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Abstract

Financial inclusion is widely considered an important tool to ensure sustainable economic growth and alleviate poverty and inequality. However, financial inclusion in Mozambique is low compared to other African countries. The revolution of ICT and financial technologies, including mobile money is a breakthrough in financial inclusion. This study aimed to analyse the effect of mobile money on financial inclusion in Mozambique using the 2021 Global Findex data. Treatment Effect Model and Propensity Score Matching techniques were used to address the research questions. Findings suggest that mobile money positively affects savings and borrowing. However, the determinants of mobile money adoption and barriers are similar to those of conventional banking. This means that mobile money is more likely to benefit individuals who are already financially included. Therefore, inclusive financial strategies will require that access points expansion is combined with initiatives that improve household income and financial literacy.

JEL Codes: G 23, G51

Keywords: Financial inclusion, Mozambique, mobile money

1. Introduction

Financial inclusion is widely considered an important tool to ensure sustainable economic growth and alleviate poverty in Africa. Besides promoting economic growth and poverty alleviation, financial inclusion can reduce inequality (Omar & Inaba, 2020). This is also true in Mozambique, where poverty is estimated at 46%, the GINI coefficient is 0.54, and the economic growth rate is estimated at 3.8% (IMF, 2022; World Bank, 2018).

Recognizing the potential role of financial inclusion in the economy, the government of Mozambique designed the first ever National Financial Inclusion Strategy (ENIF-2016-2022) aiming among others, to promote access to and use of financial services. To facilitate access to financial services and products, the government together with the banking sector through the initiative *um Distrito-um Banco* (one District-one Bank branch) established 45 bank branches in 45 districts between 2016 and 2021 and conducted regulatory framework reforms in the financial sector (BoM, 2022). Before the Financial Inclusion Strategy, the state-owned mobile operator Mcel had launched the mobile money service Mkesh in 2011. Later, in 2013, Vodacom Mozambique brought its version known as M-Pesa, and in 2017, Movitel, another mobile telecommunication operator created e-mola (Batista & Vicente, 2017).

Yet, while the costs of traditional banking hinder access to financial services for certain segments, such as women, low-income households, less educated and rural residents (Luis et al., 2022; UNCTAD, 2021) significant innovations in financial technologies (fintechs), including mobile money, may significantly improve financial inclusion (Murinde et al., 2022).

In Mozambique, where only 21% of the population is banked (FSDMo, 2019) and the gaps between men and women, poor and rich, rural and urban remain wide, mobile money may be a viable alternative for financial inclusion. The Bank of Mozambique highlights that since the launch of the first mobile money institution in 2011 more than 11 million people, or 68.5% of the adult population have subscribed to mobile money accounts, and the number of mobile money agents increased from 3,051 to 147,519. However, the increase in the financial services access points, including mobile money institutions seems not to have been commensurate with the usage, or the Central Bank has failed to capture the usage of mobile money while computing the index of financial inclusion. In 2022, the financial inclusion index in Mozambique was estimated at 12.14. This value is 1.06 points less than what it was in 2011 (13.20). Moreover, the rural population remains with limited access to financial services and products, 60% of adults in rural areas are financially excluded

compared to only 20% in urban areas (FinScope, 2019). Gender discrepancies are also substantial. Demirguc-Kunt et al. (2018) found that the gap between men and women continues to widen in Mozambique, with men's access increasing 2.4 times faster than that of women. This raises the question of who adopts and uses mobile money in Mozambique and how mobile money contributes to financial inclusion – put differently, is mobile money serving segments excluded from traditional financial institutions, or is serving those already served by the banking sector (e.g. The most educated, rich, and living in urban areas with relatively good infrastructure) and how does this affect financial inclusion?

While the literature on mobile money and financial inclusion in Africa is relatively available, the literature on mobile money and its effect on financial inclusion in Mozambique is limited. Khan and Blumenstock (2016) have shown that the determinants of mobile money adoption/use and its effect on financial inclusion are context-specific and cannot be generalized. Additionally, although mobile money has been touted as an important tool for financial inclusion some studies suggest that its potential to ensure the availability of a multiplicity of financial services capable of improving the well-being of the population such as credit and savings may somehow be hard to prove (Batista & Vicente, 2020b; Natile, 2020; Van Hove & Dubus, 2019; Yue et al., 2022).

The slowness of mobile money adoption/use and its low contribution to financial inclusion could be attributed to several factors, including the nature and cost of mobile money business models, as well as socio-economic and political influences. In the case of Mozambique, the conflict in the North, the poor economic performance in recent years, and the COVID-19 pandemic may be at the origin of low financial inclusion, including through mobile money. More than 50% of the population in Mozambique live in rural areas with limited access to basic infrastructure and a high incidence of poverty. Fanta et al (2016) and Mothobi and Grzybowski (2017) show that access to infrastructure plays an important role in mobile phone adoption which is a pre-requisite for mobile money adoption and use. Demirgüç-Kunt et al. (2022) argue that more than half of unbanked adults in Mozambique have cited the lack of mobile phones as the main barrier to mobile money adoption. In addition, the lack of money and being a woman are barriers to mobile money adoption as well. Women tend to be less favoured in accessing financial services, due to cultural norms, but also due to limited access to resources (Sahay et al., 2020). Suri (2017) has shown that initial users of M-Pesa in Kenya were richer and more educated.

Although recent studies (e.g. Demir et al., 2022; Douanla Meli et al., 2022; Fall et al., 2020; Zins & Weill, 2016) acknowledge the role of individual socio-economic variables in financial inclusion, many studies have dealt with variables at the macro level. Studies analysing the role of mobile money adoption using microeconomic data are limited, especially in Mozambique. Against this background, the objective of this study consists of, identifying the determinants of mobile money adoption, and, assessing the effect of mobile money adoption on savings and borrowing. Based on the theoretical foundations, the study hypothesizes that the level of education, gender, and income are likely to influence the adoption of mobile money. However, the low level of mobile money use for savings and borrowing will probably cause the effect of mobile money to be minimal.

Understanding how individual socio-economic factors influence the adoption and use of mobile money—and how mobile money, in turn, impacts financial inclusion in developing countries—is both relevant and timely. This is particularly important given the role of mobile money in enhancing financial inclusion, which has the potential to reduce poverty and promote economic growth. This study offers insights into the necessity of tailoring policies and financial services to the most vulnerable groups in fragile economies like Mozambique, where the adoption of mobile money appears to be lagging.

A mid-term assessment of the National Financial Inclusion Strategy by the World Bank and Alliance for Financial Inclusion in Mozambique found that one of the challenges in grasping the progress towards financial inclusion is related to the lack of empirical studies. Therefore, the lack of studies on mobile money using socio-economic variables at the individual level in Mozambique is one of the gaps this study intends to fill. The study contributes to the existing literature in two ways; first, it profiles the adopters and non-adopters of mobile money and identifies key socio-economic factors affecting its adoption in Mozambique. Second, it unveils how mobile money could affect financial inclusion in a low-income country with limited infrastructure and high levels of poverty.

The remainder of the paper is organized as follows. Section 2 provides an overview of the financial system in Mozambique, including mobile money. Section 3 presents the theoretical foundations and empirical literature on mobile money as an instrument for financial inclusion. Section 4 describes the research approach, Section 5 provides and discusses the findings, and finally, Section 6 summarizes the study and provides policy recommendations.

2. Financial system in Mozambique

Since 2003, the government of Mozambique, in collaboration with the World Bank and the International Monetary Fund, has been carrying out important structural reforms in the financial sector, including its legal framework to ensure greater financial inclusion (FSAP, 2009). In 2004, Decree 15/99 of November 1st was approved, which among others allows mobile operators to partner with financial institutions in providing financial services (Batista & Vicente, 2017). Significant progress has been made in expanding physical access points in the past decade. In 2011 there were 3.6 bank branches per 100,000 adults, increasing to 4.5 in 2019. In 2022 the Central Bank of Mozambique announced the full interoperability of the three mobile money institutions (m-pesa, e-mola, and m-kesh) creating an opportunity for expanding access and use of financial services.

The number of ATMs increased from 934 to 1755 and the number of POS from 8499 to 36701, savings and loan organizations increased from 11 to 12 while microcredit operators increased from 202 to 529 (BoM, 2013; BoM, 2020).

The Mozambican financial sector is dominated by banks, mostly of foreign-owned capital, accounting for more than half of the financial sector's total assets (IMF, 2010). The three largest banks out of 15 concentrate more than 60% of the total assets (BoM, 2022). Furthermore, regarding geographical distribution, more than half of the financial institutions are concentrated in urban areas (CIP, 2020). 45% of bank branches and ATMs, and 56% of POS are in Maputo (Maputo city and Maputo province) (BoM, 2021). Mozambique has committed to implementing the Regulatory Sandbox for fintech as part of the Sochi agreement (BoM, 2021). The current financial system in Mozambique consists of 36 credit institutions, which include 15 banks, 12 micro banks, 4 credit cooperatives, 3 electronic money institutions, one investment company, and one payment service provider. In addition to these institutions, there are 2,081 microfinance operators, comprising 13 savings and loan institutions and 2,068 microcredit operators. Overall, there are 193,209 financial service access points across the country, with 147,519 of these being mobile money agent outlets (BoM, 2023). Regarding mobile money usage, withdrawals, and deposits are the most common transactions, accounting for 91% and 81% respectively. Other types of transactions include money transfers (72%), credit top-ups (62%), and payments for goods and services (27%) (FinScope, 2019). Notably, it was only in 2020 that M-Pesa began offering loans through mobile money accounts.

3. Literature Review and Hypotheses Development

Theoretical literature

Technology-driven financial innovation influences financial inclusion by reducing financial transaction costs and allowing better risk management (Beck, 2020). Although recent literature suggests that fintech is less likely to replace the traditional banking system (Mbiti & Weil, 2016; Murinde et al., 2022), technology-driven financial innovation is more likely to influence financial inclusion indicators in developing countries where financial infrastructure is weak and transaction costs are high (Iddrisu et al., 2022).

Given that mobile money is a technology-based financial innovation, various theories can be used to explain its adoption, including financial technologies (Senyo & Osabutey, 2020). Technology and innovation diffusion theories may be used to explain how technology is spread and what factors affect its adoption. Some studies analysing the adoption and use of mobile money at the individual level are based on ICT adoption theories and models. These include the Technology Acceptance Model (TAM) and its extensions (TAM2 & TAM3), the Theory of Reasoned Action, the Theory of Planned Behaviour, the Unified Theory of Acceptance and Use of Technology (UTUAT) and its extensions (UTUAT2 and UTUAT3) (Douanla Meli et al., 2022; Kim & Crowston, 2011; Senyo & Osabutey, 2020).

Although it is criticized for its generality nature and for not taking into account organizational settings (Kim & Crowston, 2011), the Technology Acceptance Model is still valid and widely used in explaining the decisions of individuals to adopt and use technology, including fintech (e.g. Amoah et al., 2020; Douanla Meli et al., 2022). Therefore, the nature of this study fits the Technology Acceptance Model as the Conceptual Framework. The Technology Acceptance Model was developed by Davis in 1989. According to this author, the assumption behind this model is that the adoption of IT is determined by two main variables, perceived usefulness and perceived ease of use. Individuals decide whether to use a system based on the extent they believe it will help them perform their job better, that is the perceived usefulness. However, the same individuals may find the technology useful and yet not use it when they find it difficult to use, that is when the effort outweighs the benefits of using it. Therefore, technology is accepted if its adoption is perceived to be effortless - perceived ease of use.

Davis (1989) defines perceived usefulness as the degree to which a potential user believes that the use of a particular system would improve his/her

performance. Conversely, the perceived ease of use is the degree to which a potential user believes that using the said system would require less effort.

This study is grounded on TAM because individuals who adopt mobile money believe that mobile money accounts are useful for saving and borrowing money and do not face difficulties using them. For instance, 82% of those who adopted mobile money declared having used its account without help. Adopting mobile money is a choice and individuals will decide whether to adopt mobile money based on perceived usefulness and perceived ease of use. According to GSM (2017), mobile money provides a convenient payment option, saving time and cost and it reduces the risk of theft. Generally, people adopt mobile money to make safe and secure financial transactions and borrow and save money in an easier way (without help) which can be thought of as perceived usefulness and perceived ease of use. The perceptions, however, will depend on different factors, including the individual's socio-economic characteristics.

According to Moosa (2010); Tambotoh et al. (2015) and Venkatesh et al. (2003) socio-demographic factors such as age, education, gender, income, and employment may affect the perceptions and intentions of adopting a technology. For instance, individuals in the workforce and those with higher incomes may perceive mobile money as useful because it allows them to make financial transactions (payments, sending and receiving remittances, saving, and borrowing) safely at relatively low costs. In addition, skills often acquired through formal education may enable people to use technology with less effort. Therefore, youth and individuals with higher levels of education are likely to perceive the use of mobile money as effortless. We include these variables in the model to assess whether they affect mobile money adoption.

Empirical evidence

The empirical literature suggests that factors such as education, age, place of residence, gender, and trust, are likely to influence mobile money adoption (Akinyemi & Mushunje, 2020; Amoah et al., 2020) while the spread of mobile telephony, a pre-requisite for mobile money adoption is subject to the availability of infrastructure (Mothobi & Grzybowski, 2017). Moreover, there is strong evidence from the literature supporting that fintech, including its basic form-mobile money, has the potential to promote financial inclusion through savings, borrowing, and payments (Ahmad et al., 2020). Mozambique is according to the Human Development Report (2022) one of the poorest countries in the World, with low levels of education and poor infrastructure which in turn may negatively influence the adoption of mobile money.

Determinants of mobile money adoption

The adoption of mobile money as well as its determinants differ across countries. Some studies, for example, Soumaré et al. (2016) using cluster-specific fixed effect model analysed the determinants of financial inclusion in Central and West Africa and found that access to formal financial services in both regions was influenced by factors such as education, age, place of residence, and the degree of trust of financial institutions. Gender and marital status were determinants in central Africa, while income and household size were only influential in West Africa. Wang and Heng (2022) investigated factors that are correlated with the Fletcher School's three digital divides and found that the use of fintech is associated with class and rural divide, but no evidence was found for gender divide.

Zins and Weill (2016) using probit estimations and Coulibaly (2021) using probit and multinomial logit concluded that being a man, rich, more educated, and older are determinants of mobile money adoption, with education and income being the most influential. On the other hand, Akinyemi and Mushunje (2020) using a two-part model consisting of logit and multiple regression found that age, bank account ownership, employment, years of education, and income are determinants of mobile money adoption in rural Africa. Peruta (2018) highlights the role of information diffusion by earlier adopters and financial literacy as key determinants of mobile money adoption. Furthermore, mobile money services require a relatively inclusive banking system. Akinyemi and Mushunje (2020) argue that bank account ownership is a determinant of mobile money account ownership.

Using a Heckman sample selection model Fall et al. (2020) concluded that education, possession of a bank account, and family networks are determinants of mobile money adoption. In addition, they found that women adopt less compared to men due to their low level of education.

Demirguc-Kunt et al (2018) and Akinyemi and Mushunje (2020) show that educated people are more likely to adopt mobile money than their counterparts, and men tend to adopt more than women. Conversely, Ky et al (2018) suggest that women, especially in rural areas with uncertain income use mobile money to save, especially for health emergencies. Using probit estimates Douanla Meli et al. (2022) found that age, education, standards of living, and mobile phone ownership are determinants of mobile money adoption and use.

The findings presented above are related to the Technology Acceptance Model. The rationale is that rich people are likely to perform more financial transactions and those living in urban are more likely to take advantage of the

quality of mobile phone services available in urban areas. Additionally, individuals with skills through education and training may easily handle mobile phones for financial transactions. As a result, people with higher income, living in urban areas may perceive mobile money as useful and easy to use especially when the level of education is high. Therefore, the following is hypothesized.

H1: Gender, age, education, income, and mobile phone ownership are likely to influence mobile money account adoption

Effect of mobile money on financial inclusion

The literature on Fintech and financial inclusion, in general, is relatively available, however, the specific literature on mobile money and its effect on financial inclusion is limited, especially in Mozambique. Some studies have been conducted for country-specific cases in East Africa and Asian countries, although the survey methods differ considerably, they almost reach the same conclusion, with few exceptions (e.g. Batista & Vicente, 2020b; Van Hove & Dubus, 2019)

According to Beck (2020), mobile money can influence financial inclusion by reducing transaction costs and allowing more effective risk management. In addition, mobile money transaction occurs at larger distances, do not require large amounts, rely on less costly agent networks, and can be accessible to large parts of informal agents.

Ouma et al. (2017) found that those who own and use mobile financial services are more likely to save than those who do not, this is because mobile financial services make it simpler to save by reducing distance and transaction costs. On the other hand, Ky et al. (2018) found that mobile money has an influence on saving for unpredicted shocks but they found no significance in saving for future (known) events.

Naito et al. (2021) analysed the effect of mobile money on savings, borrowing, and remittance payments using two stages least squares estimation and discovered that the use of mobile money increases savings and receipt of remittance, therefore, users of mobile money do not increase borrowing when they experience negative shocks. Fernandes et al. (2020) found that digital financial services, including mobile money, contribute to financial inclusion in Mozambique, however, they note that efforts aiming to increase financial inclusion should first focus on widespread traditional methods and promoting usage altogether. Demirgüç-Kunt et al. (2022) state that mobile money became an important channel for financial inclusion, especially for women, through mobile payments, savings, and borrowing. However, the incidence of

poverty and poor physical infrastructure may lead individuals to underestimate the usefulness of mobile money.

H2: Mobile money has a positive effect on financial inclusion

Barriers to financial inclusion

Financial inclusion in general is constrained by several factors, including, limited physical access points, the costs for opening and maintaining an account, lack of documentation, especially in the banking sector, but above all by the lack of money (Demirgüç-Kunt & Klapper, 2013)

A study by FSDMOc cited by Hoernig and Maugeri (2017) shows that the financially excluded in Mozambique live in rural areas with a very low level of schooling, mostly practicing agriculture and earning less than five thousand meticais (about USD 78). In addition, the majority lack documentation to open a bank account and lack enough assets that can be used as collateral. These barriers are more emphasized in the banking sector. Thus, Fanta et al. (2016); Ndungu (2018); and Shaikh et al. (2023) suggest that mobile money could contribute to financial inclusion, especially by bringing into the financial sector the most disadvantaged segments (unemployed, low-income groups, rural population and women). This would be possible because expanding agent outlets is less costly, mobile money requires less documentation and enables transactions of relatively few amounts of money (Ky et al., 2018). However, recent literature shows that in developing countries, Fintech in general and mobile money in particular are also constrained by the same factors. Lack of money, lack of mobile phone, and the cost of mobile money accounts were among the most cited barriers to mobile money adoption in sub-Saharan Africa in 2021 (Demirgüç-Kunt et al., 2022). Other factors, such as the quality of the service, including the network and electricity are also barriers from the supply side. For instance, Mothobi and Grzybowski (2017) argue that the adoption of mobile phones is higher in regions with good physical infrastructures. Thus, limited adoption of mobile phones in areas with poor infrastructure and high poverty levels is likely to constrain the adoption of mobile money.

4. Data and Methodology

Description of data

The data used in this study were collected by Gallup, Inc. in 2021. Since 2005 as part of its Gallup World Poll, Gallup, Inc. has conducted surveys of around 1000 individuals aged 15 or over in each of the 160 economies (Demirgüç-Kunt et al., 2022). The 2021 Global Findex data is the fourth edition, following the previous three of 2011, 2014, and 2017, and comprised 128,000 adults in 123

economies. The data contain indicators of access and use of formal and informal financial services, including mobile money. The Gallup Poll strategy used for sampling relied on multistage sampling. In the first stage, the primary sampling units were identified, followed by stratification based on population size and geographic area. The selection of the sample was based on probabilities proportional to the population size or through simple random sampling depending on the availability or not of the population information. Respondents were randomly selected from the household and the survey was carried out face to face. To ensure national representativeness data weighting was used. Base sampling weight and post-stratification weight were used to correct the unequal probability of selection and sampling error, respectively. The sample size comprised 1000 individuals aged 15 years and over. The survey excluded Cabo Delgado Province and a small number of northern districts due to security reasons. Data gathered included socio-economic characteristics of the respondents, such as gender, age, level of education, employment, and income, as well as data on access to and use of financial services. Concerning access and use, data include having an account at a financial institution, a debit or credit card, as well as access to different fintechs, including mobile money. On the use side, the data include the use of the instruments for making payments, saving, or borrowing, but also the motives for borrowing and saving. The Global Findex database has been the most comprehensive in terms of micro variables for analysing demand-side financial inclusion (Demirgüç-Kunt et al., 2022).

Table 1. Descriptive statistics of adopters and non-adopters based on socio-economic variables

	(1)		(2)		(3)	
Variable	**Non-adopters**		**Adopters**		**Full Sample (1000)**	
	577		**423**			
	Obs	%	Obs	%	Obs	%
Gender						
Female	346	65%	188	35%	534	53%
Male	231	55%	235	45%	466	47%
Residence						
Rural	397	61%	253	39%	650	65%
Urban	180	51%	170	49%	350	35%
Financial account ownership						
Yes	201	40%	304	60%	505	51%

No	376	76%	119	24%	495	49%
Income						
Poorest 20%	125	76%	40	24%	165	16%
Second 20%	127	77%	39	23%	166	16%
Middle 20%	121	65%	64	35%	185	19%
Fourth 20%	103	55%	84	45%	187	19%
Richest 20%	101	34%	196	66%	297	30%
Employment						
In the workforce	309	50%	304	50%	613	61%
Out of the workforce	268	69%	119	31%	387	39%
Education						
Completed primary	425	79%	116	21%	541	54%
Completed secondary	152	33%	307	67%	459	46%
Mobile phone ownership						
Yes	281	43%	375	57%	656	66%
No	296	86%	48	14%	344	34%
Saving in the past 12 months						
Yes	204	39%	315	61%	519	52%
No	373	78%	108	22%	481	48%
Borrowing in the past 12 months						
Yes	238	43%	312	57%	550	55%
No	339	75%	111	25%	450	45%

Source: Global Findex 2021

The data in Table 1 show that 423 of the respondents or 42% are adopters of mobile money while 577 or 58% are non-adopters. It can be noted that the rate of mobile money adoption is higher among respondents living in urban areas, more educated, male, and those in the workforce. The shares of adopters and non-adopters based on their socio-demographic variables are presented in the same table. The Table has three columns. Columns 1 and 2 contain information on non-adopters and adopters respectively, while the third column provides the shares relative to the full sample. From column 2, it can be noted that the share of women adopting mobile money is 35% compared to 45% of that of men. Concerning the place of residence, the data show that 49% of urban residents adopt mobile money, compared to 39% in rural areas. Additionally, the richest quintile appears to have a larger share of adopters (66%) against only 24% of the poorest quintile. Likewise, 50% of those in the

workforce declared adopting mobile money which is greater than 31% of those out of the workforce. Among those who own an account in a financial institution, 60% adopt mobile money. Conversely, only 24% of those who do not have an account at a financial institution declared adopting mobile money. The literature suggests that the low adoption of mobile money may be explained by the low penetration of mobile phone technology. From Table 1 we note that 57% of individuals with mobile phones adopt mobile money, whereas only 14% of individuals without mobile phones adopt mobile money. 86% of those without a mobile phone do not adopt mobile money. Previous studies by Salampasis and Mention (2018) and Senyo and Osabutey (2020) have emphasized the role of physical infrastructure, including mobile phone penetration to financial inclusion. Savings and borrowing are also high among adopters of mobile money. For instance, 61% of those who saved and 57% who borrowed money in the previous year declared being adopters of mobile money.

Empirical Strategy

To assess the determinants of mobile money adoption many studies use binary models such as probit and logit (Akinyemi & Mushunje, 2020; Amoah et al., 2020; Coulibaly, 2021; Ouma et al., 2017). On the other hand, the effects of mobile money on financial inclusion indicators such as savings, are analysed using either an IV model (2SLS) (Jack & Suri, 2014; Ky et al., 2018; Munyegera & Matsumoto, 2016; Naito et al., 2021), a Heckman model (Coulibaly, 2019; Fall et al., 2020) or a Treatment Effect model. The use of these models is intended to deal with endogeneity and sample selection problems.

In this study, we use the Propensity Score Matching (PSM) and the Treatment Effect Model to compute the Average Treatment Effect (ATE) and the Average Treatment Effect on the Treated (ATT).

Propensity Score Matching

Since the observed characteristics between adopters and non-adopters of mobile money may influence financial inclusion indicators, the study applies the propensity score matching to derive the net effect of mobile money on savings and borrowing.

According to Caliendo and Kopeinig (2005), the treatment effect of a given individual is given by;

$$\tau_i = Y_i(1) - Y_i(0)$$

The potential outcome is defined as $Y_i(K_i)$; with K_i being the treatment indicator, which is equal to one if an individual received treatment and 0 otherwise. However, given that only one potential outcome can be observed, assessing the effect using this approach becomes problematic. Therefore, in

this study, the average treatment effects of mobile money on savings and borrowings were computed, as follows:

$$\tau ATT = E(\tau|K = 1) = E[Y(1)|K = 1] - E[Y(0)|K = 1]$$

$$\tau ATE = E[Y(1) - Y(0)]$$

The matching algorithm used was the Nearest Neighbour method.

Treatment Effect Model

The Treatment Effect Model (*eteffects)* fits a binary outcome and binary treatment to assess the effect of mobile money adoption on saving and borrowing. This model differs from *Heckit* models for two main reasons: First, while the sample selection is used when the outcome is observed only for the treated, the treatment effect model is used when the outcome for both the treated and non-treated is observed. Second, the dummy variable on whether an individual has received treatment or not enters the regression equation, and both are estimated in one go. In addition, the treatment effect model is indicated when using data with complex sampling frameworks such as the one used to obtain data used in the current study. The *eteffects* include the treatment assignment residuals in the potential outcome model to control for endogeneity through the control-function approach. Since we do not observe all the variables that may affect both the potential outcome (saving or borrowing) and the treatment (mobile money) we use *eteffects* to consistently estimate the ATE. The treatment effect model deals with the problem of missing data as well.

Modelling strategy

The counterfactuals for the treated and untreated are respectively given by the following equations and each one is determined by its expected value conditional on a vector of explanatory variables x_i and an unobserved random term ε_{ij} (StataCorp, 2019).

$$y_{i1} = E(y_{i1} \mid x_i) + \varepsilon_{i1} \qquad (1)$$

$$y_{i0} = E(y_{i0} \mid x_i) + \varepsilon_{i0} \qquad (2)$$

Where y_{i1} and y_{i0} are respectively the potential outcomes (saving or borrowing) of receiving and not receiving the treatment (adopting and not adopting mobile money); i indicates individual-level observation.

Again, the observed binary treatment t_i is given by its expectation conditional on a vector of explanatory variables z_i which may be similar to x_i, and a random term v_i. The corresponding equation is:

$$t_i = E(t_i \mid z_i) + v_i \quad (3)$$

The observed outcome will then be given by;

$$y_i = t_i y_{i1} + (1 - t_i) y_{i0} \quad (4)$$

The unobserved terms in the counterfactuals are independent of z_i.

$$E(\varepsilon_{ij} \mid x_i, z_i) = E(\varepsilon_{ij} \mid z_i) = E(\varepsilon_{ij} \mid x_i) = 0 \quad (5)$$

As a result, the correlation between the treatment and unobserved terms must be equivalent to the correlation between the unobserved random term ε_{ij} and the unobserved term v_i.

Adding endogeneity in the framework gives what follows below. It means that the unobservable in the counterfactuals are correlated to treatment.

$$E(\varepsilon_{ij} \mid t) \neq 0 \quad (6)$$

After computing $\hat{v}_i$ we can obtain the following for probit;

$$E(y_{ij} \mid x_i, v_i, t_i = j) = \Phi(x_i' \beta_{1j} + v_i \beta_{2j}) \quad (7)$$

Description of the variables used in the model

Dependent variables

For the treatment equation, the dependent variable is a mobile money account, a dummy variable indicating whether an individual has a mobile money account or not while for the outcome there are two variables, saving and borrowing, two dummy variables indicating whether an individual had saved or borrowed in the previous twelve months.

Independent variables

Drawing from the IT and financial theories, the perceptions of an individual (regarding the usefulness and ease of use) that determine the decision to adopt or not a technology may be influenced by socio-demographic factors. Thus, age, gender, education level, income level, and employment status were used as independent variables for both the treatment and outcome equations. Additionally, Mothobi and Grzybowski (2017) have shown a strong relationship between physical infrastructure and the adoption or use of financial services.

Therefore, given the differences in physical infrastructure endowment between rural and urban areas in Mozambique and the differences in mobile money adoption, we add in the treatment model two dummy variables, the place of residence indicating whether the respondent lives in an urban or rural area and mobile phone ownership indicating whether an individual has a mobile phone or not. The two variables are likely to influence mobile money adoption but not saving or borrowing.

Previous studies (e.g. Abdullah et al., 2015; FitzRoy & Nolan, 2020) suggest that variables such as education, employment, and asset ownership are closely related to income. In this study, a correlation test was done, and no strong relationship was found among the variables included in the model. Barriers to mobile money adoption were not included in the model because they contain information only for those not adopting mobile money.

5. Results and Discussion

Determinants of mobile money adoption

Table 2 reports the results regarding the determinants of mobile money and bank account adoption. We begin by analysing the factors affecting mobile money adoption then we compare the two. The results were obtained through the bivariate probit model and are similar to those found in Akinyemi and Mushunje (2020); Amoah et al. (2020); Coulibaly (2021); Mbiti and Weil (2016), and Naito et al. (2021). Age, gender, income, education, place of residence, and access to technology were found to influence (positively or negatively) the adoption of mobile money. Specifically, unemployment (out of the workforce) and age decrease the likelihood of adopting mobile money. The same relationship is found in Akinyemi and Mushunje (2020) and Amoah et al. (2020). The negative correlation between age and mobile money adoption could be explained by the fact that old people tend to be less flexible to changes, including in adopting new technologies.

Conversely, youth are much more dynamic in the uptake of innovation. Higher incomes are associated with the adoption of mobile money. From Table 2, it can be noted that the richest quintile was found to be positively correlated with mobile money adoption. These results concur with those found by Zins and Weill (2016) and Coulibaly (2021), meaning that the adoption of mobile money is related to higher incomes. People with regular income tend to transact more frequently to make or receive payments, and save or repay loans, therefore are more likely to adopt mobile money to simplify their transactions. Ahmad et al. (2023) have shown that the change in income is among the main determinants of financial inclusion in sub-Saharan Africa.

As far as education is concerned, the results of the study are in line with most of the literature on financial inclusion (e.g. Coulibaly, 2021; Fall et al., 2020; Munyegera & Matsumoto, 2018). Education is positively correlated with mobile money adoption, probably because educated people may easily perceive mobile money's usefulness and ease of use. Batista and Vicente (2020) found similar results, and they argue that education is linked to higher benefits of adopting mobile money. Living in urban areas increases the probability of adopting mobile money.

Access points such as mobile money agents tend to be concentrated in urban areas, therefore, adopting mobile money is more likely to occur in these areas than in rural settings. This could be explained by a considerable discrepancy in technology infrastructure between rural and urban areas. Demirgüç-Kunt et al. (2022) reached the same conclusion and demonstrated that more than one-third of those who do not own a mobile money account have cited the distance to the agent as the barrier. In addition, those who do not own a mobile phone are less likely to adopt mobile money. Similar results were found by Douanla Meli et al. (2022) and Demirgüç-Kunt et al. (2022). Theoretical literature suggests that access to technology is key to adopting Fintechs, including mobile money. Indeed, mobile phone ownership is a prerequisite for mobile money adoption but is sometimes constrained by income and technology infrastructure.

Aker and Mbiti (2010) noted that individuals using M-Pesa in Kenya were already Banked. This finding is of particular importance, especially when considering mobile money as a way to bring individuals excluded by traditional financial institutions such as banks into the financial sector. Batista and Vicente (2020) found that mobile money adoption in Mozambique tended to be positively self-selected. Overall, it turns out that variables that affect financial inclusion through traditional financial institutions affect mobile money as well. To verify this, we compare the determinants of mobile money adoption and other financial institutions.

Determinants of mobile money and Bank account ownership

To complement the analysis, we compare the determinants of mobile money and bank account ownership, and the details are presented below. The Wald test shows that the two equations should be estimated simultaneously because rho (ρ) is statistically different from zero. When assessing the factors influencing the adoption either of a bank account or a mobile money account, the results indicate that there are no substantial differences between the two. Apart from age, the determinants of mobile money adoption are similar to those of traditional methods (banking). Batista and Vicente (2020a) have shown that individuals who own a bank account are more likely to own a

mobile money account as well. Looking at each variable in the model, we find that higher incomes are associated with a higher probability of adopting mobile and bank accounts. Zins and Weill (2016) and Demirgüç-Kunt et al. (2022) show that the lack of money is one of the key barriers to financial inclusion in Africa.

Even though mobile money is said to be less costly compared to banks, high levels of poverty prevent people from accessing its services. In the 2021 Global Findex survey, 72% of those who did not own a mobile money account cited lack of money as the main cause in Mozambique. Living in rural areas and being out of the workforce are both associated with less adoption of mobile and banking accounts. The probability of having an account at a financial institution or on a mobile phone is higher among men and the most educated. The age is only significant for mobile money adoption and has a negative sign, meaning that an increase in age is associated with a decrease in the probability of adopting mobile money as previously explained.

Similar results demonstrating that mobile money is driven by the same factors as traditional banking in Africa were found by Zins and Weill (2016). This may partly be explained by the high level of poverty, low levels of schooling, and lack of basic identification documents. Many people still lack basic documentation to open an account, either in a bank or through a mobile phone. In Mozambique, for instance, only 31% of the population has an ID (DNIC, 2023).

This finding deserves particular attention, especially when considering mobile money as an alternative to include individuals excluded by conventional banking. If the individuals who have access to financial services through banks and other financial institutions are the same as those with access to and using mobile money, the impact of mobile money on bringing new segments into the financial sector may be minimal.

Table 2. Determinants of mobile and traditional banking in Mozambique

	Account at a Fin. Institution		**Mobile Money Account**	
	Coefficient	**SE**	**Coefficient**	**SE**
Gender	0.208**	(0.086)	0.336***	(0.089)
Age	0.003	(0.003)	-0.014***	(0.003)
Education	0.333***	(0.059)	0.366***	(0.059)
Income				
Second 20%	0.183	(0.148)	-0.156	(0.160)

Middle 20%	0.244*	(0.145)	0.201	(0.152)
Fourth 20%	0.667***	(0.143)	0.448***	(0.148)
Richest 20%	0.780***	(0.134)	0.900***	(0.139)
Employment	-0.503***	(0.087)	-0.469***	(0.091)
Residence	0.178**	(0.089)	0.266***	(0.091)
Constant	-0.901***	(0.293)	-0.954***	(0.305)
Wald test of rho=0:			$x^2(1) = 55.397$***	
Number of obs = 995				
Wald chi2(18) = 304.17				
Log likelihood = -1135.1675		Prob > chi2 = 0.0000		

Source: Author's computation using the Global Findex data

***, ** mean significant at 1% and 5% respectively

Barriers to mobile money adoption

From the literature, we noted that the barriers to conventional banking were similar to mobile money, especially in poor countries. The study examines the barriers to mobile money adoption in Mozambique and the results are presented in Figure 1. It can be noted that more than 70% of those not adopting mobile money cited the lack of money as the main barrier, while more than 50% pointed to the lack of a mobile phone and around 50% lacked basic identification documents. The aforementioned barriers are similar to those of traditional banking (e.g. Demirguc-Kunt et al., 2018; Zins & Weill, 2016). In a country such as Mozambique with higher levels of poverty and substantial differences in physical/technology infrastructure endowment between rural and urban areas, the lack of money and the distance to an agent constrain mobile money adoption. Generally, mobile money agents are sparser in rural areas where the incidence of poverty is also high. Fanta et al. (2016) showed that the low adoption of mobile money in Mozambique could be explained by weak mobile money infrastructure. Besides limited infrastructure, the lack of regular income, especially in rural areas where the majority rely on less productive agriculture constitutes an important barrier. Suri (2017) has shown that initial users of M-Pesa in Kenya were richer and more educated. Yet, lack of money (or regular income) is more likely to be correlated with lack of mobile phones and the cost of financial services and products. This means that unless new products and services are tailored to the most disadvantaged, mobile money is less likely to be a viable solution at least for the poor because people

choose not to adopt it due to lack of money, lack of mobile phone, and the distance to the nearest agent.

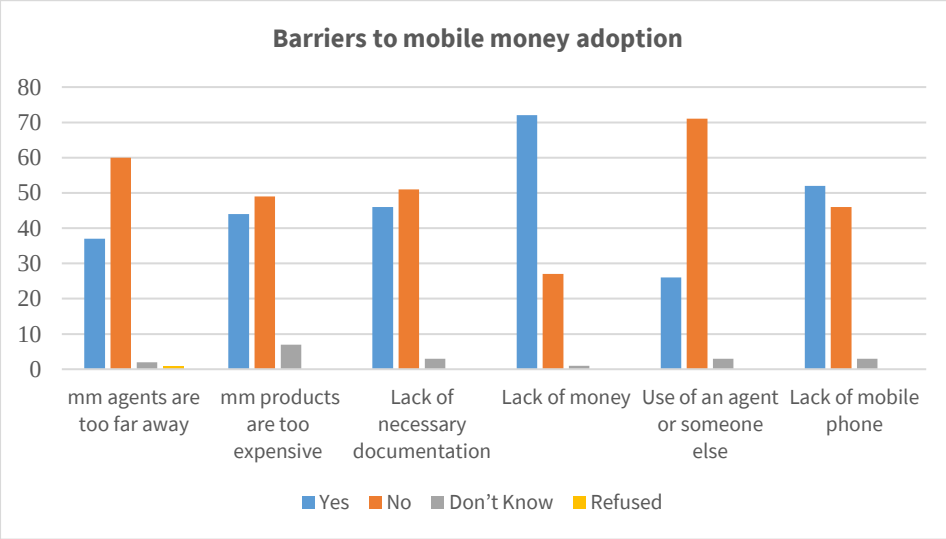

Figure 1. Barriers to mobile money adoption

Source: Author based on Global Findex 2021 data for Mozambique

Effect of mobile money on Savings and Borrowings

To assess the effect of mobile money on saving and borrowing, the average treatment effect (ATE) and the average treatment effect on the treated (ATT) were computed using the Propensity Score Matching (PSM) and Treatment Effect model. The results of both Propensity Score Matching and Treatment Effect models are presented in Table 3 and Table 4. The ATE and ATT using the two approaches differ slightly. The PSM only allows for the selection on observables, as a result, it underestimates the effect of mobile money on saving and borrowing. To address this, the Treatment Effect Model was used, and the results are presented below.

Savings

The results of the study suggest that the effect of mobile money on saving and borrowing is positive. Results in Table 3a show that when no one adopts mobile money, the probability of saving is 30%. However, the probability of saving increases by 32% when everyone adopts mobile money. This effect is almost close to the 31% obtained through propensity score matching.

Table 3a. Average Treatment Effect (ATE)

	Treatment effect Model (Probit)		PSM	
Saving	Coefficient	Robust std. err.	Coefficient	AI robust std. err.
ATE				
Mobile money				
(yes vs no)	0.320***	(0.103)	0.312***	(0.041)
POmean				
Mobile money				
no	0.307***	(0.036)		

Source: Author's computation based on Global Findex data

Note: treated are adopters of mobile money

The results of the average treatment effect on the treated (ATT) are presented in Table 3b. In the population of those who adopt mobile money, on average the probability of saving would be around 25% if none of these adopted mobile money. For those who adopt mobile money the probability of saving increases by 50%. On the other hand, using propensity score matching, the ATT is 33% - significant differences exist between the two methods. The limitations of the propensity score may explain these differences; PSM does not account for unobservable variables affecting the outcome, thus, failing to control for unobservable variables underestimates the effect. The positive effect of mobile money on savings was found in previous studies such as Ky et al. (2018); Naito et al. (2021), and Ouma et al. (2017). Moreover, the results of the study suggest that saving is also explained by the same socio-demographic factors (age, education, employment, and income) affecting mobile money adoption. It is worth noting that, the relationship between socio-demographic factors and savings is supported by other disciplines. The economic theory of life cycle hypothesis (LHC) of consumption and saving from Modigliani and Brumberg in 1954 is one of them (Kurz, 1987).

Table 3b. Average treatment effect on the treated (ATT) on Savings

	Treatment effect Model (Probit)		PSM	
Saving	Coefficient	Robust std. err.	Coefficient	AI robust std. err.
ATT				
Mobile money				
(yes vs no)	0.500***	(0.080)	0.330***	(0.058)
POmean				

Mobile money		
no	0.246***	(0.076)

Source: Author's computation based on Global Findex data

Note: treated are adopters of mobile money

Borrowing

The results of the treatment effect model and propensity score are presented in Tables 4a and 4b. The study shows that when no one adopts mobile money, the probability of borrowing is 35%, however, the probability of borrowing is around 18% more when everyone adopts mobile money. The estimates between the two models are similar for the ATE. As it can be noted, the ATE using PSM is around 18% as well.

Table 4a. Average treatment effect (ATE) on Borrowing

	Treatment Effect Model (Probit)		PSM	
Borrowing	Coefficient	Robust std. err.	Coefficient	AI robust std. err.
ATE				
Mobile money				
(yes vs no)	0.167**	(0.099)	0.179***	(0.046)
POmean				
Mobile money				
no	0.35***	(0.036)		

Source: Author's computation based on Global Findex data

In the group of adopters, the probability of borrowing would be 37% if none of these adopted mobile money. The probability of borrowing for this group increases by 36% than if none of these was an adopter. Again, the estimated effect on the treated using PSM is less than that obtained through the treatment effect model. The underlying assumptions are similar to those explained in savings. Our results corroborate the study of Munyegera & Matsumoto (2018) which found a positive impact of mobile money on borrowing. However, given that the adoption of mobile money is constrained by socio-demographic factors such as unemployment and low levels of education, borrowing from financial channels will be limited to those already in a better position to be financially included. Therefore, the efforts in bringing into the financial sector the most vulnerable, including the poor may be limited if other factors aiming to improve incomes are not considered.

Table 4b. Average treatment effect on the treated (ATT) on Borrowing

	Treatment Effect Model (Probit)		PSM	
Borrowing	Coefficient	Robust std. err.	Coefficient	AI robust std. err.
ATT				
Mobile money (yes vs no)	0.362***	(0.092)	0.210***	(0.054)
POmean				
Mobile money no	0.377***	(0.089)		

Source: Author's computation based on Global Findex data

Note: treated are adopters of mobile money

6. Conclusion and Policy Recommendations

The study aimed to assess the effect of mobile money on financial inclusion indicators, namely savings, and borrowings. Findings reveal a positive effect of mobile money on savings and borrowings; however, it was found that the determinants of mobile money adoption are similar to those influencing the adoption of the traditional methods. The results show that those who own a bank account share the same socio-demographic characteristics as those who own a mobile money account. This may explain why, despite efforts to expand access points, including mobile money, the less privileged remain financially excluded. Mobile money has not been able to bring into financial sector segments that are generally excluded by conventional banking. Barriers preventing disadvantaged segments from accessing and using traditional financial services seem to prevail for mobile money. Poverty *proxied* by lack of money, low level of education, and lack of documentation is at the heart of financial exclusion in Mozambique. Other socio-demographic variables such as being a woman and unemployed are associated with less adoption of both mobile and banking accounts. We argue that if mobile money is adopted by those groups with access to conventional financial means, its contribution to bringing disadvantaged groups into the financial sector will be minimal. Therefore, besides promoting access through the expansion of access points, including mobile money, the government should promote other initiatives that contribute to increasing household income as well.

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Mission

To strengthen local capacity for conducting independent,
rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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