

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/365668994>

Mobile banking and financial inclusion in sub-Saharan Africa: Cost versus geographical constraints

Chapter · January 2023

CITATIONS

0

READS

722

3 authors:



Boniface Ngah Epo

University of Yaoundé II

52 PUBLICATIONS 292 CITATIONS

SEE PROFILE



Mougno à Ekoula Hervé William

University of Yaoundé II

7 PUBLICATIONS 9 CITATIONS

SEE PROFILE



Yvan Audrey Kamdem

University of Yaoundé II

1 PUBLICATION 0 CITATIONS

SEE PROFILE

Mobile banking and financial inclusion in sub-Saharan Africa: cost versus geographical constraints

*Mobile banking et inclusion financière en Afrique
subsaharienne : contraintes de coût versus
contraintes géographiques*

This paper is accepted since March 2022 for a forthcoming publication
in a collective work at University of Yaoundé 2 - Cameroon,
after a triple blind peer-review process.

Epo Boniface Ngah*

epongahb@yahoo.fr

Mougnol à Ekoula Hervé William*

wmougnol@yahoo.com

Kamdem Yvan Audrey*

yvanaudrey_kamdem@yahoo.fr

*Faculty of Economics and Management, University of Yaoundé 2 - Cameroon.

Mobile banking and financial inclusion in sub-Saharan Africa: cost versus geographical constraints

Mobile banking et inclusion financière en Afrique subsaharienne : contraintes de coût versus contraintes géographiques

Abstract: This paper analyses the relationship between the diffusion of mobile banking in sub-Saharan Africa (SSA) and the barriers to financial inclusion. We use a 2017 cross-sectional data for thirty-five countries in sub-Saharan Africa gotten from the World Bank and the International Monetary Fund to appraise the effect of financial inclusion barriers/constraints associated with cost and those linked to geography using a multiple linear regression model. Running ordinary and generalized least square estimates, as well as both a Jackknife and bootstrap resampling techniques to check the robustness, we find a positive and statistically significant relationship between the diffusion of mobile banking in terms of access and usage with the different indicators of cost and geographical constraints to financial inclusion. These results posit that in SSA, cost and geographical financial inclusion constraints have encouraged the adoption as well as diffusion of mobile banking as an alternative channel for access and use of financial services for the most vulnerable, especially the poorest 40th percentile and those living in remote areas.

Keywords: Mobile Banking, Financial Inclusion, Cost Constraints, Geographical Constraints, Sub-Saharan Africa (SSA).

Résumé : Cet article analyse la relation entre la diffusion des services bancaires mobiles en Afrique subsaharienne (ASS) et les obstacles à l'inclusion financière. Nous utilisons des données transversales de 2017 pour trente-cinq pays d'Afrique subsaharienne obtenues de la Banque Mondiale et du Fonds monétaire international pour évaluer l'effet des contraintes à l'inclusion financière associées au coût et celles liées à la géographie à l'aide d'une analyse de régression linéaire multiple. En utilisant les moindres carrés ordinaires et généralisés, ainsi que des techniques de rééchantillonnage Jackknife et bootstrap pour vérifier la robustesse, nous trouvons une relation positive et statistiquement significative entre la diffusion des services bancaires mobiles en termes d'accès et d'utilisation avec les différents indicateurs de contraintes (coût et géographie) à l'inclusion financière. Ces résultats postulent qu'en ASS, ces obstacles ont encouragé l'adoption ainsi que la diffusion des services bancaires mobiles comme canal alternatif d'accès et d'utilisation des services financiers pour les plus vulnérables, en particulier les 40% plus pauvres et ceux qui vivent dans des régions éloignées.

Mots clés : Mobile Banking, Inclusion Financière, Contraintes de Coûts, Contraintes Géographiques, Afrique Subsaharienne (ASS).

1 Introduction

Mobile banking¹ is revolutionising financial inclusion throughout the developing world and particularly in sub-Saharan Africa (SSA). The scale of the phenomenon is such that, this innovation is now unavoidable and is changing the financial habits of populations (Ky et al., 2018). Due to mobile banking, it is neither necessary to go to banks' branches or have an account in a financial institution. This is because it is now possible to carry out transactions such as sending, receiving money or making payments using a mobile phone. In SSA, the popularity of mobile banking has been unbounded since the success of *M-pesa*². According to the Global Findex survey (2017), its penetration rate on the African subcontinent stands at 21%. For comparison, the global average is 4% and no other developing region exceeds 6% (Demirgüç-Kunt et al., 2018). This trend in SSA requires we appraise these dynamics to help robustly identify possible policy avenues as attempted in this paper.

In the literature, three main factors are identified as determining the spread of mobile banking in developing countries. First, the level of financial development heartens or hinder the emergence of financial innovations such as mobile banking (Della Peruta, 2015; Asongu, 2018; Senou et al., 2019). Second, structural and macroeconomic indicators such as mobile phone and internet usage encourage the deployment of mobile banking, inflation which has a negative effect on its use, or GDP per capita which have a positive or negative effect (Allen et al., 2014; Della Peruta, 2015; Ky, 2016; Asongu, 2018; Akinyemi and Mushunje, 2020). Third, demographic variables such as population, level of urbanisation, population density and level of education play an important role in the spread of mobile banking (Teo et al., 2012; Allen et al., 2014; Della Peruta, 2015; Ky, 2016).

Nonetheless, despite this extensive literature, few studies, with very little focusing on Africa, explore the relationship between mobile banking diffusion and the different constraints that hinder financial inclusion. This necessitates we densify these studies for SSA which recorded the highest penetration rate associated with mobile banking whilst also signalling significant financial inclusion deficit³. This paper therefore aims at filling this gap empirically by investigating the relationship between the diffusion of mobile banking in SSA and its association with cost and geographical barriers of financial

¹ A distinction is often made between mobile banking and mobile money in that the former represents the provision of services by banks to their customers through mobile devices, while the latter refers to the provision of basic financial services to unbanked customers (Ky, 2016). However, the concept of mobile banking has a broader meaning in the literature that also includes mobile money (Mishra and Bisht, 2013). It is this latter understanding of the concept that we adopt in this study.

² M-pesa is probably the most famous mobile money platform in the world. Launched in Kenya by the telecom company Safaricom in 2007, it registered 1.1 million users just eight months after its launch (Mbiti and Weil, 2011).

³ From 23% in 2011, the number of adults with an account in SSA has increased to 33% in 2017. However, this is the level that regions such as the Middle East, Latin America, and South Asia had already reached in 2011 (World Bank, 2018).

inclusion.

Several factors are responsible for the lag in financial inclusion in developing countries. In SSA, these include insufficient income, high cost of financial services, geographical remoteness of financial institutions, lack of documentation to open a bank account, lack of need, lack of trust, having a family member with an account, and religious reasons (Klapper et al., 2019). In this paper, we focus only on cost and geographical constraints because they are, after income insufficiency, the most prevalent in SSA⁴ (Demirgüç-Kunt and Klapper, 2012; Granata et al., 2014; Guérineau and Jacolin, 2014). Hinging from the demand side perspective, this paper explores whether these two constraints overly affect the spread of mobile banking in SSA using a 2017 snapshot sample of thirty-five SSA countries.

Differing from other studies, scope-wise because we focus on SSA, a second contribution is that, unlike most studies that emphasis on the supply side we rather investigate this relationship from the demand side. Indeed, whereas the former tries to show how the provision of mobile banking services affects financial inclusion, this paper instead investigates whether the diffusion of mobile banking in SSA is linked to the existence of constraints associated to financial inclusion. Measuring these constraints constitutes another specificity of this paper. Unlike most authors who capture access to financial services through infrastructural indicators (number of banks or bank branches for a given population or area), we opt for the proportion of unbanked people who identify cost or geographical distance as the main barrier to holding an account in a formal financial institution (Demirgüç-Kunt et al., 2018; Klapper et al., 2019). This indicator has the advantage of being measured directly on the population concerned by banking exclusion. Further, this measure pays special attention to the most vulnerable groups in the measurement of mobile banking diffusion (poorest 40% and those residing in rural areas).

Consequently, this paper set to examine the relationship between the diffusion of mobile banking in SSA and the barriers to financial inclusion. Specifically, the paper compares the effects of cost and geographical constraints associated with financial inclusion on mobile banking in SSA. The underlying postulate of the paper is that, cost and geographical constraints both increase the diffusion of mobile banking in SSA when considering the different measures of diffusion of mobile banking. The rest of the paper is organized as follows: [section 2](#) review the theoretical and empirical literature; [section 3](#) the methodology and estimation strategy; [section 4](#) discusses the empirical results and [section 5](#) concludes the paper.

⁴ According to the 2017 World Bank Global Findex survey, these two types of constraints are cited by at least a quarter of the unbanked as major obstacles to holding an account in a formal financial institution (Klapper et al., 2019).

2 Literature review

2.1 Theoretical review of the literature

The origins of mobile banking could be traced in the early 1990s in Finland, where customers of a local bank were able to access their accounts and carry out transactions via their mobile phones or any other mobile device (Barnes and Corbitt, 2003). A decade later in the 2000s, the concept of mobile banking evolved from the original banking model to a non-banking model in developing countries. This gave rise to the notion of "mobile money", as the provision of low-cost basic financial services via mobile phone, and most often to the unbanked (Ky, 2016). However, mobile banking has a broad meaning in the literature that also includes mobile money. Indeed, Porteous (2006), for example, considers all these services to be mobile banking, regardless of whether they are aimed at those having either a bank account or not.

Studies attempting to perceive the relationship between mobile banking and financial inclusion are new. Research in this area is still mostly dominated by practitioners in finance and bank marketing who are often interested in the factors associated with the adoption of this innovation, its functioning and the experiences of different platforms. Whereas there has been a growing interest in terms of academic research, the existing studies are still mainly empirical and do not really focus on establishing the theoretical framework relationship between these two concepts.

Nevertheless, a review of the literature shows that mobile banking is often analysed under the prism of the theories of diffusion of innovations (Rogers, 1983) and of the acceptance of technology (Davis, 1989). According to the former, the diffusion of an innovation such as mobile banking is based on five factors. These factors include: relative advantage, compatibility, complexity, testability and observability. The latter theory explains the success of a new technology by its ease of use and the usefulness perceived by the potential consumer. Consequently, the strong diffusion of mobile banking in SSA can be explained by its advantage over traditional financial services and its compatibility with the needs of the region's populations that face numerous constraints in accessing formal financial services. Furthermore, the usefulness of mobile banking coupled with its ease of use may constitute a strong argument for its expansion in SSA.

The two theoretical frameworks indicated above have been used by several authors to analyse the diffusion of mobile banking and its potential for financial inclusion in developing countries. Barnes and Corbitt (2003) argue that mobile banking has a comparative advantage in emerging countries such as China and India because it provides better financial access to those for whom traditional channels are inaccessible. Similarly, Datta et al., (2001) perceive mobile banking as an opportunity for developing countries to make a technological leap that bridges the gap of poor banking infrastructure and provide financial services to the unbanked, regardless of their geographical location.

Porteous (2006) concurs that there are two types of mobile banking in SSA and throughout the developing world. The "additive" model, offered by banks to their customers appears to be another channel for traditional finance. On the contrary, the "transformational" model, more often offered by telecoms and other non-bank providers to the under- or unbanked, has the potential to revolutionize financial inclusion provided that adequate regulation is put in place. Thus, mobile banking cannot be viewed as a disruptive innovation compared to the traditional financial system.

2.2 Empirical review of the literature

Three main areas in the empirical literature have been largely researched upon on mobile banking. The first area is concerned with the criteria for adoption of this innovation (see for example Mishra and Bisht, 2013; Shareef et al., 2018; Lashitew et al., 2019). The second tries to understand how mobile currencies, whose supply is rapidly increasing, influence the conduct of monetary policy (see Mbiti and Weil, 2011, 2013; Mutsune, 2015). Finally, the third area—in which this study is embedded—coincides with the arrival of mobile banking in developing countries, particularly in SSA, with platforms such as *Smart Money* and *G-CASH* in the Philippines and *M-Pesa* in Kenya. Indeed, these different experiences have fuelled a significant debate about the financial inclusion potential of mobile banking in developing countries (see for example Mbiti and Weil, 2011; Jack and Suri, 2011; Assadi and Cudi, 2011; Hamdi, 2011; Chaix and Torre, 2015; Llewellyn-Jones, 2016, to name a few). Unfortunately, there are few studies on the relationship between mobile banking diffusion and barriers to financial inclusion with even sparser publications that focus on SSA as a study region.

In terms of geographical constraints, Allen et al. (2014) investigates whether Africa has a financial inclusion gap compared to other developing regions, and how mobile banking could help to address this. To do so, they use a sample of 148 developing countries, including 45 African countries, on which they estimate a multiple linear regression model using the least squares method. Their findings suggest on one hand that, African countries have a serious gap in financial inclusion compared to other developing countries. On the other hand, they conclude that the penetration of mobile banking, especially the use of phones for money transfers, is higher in Africa than anywhere else. Mobile banking can, they argue, overcome infrastructural problems in Africa and improve financial inclusion. Nonetheless, this study do not investigate the link between the diffusion of mobile banking and the constraints to financial inclusion associated with geographic remoteness.

King (2012) investigates whether mobile banking is able to break what he calls the "tyranny of distance"⁵ from banking infrastructure in Kenya. He uses two samples collected in Kenya in 2006 and 2009 on 4308 and 6527 individuals respectively. The results

⁵ The author defines the "tyranny of distance" as a situation in which the probability of an individual being banked depends on his proximity to a bank branch.

obtained, after estimating several variants of the probit model, show that, despite the increase in the number of bank branches in Kenya between 2006 and 2009, the distance and time needed to go to a branch remain negatively related to the probability of having a bank account. In contrast, the results show that mobile banking can overcome the "tyranny of distance" from banking infrastructure and improve financial inclusion for all economic groups in Kenya.

Regarding cost constraints, Ky (2016) focuses on factors related to mobile banking penetration in developing countries. He estimates a multiple linear regression model on a sample of 72 developing countries including 32 SSA countries. The results show that in developing countries, and particularly in SSA, the diffusion of mobile banking is related to, among other factors, the costs of banks on total assets, the average cost of transfers and agricultural payments. Mbiti and Weil (2011) show that in Kenya mobile banking has led to increased competitiveness in the financial market, particularly in the money transfer market, by setting more affordable fees than traditional providers. Similarly, Kumar et al. (2010) analyse similar studies in India and Brazil where the use of mobile banking by banks and microfinance institutions has led to a reduction in costs for them and their customers. The study however limits the analyse to the supply side and does not include demand side factors.

Finally, Bair and Tritah (2019) study the impact of the introduction of mobile money since 2010 in Madagascar on the frequency and volume of money transfers between households. The approach adopted a selection model combined with an instrumental variable approach. Their results show that, though transaction cost associated with money transfer services represent a barrier to the poor, new technologies such as mobile money could mitigate these barriers and reduce financial exclusion. Indeed, a CGAP⁶ study reported by McKay and Pickens (2010) find that, on average, mobile transactions were 19% cheaper than in-branch transactions and that this rate could be as high as 50% if customers used this channel for medium-term savings and bill payments.

Overall, appraising the literature the key gaps this paper attempts to fill are: (a) it contributes empirically to the very sparse studies investigating the relationship between mobile banking diffusion and the different constraints that hinder financial inclusion; (b) it focuses on Africa which has reported significant increases in mobile phone usage; (c) it peruses this relationship from barriers to financial inclusion associated to cost and geography and (d) the measure of barriers is novel because we elect for the share of unbanked people who identify cost or geographical distance as the main barrier to holding an account in a formal financial institution (Demirgüç-Kunt et al., 2018; Klapper et al., 2019). This indicator has the advantage of being measured directly on the population concerned by banking exclusion.

⁶ Consultative Group to Assist the Poor.

3 Methodology

3.1 Model specification

This paper attempts to demonstrate that cost and geographical constraints to formal financial services stir the adoption of mobile banking in SSA. Following Allen et al., (2014) and Ky (2016), we specify a multiple linear regression model as follows:

$$MB_i = \alpha_0 + \alpha_1 constraints_i + \alpha_2 X_i + \varepsilon_i \quad (1)$$

where $i = 1 \dots N$, with i representing the different SSA countries under consideration and N the number of countries in the sample. The dependent variable MB_i represents the diffusion of mobile banking in country i and is computed separately for account access to and use of mobile banking. To compute access to mobile banking for each of the countries in this study, we calculate indicators associated with having a mobile money account (Senou et al., 2019). They include the share of the poorest 40% of the population that have a mobile money account, the proportion of the richest 60% of the population having a mobile money account, the percentage of rural populations having a mobile money account and the proportion of the entire population having a mobile money account. To compute the use of mobile banking, we calculate two measures. These include the proportion of individuals aged fifteen and above that transfer money using their mobile money accounts and the percentage of these individuals in the population that pay bill via their mobile phones (Asongu, 2018). X_i is a vector of the other covariates that explain the adoption of mobile banking in developing regions. The other parameters, α_i and ε_i , represent respectively the coefficients that will be estimated and the error term that takes into account the imperfections of the model.

$constraints_i$ represents the barriers to financial inclusion in a given country and comprises: (a) cost constraints measured by the proportion of the unbanked who consider the high cost of formal financial services as the main barrier to holding an account and (b) geographical constraints measured by the proportion of the population not having a bank account and indicate that the major barrier is the physical distance to banking facilities (Demirgüç-Kunt et al., 2018; Klapper et al., 2019). The presence of these constraints in SSA's financial markets makes it difficult for individuals to access traditional financial services, and could therefore encourage the adoption of mobile banking by individuals as an alternative channel for their financial transactions. We therefore expect a positive sign for these variables in line with the assumption suggested in the introduction.

Table 1 below describes the variables, their expected signs and the sources. The choice of these variables is justified by the numerous works that show their link with the adoption of mobile banking in developing countries (Teo et al., 2012; Allen et al., 2014; Della Peruta, 2015; Ky, 2016; Asongu, 2018; Senou et al., 2019; Akinyemi and Mushunje,

2020).

Table 1: Control variables

Variable	Description	Expected sign	Source
Domestic remittances	Sent or received domestic remittances in the past year (% age 15+)	+	GFD
Inflation	Inflation, consumer price (annual %)	-	WDI
Population density	Population density (people per sq. km of land area)	+	WDI
GDP per capita	GDP per capita (constant 2010 US\$)	+/-	WDI
Lending interest rate	Lending interest rate (%)	+	WDI
Mobile phone	Cellular subscription (per 100 people)	+	WDI
Internet usage	Individuals using the Internet (% of population)	+	WDI
Population	total population	+	WDI
Primary school	School enrolment, primary (% gross)	+	WDI
Mobile money agent	Number of registered mobile money agent outlets per 1,000 km ²	+	FAS

Sources: Authors. Note: Global Findex Database (GFD), World Development Indicators (WDI), Financial Access Survey (FAS).

There is a possible strong linear association between cost and geographical constraints leading to a possible multicollinearity in the regression. This because, unbanked individuals tend to report high cost and long distances as the two main limitations to financial inclusion (see 2017 Global Findex Database survey results). To resolve this possible multicollinearity, we run two separate estimations (Wheeler and Tiefelsdorf, 2005) for cost and geographical constraints, respectively. Equation 2 and 3 are expressions of Equation 1 which consider cost constraints for the former and geographical constraints to financial inclusion for the latter as indicate below:

$$MB_i = \beta_0 + \beta_1 costconst_i + \beta_2 X_i + \varepsilon_i \quad (2)$$

$$MB_i = \gamma_0 + \gamma_1 geoconst_i + \gamma_2 X_i + \varepsilon_i \quad (3)$$

3.2 Estimation strategy

Allen et al. (2014) and Ky (2016) use the ordinary least squares (OLS) method to estimate the parameters of their models investigating issues of mobile banking. This is principally driven by the nature of the data which is cross sectional in nature. In this paper, we run both the OLS and the generalized least squares (GLS) method. This is principally motivated by the fact that, cross-sectional data are subject to heteroscedasticity, which runs counter to the standard OLS assumptions. To overcome such bias, we run the gen-

eralized least squares (GLS) method. This method applies OLS estimation procedure to transformed data to correct the heteroscedasticity problem. We further apply the Jackknife and bootstrap resampling methods that reduce estimation bias and provide robust results (Flachaire, 2000; Azubuike et al., 2019; Fanta and Makina, 2019).

3.3 Data of the study

The data used in this study are obtained from three databases, namely the Global Findex Database (GFD) and the World Development Indicators (WDI) of the World Bank, as well as the Financial Access Survey (FAS) of the International Monetary Fund. Our indicators of cost and geographical constraints are only available for 2017. Therefore, we opt for a cross-sectional analysis in 2017 on a sample of 35 SSA countries (see Table 5 in the annexes for the list of countries).

4 Empirical results

4.1 Preliminary analysis

The descriptive statistics of the variables used in this study are reported in Table 2, whilst the correlation matrix between the variables in the study are reported in Table 9 in the annex. Concerning the different measures of mobile banking diffusion, we observe a certain homogeneity of the sample, with standard deviations lower than the means, except for the proportion of adults paying utility bills using mobile phone. Table 2 indicates that about 24% of the adult population (15 years and older) have a mobile money account. This proportion was 18% for the poorest 40% of the population, 29% of the richest 60% of the population and 22% for the population in rural areas. In addition, money transfers by mobile phone are effectuated by more than 24% of the total population. This is a clear indication of the high diffusion of mobile banking in SSA in recent decades, as revealed by numerous international surveys, including the World Bank's Global Findex (Demirgüç-Kunt et al., 2018). These observations are similar regarding constraints to financial inclusion. Over 28% of the unbanked in SSA reported high cost of financial services as their main obstacle, while 25% indicated that difficulties due to the geographical distance to bank branches constitute their main hindrance. This corroborates the observation that, the two constraints are very prevalent in the region.

Table 8 in the annex demonstrates that in SSA, compared to over 100 developing countries⁷, there is a strong association between all the different measures of mobile banking diffusion constructed in this paper for both cost and geographical constraints. This is however not the case for developing countries where only the measure proportion

⁷The data concerning the other developing countries come from the same sources presented above for SSA countries, namely GFD, WDI and FAS.

Table 2: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Mobile money account	0,2443	0,1594	0,0032	0,7293
Mobile money account (poorest)	0,1774	0,1322	0,0000	0,5936
Mobile money account (richest)	0,2888	0,1808	0,0053	0,8193
Mobile money account (rural)	0,2239	0,1553	0,0032	0,7259
Remittances using mobile phone	0,2443	0,1483	0,0022	0,6304
Pay bills using mobile phone	0,0659	0,0707	0,0000	0,3710
Cost constraints	0,2898	0,1009	0,0515	0,5314
Geographical constraints	0,2547	0,0929	0,0614	0,5112
Domestic remittances	0,4406	0,1189	0,2387	0,7064
Inflation	0,1116	0,3213	-0,0154	10,8785
Lending interest rate	0,1484	0,1217	0,0514	0,6000
Mobile phone	83,7112	36,2276	25,5613	155,2324
Primary school	0,8310	0,1399	0,4426	0,9734
Population	26900000	36800000	1264613	191000000
Internet usage	0,2218	0,1441	0,0434	0,5617
mobile money agent	309,9646	680,4116	0,0482	3385,9340
GDP per capita	2098,5140	2666,7730	371,1088	10199,4800
Population density	91,3943	129,4439	2,9183	622,9621

Sources: Authors

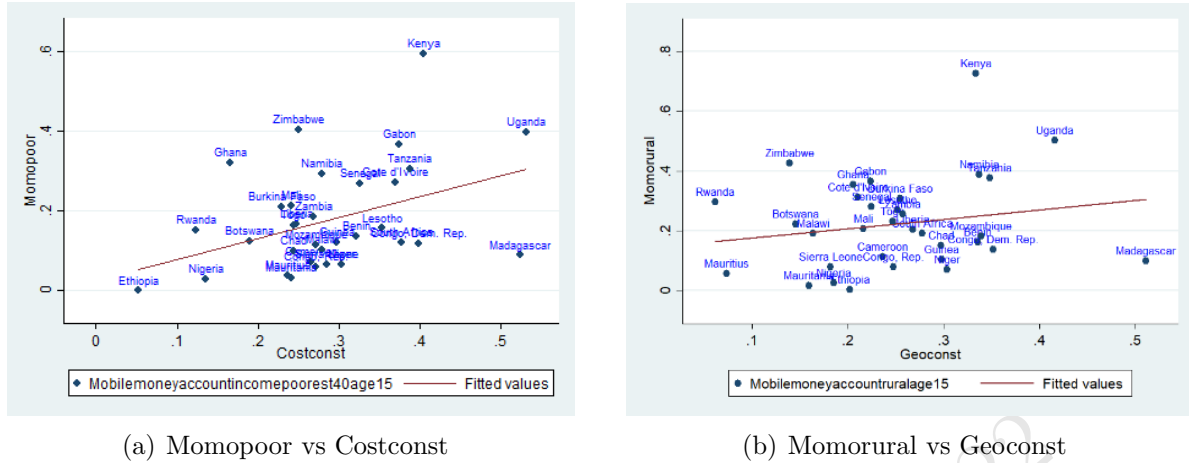
of individual aged 15 and above that indicated using the mobile money account to transfer funds was significantly positive. This highlights the need to focus on SSA because these measures have the merit of reflecting characteristics of poor unbaked individuals, thereby having some policy relevance for SSA.

We also observe a high difference, between the minimum and maximum values in the sample revealing some form of heterogeneity, which is treated by running the GLS estimates. This reflects a strong difference between countries with lower financial development and their corresponding counterparts having higher financial development levels. Outliers therefore exist in the sample, such as Kenya, which is the world leader in mobile money with an adoption rate of almost 73%, and Ethiopia, which has a very low adoption rate of 0.3%. Ideally, these countries should be removed from the study. But this will not be done, given the already small sample size.

To preliminary assess the relationship we investigate, we plotted the fitted scatter plots between indicators of mobile banking adoption in SSA and measures of cost and geographical constraints to financial inclusion.

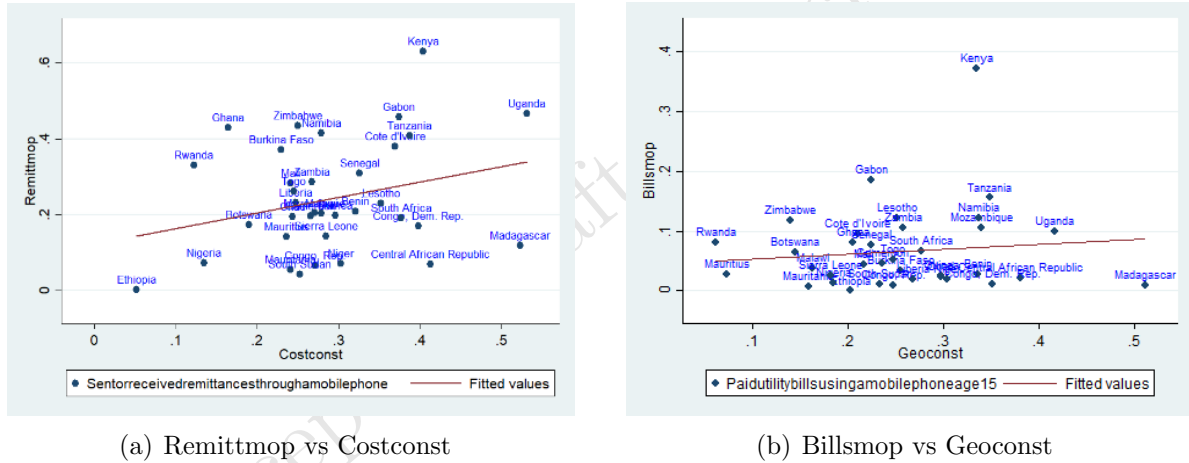
As shown in Figure 1, there is a positive correlation between (a) mobile money account ownership among the poorest 40% and cost constraints and (b) mobile money account ownership among rural people and geographical constraints. Appraising the different countries suggest that Kenya and Uganda have high levels of both constraints to financial inclusion and mobile money adoption. Likewise, countries like Ethiopia and Nigeria have both low levels of constraints to financial inclusion as well as low levels of mobile money

Figure 1: Mobile money account vs constraints to financial inclusion



Sources: Authors' construction based on data from the World Bank (GFD)

Figure 2: Mobile transfers and payments vs constraints to financial inclusion



Sources: Authors' construction based on data from the World Bank (GFD)

adoption. In contrast, countries such as Madagascar and the Democratic Republic of Congo reporting high constraints to financial inclusion, nonetheless have low mobile money adoption. Similarly, Ghana and Zimbabwe both show high rates of adoption of mobile banking despite lower levels of financial inclusion constraints. The same trends are equally observed regarding the correlation between financial inclusion constraints and the use of mobile banking for money transfers and bill payments (see Figure 2).

4.2 Regression results

Table 3 and Table 4 (page 14 and page 16) below present the results of the linear regression between indicators of mobile banking diffusion in SSA in terms of access and usage, and constraints to financial inclusion. The results of the multicollinearity tests can be found in the annexes (Table 6 and Table 7). For all the variable, the variance inflation factors

(VIF) are low (less than 10) with high tolerances ($1/\text{VIF}$ greater than 0.1). This indicates an absence of multicollinearity.

Table 3 highlight that, the presence of cost constraints to financial inclusion is significantly and positively related to the diffusion of mobile banking in SSA, in terms of both access and usage. In terms of access, there is a positive and statistically significant relationship between cost constraints and the proportion of adults holding a mobile money account among the poorest 40% of the population, as well as among the richest 60%. Regarding usage, results also show a positive and statistically significant association between the proportion of adults facing cost constraints and the use of mobile phones for money transfers on the one hand, and for bill payments on the other. These results also remain significant and positive when the Jackknife and bootstrap resampling techniques are used for further investigation. This confirms the robustness of the results obtained.

These results show that strong cost constraints to financial inclusion in SSA drive the diffusion of mobile banking in SSA. This effect is evident for both the poorest 40% of the population and the richest 60%. This aligns with findings from the World Bank's Global Findex survey which argue that there has been an unprecedented success of fintechs such as mobile banking in developing countries, and particularly in SSA. This success can partly be explained by the low level of development of financial systems that results in a deficit of financial services (Demirgüç-Kunt et al., 2018). Among other multiple causes also identify the high cost of financial services (Granata et al., 2014; Guérineau and Jacolin, 2014). To resolve the high-cost issues, mobile banking, unlike traditional finance, allows users to benefit from basic financial services at low cost. McKay and Pickens (2010) reveal that mobile phone transactions can cost up to 50% less than branch transactions. This highlights the situation in Kenya, where mobile banking has led to an increased competitiveness of the financial market, especially in money transfer and payments, by setting fees that are much more affordable than those of traditional providers (Mbiti and Weil, 2011).

Our regression equally highlights the significant influence of other factors in the diffusion of mobile banking in SSA (Table 3). In particular, the rate of mobile telephone subscription is positively and significantly related to the adoption of mobile money among the poorest 40% and for the measure of mobile banking diffusion capture by the proportion of individuals aged fifteen and above who transfer money using their mobile phone accounts. The rate of enrolment in primary school has a positive influence on the percentage of individuals that use of mobile phones for payments. We also note the positive relationship between the variables indicating the number of mobile money agents per 1000 km² and the two measures of usage of mobile banking diffusion. These results are in line with the findings of Ky (2016), Asongu (2018) and Akinyemi and Mushunje (2020).

Table 3: Mobile banking and cost constraints to financial inclusion

VARIABLES	Momopoor			Momorich			Remittmop			Billsmop		
	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Ols</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>
Costconst	0.497** (0.0382)	0.497* (0.0837)	0.497* (0.0596)	0.864*** (0.00966)	0.864** (0.0307)	0.864** (0.0148)	0.394** (0.0416)	0.394* (0.0759)	0.394* (0.0933)	0.306** (0.0297)	0.306** (0.0384)	0.306** (0.0321)
Interestlend	0.0570* (0.0548)	0.0570 (0.698)	0.0570 (0.571)	-0.313 (0.161)	-0.313 (0.142)	-0.313 (0.119)				-0.0346 (0.264)	-0.0346 (0.333)	-0.0346 (0.445)
lMobilcel	0.123** (0.0107)	0.123** (0.0222)	0.123*** (0.00822)	0.0888 (0.179)	0.0888 (0.124)	0.0888 (0.215)	0.141*** (0.000460)	0.141*** (0.00220)	0.141*** (0.00276)	0.0213 (0.261)	0.0213 (0.308)	0.0213 (0.383)
Primschool	-0.178* (0.0906)	-0.178 (0.176)	-0.178 (0.184)							0.170* (0.0526)	0.170* (0.0602)	0.170* (0.0500)
lPopulation	0.0205 (0.351)	0.0205 (0.403)	0.0205 (0.385)				0.0306 (0.134)	0.0306 (0.177)	0.0306 (0.154)			
Inflation				0.104 (0.301)	0.104 (0.594)	0.104 (0.768)	-0.168*** (0.000548)	-0.168 (0.164)	-0.168 (0.272)	0.0473 (0.112)	0.0473 (0.729)	0.0473 (0.770)
lMomoag_km							0.0137*** (0.000105)	0.0137*** (0.000676)	0.0137*** (0.000637)	0.00801** (0.0373)	0.00801* (0.0558)	0.00801* (0.0696)
Constant	-0.706 (0.181)	-0.706 (0.234)	-0.706 (0.179)	-0.320 (0.302)	-0.320 (0.257)	-0.320 (0.374)	-1.032** (0.0185)	-1.032** (0.0353)	-1.032** (0.0413)	-0.283** (0.0131)	-0.283** (0.0222)	-0.283** (0.0125)
Observations	35	35	35	35	35	35	35	35	35	35	35	35
R-squared	0.367	0.367	0.367	0.250	0.250	0.250	0.545	0.545	0.545	0.400	0.400	0.400
F	5.410***	3.208**		2.498*	1.963		18.74***	9.333***		4.955***	1.992*	
N_reps		35	100		35	100		35	100		35	100
chi2			16.44***			8.753*			32.27***			14.91**

Sources: Authors. Robust pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Concerning geographical constraints, [Table 4](#) indicate that, they also relate positively and significantly with the indicators for access and usage associated to mobile banking diffusion. The proportion of people not having a bank account and who reported geographical distance as the main obstacle opt to use mobile banking as a palliative when we consider the entire population and especially individuals residing in the rural area. This same measure of mobile banking diffusion is positively and significantly associated with mobile phone usage regarding money transfers and bill payments. These results remain statistically significant for the Jackknife and bootstrap techniques estimation methods, therefore confirming the robustness of the preceding results (OLS, GLS).

These results show that, in SSA, geographical constraints to financial inclusion are accompanied by a significant diffusion of mobile banking. This is particularly true in rural areas, where the problem of isolation is particularly acute. Geographical remoteness from banking infrastructure is a major cause of banking exclusion in developing countries and particularly in SSA (Demirgüç-Kunt et al., 2018; Klapper et al., 2019). According to Allen et al. (2014), mobile banking has the potential to facilitate financial development and financial inclusion in Africa, mainly outside of major urban areas. Through remote mobile phone transactions and their huge network of agents, mobile banking providers can serve remote areas where there are no bank branches. This potential for technological leapfrogging of mobile banking had already been highlighted by Datta et al. (2001), who made it a strong argument for the implementation of this innovation in developing countries. In Kenya, for example, King (2012) has shown that mobile banking is able to break the "tyranny of distance" from bank branches, thereby increasing financial access for people in remote areas.

The regression results overly reveal the statistically significant role of other factors reported in the literature. These are domestic money transfers (as a % of the population), which are positively associated with the adoption of mobile banking and its use for mobile transfers and payments. Internet coverage, which is positively related to the adoption of mobile banking and its use for transfers and payments. However, their effect when considering the measuring of mobile banking diffusion as proportion of individuals in rural areas having a mobile money account is not statistically significant. Inflation discourages the adoption and use of mobile banking, as does GDP per capita. Finally, the number of mobile banking agents per 1000 km² favours the adoption of mobile banking in rural areas and its use for money transfers and mobile phone payments.

Table 4: Mobile banking and geographical constraints to financial inclusion

VARIABLES	Momo			Momorural			Remittmop			Billsmop		
	<i>Ols</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>	<i>Gls</i>	<i>Jackknife</i>	<i>Bootstrap</i>
Geoconst	0.574*	0.574	0.574*	0.630**	0.630*	0.630**	0.355*	0.355*	0.355*	0.314**	0.314**	0.314**
	(0.0581)	(0.181)	(0.0966)	(0.0447)	(0.0932)	(0.0425)	(0.0575)	(0.0811)	(0.0831)	(0.0173)	(0.0180)	(0.0246)
Domremitt	0.733***	0.733	0.733**	0.583*	0.583	0.583*	0.651***	0.651***	0.651***			
	(0.00765)	(0.150)	(0.0394)	(0.0850)	(0.154)	(0.0978)	(8.61e-05)	(0.000231)	(0.000273)			
Internetuse	0.621**	0.621***	0.621***	0.174	0.174	0.174	0.246**	0.246**	0.246*	0.187***	0.187***	0.187***
	(0.0211)	(0.00347)	(0.00164)	(0.347)	(0.449)	(0.481)	(0.0171)	(0.0480)	(0.0630)	(0.000270)	(0.000603)	(0.00300)
Inflation	0.0766	0.0766	0.0766	-0.492***	-0.492***	-0.492**	-0.142***	-0.142**	-0.142	-0.0658***	-0.0658**	-0.0658
	(0.399)	(0.849)	(0.756)	(7.47e-07)	(0.000438)	(0.0219)	(0.000417)	(0.0260)	(0.106)	(0.00115)	(0.0262)	(0.450)
IGdppercapita	-0.126***	-0.126*	-0.126**									
	(0.00488)	(0.0793)	(0.0147)									
IMomoag_km				0.00773***	0.00773**	0.00773**	0.0113***	0.0113***	0.0113***	0.00431***	0.00431***	0.00431***
				(0.00580)	(0.0189)	(0.0287)	(0.000176)	(0.00439)	(0.000284)	(0.00428)	(0.00859)	(0.00785)
IPopdensity							0.0168	0.0168	0.0168			
							(0.132)	(0.210)	(0.161)			
Primschool										0.0492	0.0492	0.0492
										(0.298)	(0.328)	(0.338)
Constant	0.476*	0.476	0.476	-0.390*	-0.390	-0.390*	-0.280***	-0.280***	-0.280***	-0.104**	-0.104**	-0.104**
	(0.0747)	(0.225)	(0.102)	(0.0802)	(0.148)	(0.0999)	(0.00390)	(0.00691)	(0.00416)	(0.0141)	(0.0224)	(0.0387)
Observations	35	35	35	35	35	35	35	35	35	35	35	35
R-squared	0.529	0.529	0.529	0.626	0.626	0.626	0.775	0.775	0.775	0.344	0.344	0.344
F	5.245***	4.234***		105.5***	6.002***		33.42***	11.08***		14.63***	12.18***	
N_reps		35	100		35	100		35	100		35	100
chi2			35.55***			21.46***			71.73***			23.51***

Sources: Authors. pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

Mobile banking is a major issue in SSA and plays a key role towards enhancing financial inclusion. However, existing studies did not clearly establish the link between the high diffusion of mobile banking in SSA and constraints (cost and geography) to financial inclusion. This study aimed to fill this gap by undertaking an empirical assessment of the relationship using different measures of mobile banking diffusion that encompasses the specificities of the SSA continent. The empirical method consisted of a multiple linear regression, estimated by means of the ordinary and generalized least squares methods as well as the Jackknife and bootstrap resampling techniques for robustness.

Results indicate that, strong cost constraints to financial inclusion cause an increase in the diffusion of mobile banking, in terms of access (possession of a mobile money account) among both the poorest 40% and the richest 60%, but also in terms of use (money transfers and mobile payments). The same is true for geographical constraints as they positively relate to the possession of a mobile money account when considering the entire population, particularly those residing in rural areas. This affirmation is also verified when we consider other measures of mobile banking usage such as money transfers and bill payments via mobile phones.

The main policy herald should upgrade telecommunications road maps to encompass challenges that mobile banking and mobile financial services in general pose for financial sector regulation given the fast-paced innovations registered in the mobile banking sector. This should be primarily aimed at developing infrastructures that act as barrier linked to geographical constraints. By digitalizing and reducing ICT infrastructure, through robust investment schemes, governments can mitigate geographical barriers and vulgarize usage of ICT facilities. This coupled with appropriate sensitization and ICT-education programmes should help poor households. Furthermore, the fast-paced development of ICT and the constant inclusion of new plays should stir governments and authorities to enhance institutional and regulatory framework that encourage and attract investment in ICTs and adoption of technology that optimizes mobile banking. More still, given that rural areas are disproportionately disfavoured authorities should design incentive schemes that encourage the financial service providers and ICT enterprises to invest in rural areas.

References

- Akinyemi, B. E., and Mushunje, A. (2020). "Determinants of mobile money technology adoption in rural areas of Africa.", *Cogent Social Sciences*, 6 (2020).
- Allen, F., Carletti, E., Cull, R., Qian, J. Q., Senbet, L., and Valenzuela, P. (2014). "The African financial development and financial inclusion gaps.", *Journal of African Economies*, 23, 614–642.
- Asongu, S. A. (2018). "Conditional determinants of mobile phones penetration and

- mobile banking in sub-Saharan Africa.”, *Journal Knowledge Economy*, 9(2018), 81–135.
- Assadi, D., and Cudi, A. (2011).** “Le potentiel d’inclusion financière du “mobile banking”. Une étude exploratoire.”, *Management Avenir* (6), 227–243.
- Azubuike, I. M., Chris-Chinedu, and Nonso, J. (2019).** “Jackknife and bootstrap techniques in the estimation of regression parameters.”, *International Journal of Mathematics Trends and Technology*, 65(12), 25–35.
- Bair, S., and Tritah, A. (2019).** “Mobile money and inter-household financial flows: Evidence from Madagascar.”, *Revue Economique*, 70(5), 847–871.
- Barnes, S., and Corbitt, B. (2003).** “Mobile banking: concept and potential.”, *Int. J. Mobile Communications* 3 (1), 273–288.
- Chaix, L., and Torre, D. (2015).** “Le double rôle du paiement mobile dans les pays en développement.”, *Revue Economique*, 66, 703–727.
- Datta, A., Pasa, M., and Schnitker, T. (2001).** “Could mobile banking go global?”, *The McKINSEY Quarterly: Emerging Markets* (4), 71–80.
- Davis, F. D. (1989).** “Perceived usefulness, perceived ease of use, and user acceptance of information technology.”, *MIS Quarterly*, 13(3), 319–340.
- Della Peruta, M. (2015).** “Mobile money adoption and financial inclusion objectives: A macroeconomic approach through a cluster analysis.”, GREDEG Working paper series, No. 2015-49.
- Demirgüç-Kunt, A., and Klapper, L. (2012).** “Financial inclusion in Africa: An overview.”, *Policy Research Working Paper*, No. 6088.
- Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J. (2018).** “*The global Findex database 2017: Measuring financial inclusion and the fintech revolution*”, Washington, DC: World Bank.
- Fanta, A. B., and Makina, D. (2019).** “The relationship between technology and financial inclusion: Cross-sectional evidence.”, In *Extending financial inclusion in Africa* (Vol. 65, pp. 211–230) Elsevier.
- Flachaire, E. (2000).** “Les méthodes du bootstrap dans les modèles de régression.”, *Economie and Prévision*, 1(142), 183–194.
- Granata, P., Kibuuka, K., and Yira, M. (2014).** “Le coût du financement en Afrique : quelles politiques publiques pour réduire son coût et renforcer l’inclusion financière ?” *Revue d’Économie Financière*, Décembre 2014, 121–149.
- Guérineau, S., and Jacolin, L. (2014).** “L’inclusion financière en Afrique subsaharienne : faits stylisés et déterminants”, *Revue d’Économie Financière*, 4(116), 57–80.
- Hamdi, H. (2011).** “Can e-payment systems revolutionize finance of the less developed countries? the case of mobile payment technology.”, *International Journal of Economics and Financial Issues*, 1(2), 46–53.

- Jack, G., and Suri, T. (2011).** “Mobile money: The economics of MPESA”, *NBER Working Paper* No.16721.
- King, M. (2012).** “Is mobile banking breaking the tyranny of distance to bank infrastructure? evidence from Kenya.”, *IIIS Discussion Paper* No.412.
- Klapper, L., Ansar, S., Hess, J., and Singer, D. (2019).** “*Sub-Saharan Africa series: mobile money and digital financial inclusion.*”, FINDEX NOTE 1, Development Research Group the World Bank.
- Kumar, K., McKay, C., and Rotman, S. (2010).** “Microfinance et banque mobile : quelles expériences à ce jour ?”, *Note Focus*, No., 62.
- Ky, S. (2016).** “*Essays on the rise of mobile financial technology in developing countries and its impacts on individual financial behaviours*”. Thèse de Doctorat, Université de Limoge, Archives Ouvertes (HAL).
- Ky, S., Rugemintwari, C., and Sauviat, A. (2018).** “Does mobile money affect saving behaviour? evidence from a developing country.”, *Journal of African Economies*, 27(3), 285–320.
- Lashitew, A. A., Tulder, R., and Liasse, Y. (2019).** “Mobile phones for financial inclusion: What explain’s the diffusion of mobile money innovations?”, *Research Policy*, No. 48, 1201–1215.
- Llewellyn-Jones, L. (2016).** “Mobile money: part of the African financial inclusion solution?”, *Economic Affairs*, 36(2), 212–216.
- Mbiti, I., and Weil, D. N. (2011).** “Mobile banking: the impact of m-pesa in Kenya.”, *NBER Working Paper Series*, No. 17129.
- Mbiti, I., and Weil, D. N. (2013).** “The home economics of e-money: Velocity, cash management, and discount rates of m-pesa users.”, *American Economic Review: Papers and Proceedings*, 3(103).
- McKay, C., and Pickens, M. (2010).** “*Branchless banking 2010: Who’s served? at what price? what’s next?*”, Washington, D.C.: CGAP, September, No. 66.
- Mishra, V., and Bisht, S. (2013).** “Mobile banking in a developing economy: A customer-centric model for policy formulation.”, *Telecommunications Policy* (37), 503–514.
- Mutsune, T. (2015).** “No Kenyan left behind: The model of financial inclusion through mobile banking.”, *Review of Business and Finance Studies*, 6(1), 35–42.
- Porteous, D. (2006).** “*The enabling environment for mobile banking in Africa*”. Department for International Development (DFID).
- Rogers, E. M. (1983).** *Diffusion of innovations*. The Free Press a Division of Macmillan Publishing Co., Inc.
- Senou, M. M., Ouattara, W., and Houensou, D. A. (2019).** “Is there a bottle-neck for mobile money adoption in WAEMU?”, *Transnational Corporations Review*, 11(2), 143–156.

- Shareef, M. A., Baabdullah, A., Dutta, S., Kumar, V., and Dwivedi, Y. K. (2018).** “Consumer adoption of mobile banking services: an empirical examination of factors according to adoption stages.”, *Journal of Retailing and Consumer Services*, 43(2018), 54–67.
- Teo, A.-C., Tan, G. W.-H., Cheah, C.-M., Ooi, K.-B., and Yew, K.-T. (2012).** “Can the demographic and subjective norms influence the adoption of mobile banking?”, *Int. J. Mobile Communications*, 10(6), 578–597.
- Wheeler, D., and Tiefelsdorf, M. (2005).** “Multicollinearity and correlation among local regression coefficients in geographically weighted regression.”, *Journal of Geographic Systems*, 2005(7), 161–187.
- World Bank, G. (2018).** “*The little data book on financial inclusion 2018*”, World Bank: Washington, DC.

Annexes

Table 5: Sample country

Benin, Burkina Faso, Botswana, Chad, Cameroon, Central African Republic, Congo Dem. Rep., Congo Rep., Cote d’Ivoire, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Mali, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, South Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Source: Authors.

Table 6: Results of VIF test for multicollinearity

Model	Momopoor		Momorich		Remittmop		Billsmop	
Variables	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
Costconst	1.17	0.855564	1.29	0.775303	1.04	0.963355	1.24	0.803772
Interestlend	1.49	0.670760	1.40	0.711838			1.20	0.833911
lMobilcel	1.43	0.697650	1.35	0.740835	1.37	0.728657	1.53	0.651522
Primschool	1.03	0.967823					1.23	0.814122
lPopulation	1.21	0.823420			1.12	0.894335		
Inflation			1.23	0.815977	1.64	0.609569	2.08	0.481069
lMomoag_km					1.41	0.706848	2.23	0.449062
Mean VIF	1.27		1.32		1.32		1.59	

Sources: Authors

Table 7: Results of VIF test for multicollinearity

Model	Momo		Momorural		Remittmop		Billsmop	
Variables	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
Geoconst	1.38	0.725941	1.20	0.829885	1.58	0.633235	1.38	0.723270
Domremitt	1.88	0.532037	1.65	0.605494	1.30	0.772078		
Internetuse	3.20	0.312151	2.02	0.494445	1.62	0.617597	1.70	0.587559
Inflation	1.71	0.586505	4.29	0.233349	1.61	0.622678	1.40	0.713888
lGdppercapita	3.82	0.262008						
lMomoag_km			4.19	0.238652	1.48	0.674542	1.41	0.707142
lPopdensity					1.15	0.873178		
Primschool							1.45	0.688024
Mean VIF	2.18		2.45		1.45		1.47	

Sources: Authors

Table 8: Mobile banking and constraints to financial inclusion (estimate on 100 developing countries including our sample of SSA country)

	(1)	(2)	(3)		(1)	(2)	(3)
VARIABLES	Momopoor	Remittmop	Billsmop	VARIABLES	Momorural	Remittmop	Billsmop
Costconst	0.0328	0.188*	0.0169	Geoconst	0.0374	0.0259	0.0943
	(0.718)	(0.0953)	(0.624)		(0.758)	(0.738)	(0.184)
Interestlend	-0.0640			Domremitt	0.408***	0.431***	
	(0.392)				(0.00683)	(0.000)	
lMobilcel	0.0674*	0.0588**	0.0190*	Internetuse	0.137	0.00332	0.0602*
	(0.0612)	(0.0392)	(0.0733)		(0.129)	(0.934)	(0.0614)
Primschool	0.166**		0.104**	Inflation	-0.0572**	-0.0615***	-0.0241**
	(0.0284)		(0.0183)		(0.0279)	(0.000381)	(0.0107)
lPopulation	-0.000184	0.0106		lMomoag_km	0.00206	0.0129***	0.00640**
	(0.986)	(0.190)			(0.727)	(0.00192)	(0.0145)
Inflation		-0.0414	-0.0265**	lPopdensity		0.00169	
		(0.202)	(0.0122)			(0.845)	
lMomoag_km		0.0111**	0.00348*	Primschool			0.0445
		(0.0293)	(0.0558)				(0.299)
SSA	0.154***	0.215***	0.0426***	SSA	0.0922**	0.134***	0.0469***
	(3.12e-06)	(0)	(0.00324)		(0.0119)	(2.55e-05)	(0.00206)
Constant	-0.404	-0.499**	-0.163***	Constant	-0.148*	-0.144**	-0.0800
	(0.144)	(0.0101)	(0.00318)		(0.0852)	(0.0125)	(0.138)
Observations	100	100	100	Observations	100	100	100
R-squared	0.237	0.468	0.184	R-squared	0.316	0.683	0.194
F	4.998***	12.25***	5.187***	F	7.093***	0.431***	4.024***

Source: Authors. Robust pval in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 9: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Momo	1.0000																	
(2) Momopoor	0.9687	1.0000																
(3) Momorich	0.9932	0.9332	1.0000															
(4) Momorural	0.9349	0.9101	0.9266	1.0000														
(5) Remittmop	0.8996	0.9239	0.8690	0.8745	1.0000													
(6) Billsmop	0.8198	0.8309	0.7970	0.7770	0.8095	1.0000												
(7) Costconst	0.3918	0.4098	0.3747	0.3506	0.2831	0.3013	1.0000											
(8) Geoconst	0.2112	0.2175	0.2034	0.1878	0.1095	0.1089	0.7290	1.0000										
(9) Domremitt	0.4829	0.5312	0.4500	0.5235	0.5872	0.5114	0.0958	-0.1799	1.0000									
(10) Inflation	-0.2756	-0.2545	-0.2802	-0.5681	-0.2502	-0.1456	-0.0752	-0.0233	-0.2693	1.0000								
(11) Interestlend	0.2359	0.1397	0.2758	0.1242	0.0004	0.1162	0.4422	0.2115	0.0105	-0.0529	1.0000							
(12) Internetuse	0.2506	0.2492	0.2460	0.2785	0.3095	0.3336	0.0079	-0.3584	0.5989	-0.2016	-0.0031	1.0000						
(13) Primschool	0.2502	0.1348	0.2990	0.3297	0.1766	0.2591	0.0254	-0.1431	0.2000	-0.3301	0.0695	0.2326	1.0000					
(14) lPopdensity	-0.0083	0.0059	-0.0146	0.0919	0.1157	0.0262	-0.0940	-0.2299	0.2238	-0.0802	-0.2843	0.0368	0.1186	1.0000				
(15) lGdppercapta	0.2575	0.2455	0.2581	0.5216	0.2620	0.2307	0.0084	-0.1302	0.5000	-0.8946	0.0384	0.5231	0.3182	0.0231	1.0000			
(16) lMobilcel	0.2422	0.2891	0.2153	0.3608	0.4037	0.3111	-0.1209	-0.4483	0.6598	-0.4179	-0.2008	0.7077	0.2868	0.0551	0.6611	1.0000		
(17) lPopulation	-0.0008	0.0472	-0.0234	0.0367	0.0786	0.0357	0.0218	0.2737	-0.1909	0.0280	-0.2771	-0.2923	-0.2954	0.3517	-0.1520	-0.3008	1.0000	
(18) lMomoag_km	-0.0984	-0.0631	-0.1133	-0.3710	0.0072	0.0341	-0.0062	-0.1214	-0.1564	0.8632	0.0499	-0.1244	-0.1815	0.0567	-0.7836	-0.2569	-0.1033	1.0000

Sources: Authors.