.1090)
PEDUC	−0.3081** (0.1218)
LSIZE	0.0701*** (0.0096)
RURAL	−1.0787*** (0.1256)
Constant	−0.9168*** (0.2100)
No. of obs.	3851
LR chi2(8)	338.67
Prob>chi2	0.0000
Pseudo R-squared	0.0722
log likelihood	−2176.8834

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table 4
Balancing property.

	Mean		Bias reduction	P-value
	Treated	Control		
Before matching				
AGE	37.385	33.726		0.000
FEMALE	0.3606	0.5346		0.000
HSIZE	9.4347	8.5927		0.000
TTM	2.3545	2.4229		0.077
MP	0.8841	0.7998		0.000
PEDUC	0.8632	0.8975		0.002
LSIZE	6.0233	4.6112		0.000
RURAL	0.8615	0.9423		0.000
After matching				
AGE	36.968	36.647	91.2	0.632
FEMALE	0.3802	0.3840	97.8	0.858
HSIZE	9.1906	9.1943	99.6	0.986
TTM	2.3792	2.3943	77.9	0.751
MP	0.8755	0.8792	95.5	0.791
PEDUC	0.8802	0.8651	56.0	0.297
LSIZE	5.3807	5.3605	98.6	0.918
RURAL	0.8981	0.8840	82.5	0.296

Table 5
ATTs of financial inclusion.

	PSM	IPWRA
LON	−0.1635*** (0.0449)	−0.2032*** (0.0394)
LOH	−0.1673*** (0.0435)	−0.2354*** (0.0395)
LOE	−0.2401*** (0.0433)	−0.3018*** (0.0391)

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

evaluate the role of mobile money, we further divide financially included individuals (financial inclusion) into two groups based on the usage of mobile money, and our whole sample now comprises three groups: (i) financially included individuals without mobile money (financial inclusion without mobile money) (FI = 1 and MM = 0), (ii) financially included individuals with mobile money (financial inclusion with mobile money) (FI = 1 and MM = 1), and (iii) financially excluded individuals (financial exclusion) (FI = 0 and MM = 0). In the data set, there exist a small number of individuals who do not have financial accounts in financial institutions but who use mobile money (27 out of 3878). This case is extremely rare because people need to open financial accounts in financial institutions to use mobile money. Thus, we exclude such samples from our data set. Table 6 shows the descriptive statistics for our whole sample and each of the three groups. Among 1148 financially included individuals, there are 731 who used mobile money (63.68 percent) and 417 who did not use mobile money (36.32 percent). We observe that the differences in means of the three poverty statuses appear to be substantial among the three groups.

To evaluate the effects of mobile money, this study applies two matching methods (PSM and IPWRA) after the satisfaction of the balancing properties of our covariates over each of the following three subsamples separately.[13] The first subsample (subsample 1) consists of (i) financially included individuals without mobile money (financial inclusion without mobile money) and (iii) financially excluded individuals (financial exclusion), where the treatment and control groups comprise financial inclusion without mobile money and financial exclusion, respectively. Subsample 1 allows us to examine how financially excluded individuals improve their poverty status by accessing financial services without mobile money. The second subsample (subsample 2) consists of (ii) financially included individuals with mobile money (financial inclusion with mobile money) and (iii) financially excluded individuals (financial exclusion), where the treatment and control groups comprise financial inclusion with mobile money and financial exclusion, respectively. Subsample 2 enables us to evaluate how financially excluded individuals enhance their poverty status by accessing financial services with mobile money. The third subsample (subsample 3) consists of (ii) financially included individuals with mobile money (financial inclusion with mobile money) and (i) financially included individuals without mobile money (financial inclusion without mobile money), where the treatment and control groups comprise financial inclusion with and without mobile money, respectively. Subsample 3 allows us to evaluate how financially included, but without mobile money, individuals enhance their poverty status by using mobile money, i.e., the value added of mobile money for individuals who have already accessed financial services. Fig. 1 presents the three groups (financially excluded individuals, financial inclusion without mobile money, and financially included individuals with mobile money) and three subsamples (subsamples 1, 2, and 3). For each of the three subsample analyses, we use the same pretreatment variables or covariates as those in the previous section. Table 7 shows the estimated results of logistic regressions, which enable us to obtain propensity scores of the PSM method for each subsample analysis. The estimated results generally coincide with the findings in the previous case of the full sample, where the treatment and control groups comprise financially included individuals and financially excluded individuals, respectively.

Table 8 presents the estimated results of the ATTs based on the PSM and IPWRA methods for each of the three subsamples. We also conduct OLS regressions (Table A3 in the appendix), which support the PSM and IPWRA results.[14] The first two columns correspond to the first subsample, where the treatment and control groups comprise financial inclusion without mobile money and financial exclusion, respectively; the next two columns correspond to the second subsample, where the treatment and control groups comprise financial inclusion with mobile money and financial exclusion, respectively; and the last two columns correspond to the third subsample, where the treatment and control groups comprise financial inclusion with and without mobile money, respectively. Concerning the first subsample analysis, the estimated results reveal that financial inclusion, even without mobile money use, reduces our three measures of poverty status: lack of nutrition, healthcare, and education. For the second subsample analysis, the results show that financial inclusion with mobile money also reduces our three measures of poverty status. Importantly, the estimated ATTs are larger than those in the first subsample analysis, which suggests that the favorable effects of financial inclusion on an individual's welfare would be intensified by the usage of mobile money. The finding in the second subsample analysis can also be verified by the third

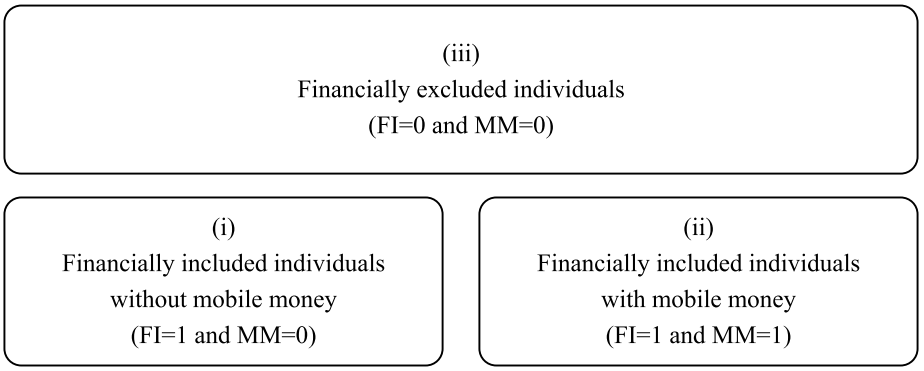
[13] The results of the balancing properties regarding each binary treatment variable are displayed in Tables A5, A6, and A7 in the appendix and show how best ours matching methods reduce controls variables bias after matching.

[14] Similar to the previous discussions about the weakness of the PSM in footnote 12, we also conduct the robustness checks by applying two alternative matching methods, (i) kernel matching and (ii) 2-nearest neighbor matching, for each of the three subsamples. Table A4 in the appendix confirms that the estimated ATTs are consistent with those of the PSM and IPWRA.

Table 6
Descriptive statistics.

	Whole sample		Financial inclusion Without mobile money		Financial inclusion With mobile money		Financial exclusion		Mean diff	
	(1)		(2)		(3)		(4)		(4)-(2)	(4)-(3)
	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev	Mean	
LON	1.8886	1.0692	1.8201	1.0533	1.6703	0.9859	1.9582	1.0849	0.1380**	0.2879***
LOH	1.8489	1.0482	1.7746	0.9937	1.6388	0.9585	1.9171	1.0714	0.1425***	0.2783***
LOE	1.6964	1.0566	1.6499	1.0177	1.4419	0.8458	1.7725	1.1019	0.1226**	0.3306***
FI	0.2981	0.4575	-	-	-	-	-	-	-	-
AGE	34.8169	14.8407	37.6834	15.1887	37.2148	14.2084	33.7262	14.8240	-3.9572***	-3.4885***
FEMALE	0.4827	0.4998	0.4245	0.4948	0.3242	0.4684	0.5346	0.4989	0.1101***	0.2104***
HSIZE	8.8437	4.7546	9.0288	4.5662	9.6662	5.2374	8.5927	4.6193	-0.4361*	-1.0735***
TTM	2.4025	1.0959	2.4988	1.1522	2.2722	1.0461	2.4229	1.0977	0.0759	0.1506***
MP	0.8250	0.3800	0.8297	0.3763	0.9152	0.2788	0.7998	0.4002	-0.0299	-0.1153***
PEDUC	0.8873	0.3800	0.9161	0.2776	0.8331	0.3731	0.8975	0.3033	-0.0185	0.0644***
LSIZE	5.0321	4.6823	6.0460	6.6839	6.0103	6.7160	4.6111	3.4030	-1.4348***	-1.3992***
RURAL	0.9182	0.2741	0.9113	0.2847	0.8331	0.3731	0.9423	0.2332	0.0310**	0.1092***
No of obs.	3,851		417		731		2,703			

Note: ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.



	Treatment group	Control group
Subsample 1	(i) Financially included individuals without mobile money	(iii) Financially excluded individuals
Subsample 2	(ii) Financially included individuals with mobile money	(iii) Financially excluded individuals
Subsample 3	(ii) Financially included individuals with mobile money	(i) Financially included individuals without mobile money

Fig. 1. Incorporating mobile money use.

subsample analysis showing the positive effects of mobile money use for the sample restricted to financially included individuals.[15]

Our results provide clear evidence supporting the important role of mobile money in enhancing the positive effects of financial inclusion in Burkina Faso. The 'interoperability' of financial services and mobile money has been emphasized to enable financial institutions to provide swift financial transactions for people anywhere (GSMA, 2017b; Peric et al., 2018). Such convenient functions can be beneficial for people in rural areas, people who are far from branches of financial institutions, and people who often face the difficulty of accessing financial services. More specifically, our analysis confirms that the prevalence of financial inclusion through mobile money improves the welfare status related to nutrition, healthcare, and education for poor people, which helps achieve some of the seventeen goals of the SDGs (GSMA, 2017a). First, the improvement in nutrition status is related to zero hunger in Goal 2. Easy access to financial services through mobile money helps small-sized agricultural farmers, particularly in rural regions, increase crop productivity (Ogutu et al., 2014). This can inevitably curb hunger and improve the nutrition status of poor farmers in Burkina Faso,

[15] For the robustness check, we also estimate multivalued treatment effects (ATTs) by applying the IPWRA method. In this specification, we divide all individuals into three groups: (i) financial exclusion, (ii) financial inclusion without mobile money, and (iii) financial inclusion with mobile money. Table 9 shows the estimated results, which generally support the baseline findings shown in Table 8.

Table 7
Logistic regression.

	Subsample 1 Financial inclusion without mobile money vs financial exclusion	Subsample 2 Financial inclusion with mobile money vs financial exclusion	Subsample 3 Financial inclusion with mobile money vs financial inclusion without mobile money
AGE	0.0161*** (0.0036)	0.0195*** (0.0031)	0.0008 (0.0046)
FEMALE	−0.4208*** (0.1098)	−0.8086*** (0.0927)	−0.4655*** (0.1337)
HSIZE	−0.0106 (0.0124)	0.0245*** (0.0094)	0.0410*** (0.0149)
TTM	0.0812* (0.0484)	−0.0791* (0.0419)	−0.1781*** (0.0581)
MP	0.2383* (0.1435)	0.9905*** (0.1476)	0.7492*** (0.1924)
PEDUC	0.1231 (0.2050)	−0.5041*** (0.1376)	−0.6590*** (0.2169)
LSIZE	0.0747*** (0.0121)	0.0629*** (0.0110)	−0.0110 (0.0104)
RURAL	−0.6206*** (0.1964)	−1.2530*** (0.1397)	−0.6265*** (0.2097)
Constant	−2.4633*** (0.3246)	−1.3122*** (0.2503)	1.3443*** (0.3626)
No. of obs.	3120	3434	1148
LR chi2(8)	90.51	352.23	71.70
Prob>chi2	0.0000	0.0000	0.0000
Pseudo R-squared	0.0369	0.0991	0.0477
log likelihood	−1181.7611	−1601.7893	−716.3887

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table 8
ATTs of financial inclusion and mobile money.

	Subsample 1 Financial inclusion without mobile money vs financial exclusion without mobile money		Subsample 2 Financial inclusion with mobile money vs financial exclusion without mobile money		Subsample 3 Financial inclusion with mobile money vs financial inclusion without mobile money	
	PSM	IPWRA	PSM	IPWRA	PSM	IPWRA
LON	−0.0757 (0.0739)	−0.1358** (0.0569)	−0.2586*** (0.0562)	−0.2413*** (0.0459)	−0.1328* (0.0745)	−0.1088* (0.0647)
LOH	−0.1373* (0.0726)	−0.1648*** (0.0544)	−0.2535*** (0.0547)	−0.2765*** (0.0465)	−0.1432** (0.0703)	−0.1013 (0.0629)
LOE	−0.1425* (0.0734)	−0.1584*** (0.0554)	−0.3759*** (0.0538)	−0.3845*** (0.0447)	−0.2187*** (0.0678)	−0.2183*** (0.0622)

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table 9
ATTs of multivalued treatments.

		IPWRA
LON	Financial inclusion without mobile money vs financial exclusion	−0.1351** (0.0568)
	Financial inclusion with mobile money vs financial exclusion	−0.2720*** (0.0486)
LOH	Financial inclusion without mobile money vs financial exclusion	−0.1643*** (0.0544)
	Financial inclusion with mobile money vs financial exclusion	−0.3175*** (0.0473)
LOE	Financial inclusion without mobile money vs financial exclusion	−0.1580*** (0.0554)
	Financial inclusion with mobile money vs financial exclusion	−0.3613*** (0.0431)

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

where approximately 672,000 children under 5 years old (representing 21 percent of children under 5 years old), suffer from chronic malnutrition (stunting or low height-for-age), and 10 percent of them suffer from acute malnutrition (United States Agency for International Development (USAID) (2018).

Second, the results showing the favorable effects on healthcare status support good health and wellbeing in Goal 3 of the SDGs. Communicable diseases have continued to be the primary cause of morbidity and mortality in Burkina Faso, with malaria being the largest contributor to mortality for children under 5 years of age (USAID, 2018). Financial services through mobile phones improves individuals' ability to successfully manage their own health and that of their family by tracking medical expenses, saving income, receiving remittances in times of external shocks, and purchasing health insurance. Third, the improvement in education status as the effect of financial inclusion would be consistent partly with the quality of education in Goal 4 of the SDGs. Currently, mobile money providers often work with schools as well as universities, either directly or through government authorities, to digitize the payments of various fees, including registration fees, tuition fees, and examination fees, from students, and they also digitize salary payments to school teachers and staff. Such advanced technology would help achieve access to education for children in Burkina Faso, where a third of school-age children (around one million girls and boys) do not have access to education, and where 70 percent of the adult population is illiterate (Swiss agency for Development and Cooperation, 2016). In sum, the interoperability of financial services and mobile money could be an efficient means of improving conditions related to nutrition, healthcare, and education, which are crucial nonmonetary elements of an individual's welfare. Our results in the case of Burkina Faso coincide with the argument of Suri and Jack

(2016), who find that interoperability is a key driver in mitigating poverty in Kenya, as the introduction of the mobile money system (M-PESA) has increased per capita consumption levels and lifted 194,000 households, or 2 percent of households, out of poverty (Jenkins, 2008).

6. Conclusion

Financial inclusion is one of the important agendas for less developed countries to solve poverty issues and achieve the SDGs. The recent prevalence of mobile money services has been expected to promote financial inclusion for poor people. This study has evaluated how financial inclusion and mobile money in the context of their interoperability help reduce poverty and improve individuals' welfare in the case of a least-developed country, Burkina Faso, where the penetration rate of mobile money is relatively low compared to other developing countries. In particular, we have focused on nonmonetary poverty indicators of nutrition, healthcare, and education. Our three poverty-related indicators have been targeted to achieve poverty reduction in Burkina Faso. In fact, the proportion of households with poor or limited food consumption increased nationally from 26 percent in 2008 to 32 percent in 2012. Food consumption quality dropped significantly among urban households, with 30 percent exhibiting poor or limited food consumption compared to 12 percent in 2008 (World Food Programme, 2014). The government has emphasized the improvement of people's nutrition status since 2016 under the National Food and Nutrition Security Policy (PNSAN) (Murphy, Oot, & Sethuraman, 2017). In addition, 79 percent of women reported at least one problem in accessing healthcare, 72 percent of women reported a lack of money to pay for services as a barrier, 44 percent cited distance to the health center as a deterrent, and only 23 percent of women were literate in Burkina Faso (Institut National de la Statistique et de la Démographie (INSD) & Inner City Fund (ICF) International, 2012) , so the government has also targeted the improvement of healthcare and education by establishing the General Directorate of Health Information and Statistics (DGISS) and the Programme Sectoriel de l'Education et de la Formation (PSEF) (Zida et al., 2017). The estimated results of the matching methods have presented the favorable effects of financial inclusion on poverty reduction in terms of individuals' nonmonetary welfares (nutrition, healthcare, and education). More importantly, once financial services are provided through mobile money, such favorable effects become more substantial. Our analysis has revealed the crucial role of the interoperability of financial services and mobile money, such that financial and telecommunication regulators should create a sound environment for the prevalence of mobile money, as suggested by Suárez (2016).

Appendix

Table A1
OLS results

	Full sample analysis		
	LON	LOH	LOE
Treatment	−0.2016*** (0.0377)	−0.2262*** (0.0365)	−0.2791*** (0.0358)
AGE	0.0063*** (0.0012)	0.0070*** (0.0013)	0.0050*** (0.0013)
FEMALE	−0.0156 (0.0348)	−0.0188 (0.0342)	−0.0250 (0.0347)
HSIZE	0.0105*** (0.0039)	0.0150*** (0.0037)	0.0282*** (0.0038)
TTM	−0.0449*** (0.0157)	−0.0218 (0.0156)	−0.0809*** (0.0159)
MP	- 0.4727*** (0.0489)	- 0.3621*** (0.0475)	−0.2974*** (0.0483)
PEDUC	0.0788 (0.0550)	0.0956* (0.0529)	0.0951* (0.0524)
LSIZE	−0.0209*** (0.0061)	−0.0158*** (0.0047)	−0.0047 (0.0036)
RURAL	−0.0304 (0.0649)	−0.1264* (0.0646)	−0.0866 (0.0632)
Constant	2.2035*** (0.1037)	2.0091*** (0.1013)	1.8256*** (0.1006)
No. of obs.	3851	3851	3851
R-squared	0.0610	0.0502	0.0494

Notes: (1) Treatment equals one for financially included individuals and zero for financially excluded individuals in the full sample analysis. (2) Robust standard errors are in parentheses. (3) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table A2
ATTs using Kernel matching and 2-nearest neighbor matching estimations

	Whole sample Financial inclusion	
	Kernel matching	2-nearest neighbor matching
LON	−0.1990*** (0.0400)	−0.1995*** (0.0479)
LOH	−0.2216*** (0.0389)	−0.2461*** (0.0473)
LOE	−0.2958*** (0.0383)	−0.3193*** (0.0483)

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table A3
OLS results

	Subsample analysis 1			Subsample analysis 2			Subsample analysis 3		
	LON	LOH	LOE	LON	LOH	LOE	LON	LOH	LOE
Treatment	−0.1136**	−0.1437***	−0.1444***	−0.2525***	−0.2753***	−0.3640***	−0.1317**	−0.1319**	−0.2092***
	(0.0558)	(0.0534)	(0.0546)	(0.0436)	(0.0424)	(0.0394)	(0.0639)	(0.0608)	(0.0588)
AGE	0.0060***	0.0067***	0.0055***	0.0073***	0.0076***	0.0049***	0.0038*	0.0062***	0.0042**
	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0014)	(0.0014)	(0.0022)	(0.0022)	(0.0020)
FEMALE	−0.0344	−0.0264	−0.0510	−0.0325	−0.0564	−0.0675*	0.0554	0.0859	0.1423**
	(0.0384)	(0.0379)	(0.0393)	(0.0368)	(0.0362)	(0.0367)	(0.0661)	(0.0629)	(0.0590)
HSIZE	0.0081*	0.0126***	0.0280***	0.0109***	0.0160***	0.0282***	0.0205***	0.0224***	0.0328***
	(0.0043)	(0.0042)	(0.0046)	(0.0042)	(0.0040)	(0.0040)	(0.0071)	(0.0066)	(0.0061)
TTM	−0.0480***	−0.0269	−0.1043***	−0.0487***	−0.0176	−0.0824***	−0.0323	−0.0279	−0.0256
	(0.0176)	(0.0176)	(0.0182)	(0.0167)	(0.0168)	(0.0171)	(0.0274)	(0.0267)	(0.0248)
MP	−0.4587***	−0.3662***	−0.2879***	−0.4819***	−0.3535***	−0.3096***	−0.4145***	−0.3138***	−0.2005**
	(0.0520)	(0.0504)	(0.0522)	(0.0517)	(0.0506)	(0.0516)	(0.1070)	(0.1001)	(0.0942)
PEDUC	0.1213*	0.1271**	0.0951	0.0558	0.0884	0.1025*	0.0094	0.0174***	0.0235
	(0.0638)	(0.0625)	(0.0639)	(0.0576)	(0.0554)	(0.0552)	(0.0939)	(0.0866)	(0.0788)
LSIZE	−0.0284***	−0.0181***	−0.0035	−0.0234***	−0.0202***	−0.0077**	−0.0133*	−0.0102*	−0.0044
	(0.0079)	(0.0068)	(0.0052)	(0.0067)	(0.0050)	(0.0037)	(0.0074)	(0.0054)	(0.0039)
RURAL	−0.0048	−0.0986	−0.0566	−0.0466	−0.1234*	−0.1133*	−0.0590	−0.1915**	−0.1241
	(0.0842)	(0.0832)	(0.0818)	(0.0696)	(0.0691)	(0.0683)	(0.0906)	(0.0913)	(0.0556)
Constant	2.2127***	2.0191***	1.8385***	2.2398***	2.0077***	1.8972***	2.0168***	1.8529***	1.4832***
	(0.1251)	(0.1205)	(0.1226)	(0.1094)	(0.1078)	(0.1066)	(0.1868)	(0.1808)	(0.1635)
No. of obs.	3120	3120	3120	3434	3434	3434	1148	1148	1148
R-squared	0.0582	0.0430	0.0409	0.0683	0.0556	0.0559	0.0384	0.0424	0.0566

Notes: (1) Treatment equals one for financially included individuals without mobile money and zero for financially excluded individuals in the subsample analysis 1. (2) Treatment equals one for financially included individuals with mobile money and zero for financially excluded individuals in the subsample analysis 2. (3) Treatment equals one for financially included individuals with mobile money and zero for financially included individuals without mobile money in the subsample analysis 3. (4) Robust standard errors are in parentheses. (5) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table A4
ATTs using Kernel matching and 2-nearest neighbor matching estimations

	Subsample 1 Financial inclusion without mobile money vs financial exclusion without mobile money		Subsample 2 Financial inclusion with mobile money vs financial exclusion without mobile money		Subsample 3 Financial inclusion with mobile money vs financial inclusion without mobile money	
	Kernel matching	2-nearest neighbor matching	Kernel matching	2-nearest neighbor matching	Kernel matching	2-nearest neighbor matching
LON	−0.1332**	−0.0915 (0.0674)	−0.2371***	−0.2312*** (0.0569)	−0.1117 (0.0686)	−0.0814 (0.0719)
	(0.0568)		(0.0464)			
LOH	−0.1619***	−0.1691** (0.0679)	−0.2603***	−0.2629*** (0.0544)	−0.0988 (0.0653)	−0.0205 (0.0674)
	(0.0540)		(0.0454)			
LOE	−0.1506***	−0.2040*** (0.0712)	−0.3725***	−0.3951*** (0.0517)	−0.2208***	−0.1990*** (0.0680)
	(0.0555)		(0.0428)		(0.0643)	

Notes: (1) Standard errors are in parentheses. (2) ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table A5
Balancing property. Subsample 1: Financial inclusion without mobile money vs financial exclusion

	Mean		Bias reduction	P-value
	Treated	Control		
Before matching				
AGE	37.683	33.726		0.000
FEMALE	0.4244	0.5346		0.000
HSIZE	9.0288	8.5927		0.072
TTM	2.4988	2.4229		0.192
MP	0.8297	0.7998		0.153
PEDUC	0.9161	0.8975		0.240
LSIZE	6.046	4.6112		0.000
RURAL	0.9113	0.9423		0.014
After matching				
AGE	37.715	37.877	95.9	0.884
FEMALE	0.4227	0.4227	100.0	1.000
HSIZE	8.9179	8.715	53.5	0.500
TTM	2.4952	2.4928	96.8	0.976
MP	0.8385	0.8382	67.7	0.710

(*continued on next page*)

Table A5 (*continued*)

	Mean		Bias reduction	P-value
	Treated	Control		
PEDUC	0.9155	0.9082	60.9	0.713
LSIZE	5.7444	5.6289	91.9	0.754
RURAL	0.9106	0.9034	76.6	0.720

Table A6
Balancing property. Subsample 2: Financial inclusion with mobile money vs financial exclusion

	Mean		Bias reduction	P-value
	Treated	Control		
Before matching				
AGE	37.215	33.726		0.000
FEMALE	0.3242	0.5346		0.000
HSIZE	9.6662	8.5927		0.000
TTM	2.2722	2.4229		0.001
MP	0.9152	0.7998		0.000
PEDUC	0.8331	0.8975		0.000
LSIZE	6.0103	4.6112		0.000
RURAL	0.8331	0.9423		0.000
After matching				
AGE	36.933	36.339	83.0	0.483
FEMALE	0.3416	0.3504	95.8	0.734
HSIZE	9.5124	9.7942	73.8	0.325
TTM	2.292	2.3036	92.2	0.838
MP	0.9095	0.9080	98.7	0.925
PEDUC	0.8525	0.8467	90.9	0.763
LSIZE	5.5519	5.5454	99.5	0.980
RURAL	0.8701	0.8496	81.3	0.276

Table A7
Balancing property. Subsample 3: Financial inclusion with mobile money vs financial inclusion without mobile money

	Mean		Bias reduction	P-value
	Treated	Control		
Before matching				
AGE	37.215	33.683		0.600
FEMALE	0.3242	0.4245		0.001
HSIZE	9.6662	9.0288		0.038
TTM	2.2722	2.4988		0.001
MP	0.9152	0.8297		0.000
PEDUC	0.8331	0.9161		0.000
LSIZE	6.0103	6.046		0.931
RURAL	0.8331	0.9113		0.000
After matching				
AGE	37.32	37.877	50.0	0.822
FEMALE	0.4088	0.4227	55.8	0.216
HSIZE	9.1536	8.715	32.2	0.175
TTM	2.4271	2.4928	31.0	0.052
MP	0.8776	0.8382	81.7	0.521
PEDUC	0.9088	0.9082	52.9	0.036
LSIZE	6.1163	5.6289	−152.6	0.857
RURAL	0.9036	0.9034	50.0	0.042

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