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DIGITALIZATION AND FINANCIAL INCLUSION IN AFRICA

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ABSTRACT

The ineffectiveness of economic development policies over the past few years has been largely due to the exclusion of the population from participating in wealth creation. This is probably the main source of income inequality. To remedy this problem and bridge the gap, technological innovation and financial digitalization are effective tools for development actors. This paper aims to assess the impact of the digitalization of financial services on financial inclusion using panel data from 48 African countries over the 2011- 2017 period. Our results show that mobile money and digital payments have a positive and significant impact on bank account penetration, access to credit and savings mobilization. However, the digital inclusion process is hampered in many countries by the dearth of Internet servers, the lack of infrastructure and lengthy administrative procedures.

Keywords: Economic development, financial digitalization, financial services, financial inclusion.

JEL Classification: G18, G20, O10, R11

INTRODUCTION

On the whole, economic policies to counter poverty in developing countries (DCs) are globally ineffective (Chibba 2009), especially for the countries in Sub-Saharan African (SSA). One of the main causes of this ineffectiveness is financial exclusion, which affects 1.7 billion adults worldwide. Financial inclusion can be defined as access to the full range of banking and financial services (demand deposits, savings, credit, insurance, payments, transfers, etc.) at reasonable prices for all households and companies that were previously excluded. According to Global Findex (2017), Africa is the region with the lowest bank account penetration in the world. In SSA, 57.4% of natural and legal persons do not possess a bank account, which compels them to remain in the informal economy.

The G20 summit in Seoul in 2010 made financial inclusion a key pillar in the fight against poverty. And the Maya Declaration in Mexico in 2011 (Postel-Vinay 2011) urges central banks and national economic policy agencies to combat financial exclusion. Inclusion allows people to escape poverty and participate in economic development by investing in education and projects (Demirgüç-Kunt 2012). It allows the poor and traditionally excluded populations (rural households and women) to increase their income and likelihood of obtaining employment (Bruhn & Love 2014). Access to banking and financial services is therefore, at least partly, a prerequisite for development.

What explains financial exclusion in SSA? Kempson & Whyley (1999) blame this phenomenon on difficulties in accessing financial infrastructure due to distance, the cost of basic services, the access requirements (e.g. paperwork) or self-exclusion for religious or cultural reasons. The Alliance for Financial Inclusion (AFI) identifies three types of factors. The first is the proximity of formal, affordable and regulated banking and financial services networks. The second is the frequency of use of these services. The third factor is the adequacy of the supply of banking and financial services in relation to the demand from the poor. Global Findex data (2014), the findings of Demirgüç-Kunt & Klapper (2012), and Demirgüç-Kunt (2012) show that variables such as the high cost of supply, distance, lack of formal documentation, and low levels of income and education are relevant explanations for financial exclusion in Africa.

How can these obstacles be overcome? 66% of excluded people own a cellular telephone, corresponding to nearly 660 million people in Africa (Deloitte 2018). The cellular mobile penetration rate, estimated at 55%, offers powerful development prospects. That is why the digitalization of financial services was the chosen strategy for financial inclusion at the Maya Summit in 2011. This digitalization concerns all types of banking and financial transactions carried out in a dematerialized manner through digital networks (smartphones, tablets, computers, etc.). M-PESA,[3] the mobile money system launched in Kenya by Vodafone in 2007, has been so successful that it is used three times more than the traditional payment methods issued by commercial banks (Chakroun & Huet 2018).

In June 2019, the WAEMU countries[4] adopted a regional financial inclusion strategy based on innovation in general, and digitalization, especially the BCEAO (2019).[5] Between 2017 and 2021, the NGO "Appui au Développement Autonome" (ADA) ran a financial inclusion project entitled "Digital Finance Initiative" for thirteen SSA countries.[6] Digitalization now appears to be the key to accelerating financial inclusion in Africa (Zins & Weill 2016). It eliminates barriers to accessing services, such as distance, lack of infrastructure, lack of education and cost. Digitalization also makes cell phones a catalyst for inclusive economic development because it requires minimal investments compared to those required to set up traditional banking services. The ADA (2019) estimates that digital finance is 90% less expensive than traditional finance.

The purpose of this article is to identify the channels through which digitalization is driving financial inclusion in Africa. Our objective is to assess the impact of digitalization on bank account penetration, savings mobilization, and access to credit.

To address this issue, we analyzed how digitalization can accelerate financial inclusion in Africa. We then panel tested (48 countries over the 2011-2017 period) how the use of digital services combined with the individual characteristics of the population outlines a more effective financial inclusion policy by assessing the impact on bank-account penetration, access to credit, the savings rate and the number of savers.

How does our study contribute to the existing literature? It extends the research on the determinants of financial inclusion in Africa beyond the traditional determinants (Andrianaivo & Kpodar 2012b, Demirgüç-Kunt & Klapper 2012, Demirgüç-Kunt *et al.* 2018, Zins & Weill 2016), and also helps to identify the transmission channels for digitalization in Africa in order to maximize its effectiveness. Our article is divided into four main sections. The first part of the paper reviews the current state of financial inclusion in Africa and the literature on financial digitalization. We then present our methodology and empirical strategy in the second part. In this section, we present our estimation models and variables. In the third part of the paper, we present the empirical results after the econometric estimations. The fourth and final section contains our conclusion and discusses policy recommendations.

I. LITERATURE REVIEW

I.1. A Review of the Current State of Financial Inclusion in Africa

The situation is improving rapidly: 63% of adults in developing economies possessed a bank account in 2017, compared to 51% in 2011 (Demirgüç-Kunt *et al*. 2018). SSA records the highest number of mobile accounts, but lags far behind in terms of traditional bank accounts. This can be seen in Figure 1, which shows the different regions of the world with traditional bank account penetration and mobile account penetration on the Y-axis. Traditional bank account penetration stands at 32% in SSA compared to 67% for the global average, but the percentage of mobile accounts held by adults amounts to more than 28%, against only 4% for the global average. The centuries-old development of traditional banking systems in developed countries explains the relatively lesser use of mobile money.

More than half of the countries in SSA have extremely low financial inclusion rates, at below 20% (Kone 2019). Moreover, this low financial inclusion varies significantly across countries, regions, and populations (Global Findex, 2017). This phenomenon is illustrated by the following statistics:

— 21% of women possess a bank account compared to 26% of men: a difference of 5%. This gender gap varies between 8 and 20 percent across countries in SSA.

— 12% of the population with a primary level of education have a bank account compared to 38% of those with a secondary level of education.

— Similarly, 39% of adults in rural areas possess a bank account, a below-average rate for SSA (43%).

— The majority of the unbanked population, corresponding to 57% of adults, is poor, and 47% is economically inactive.

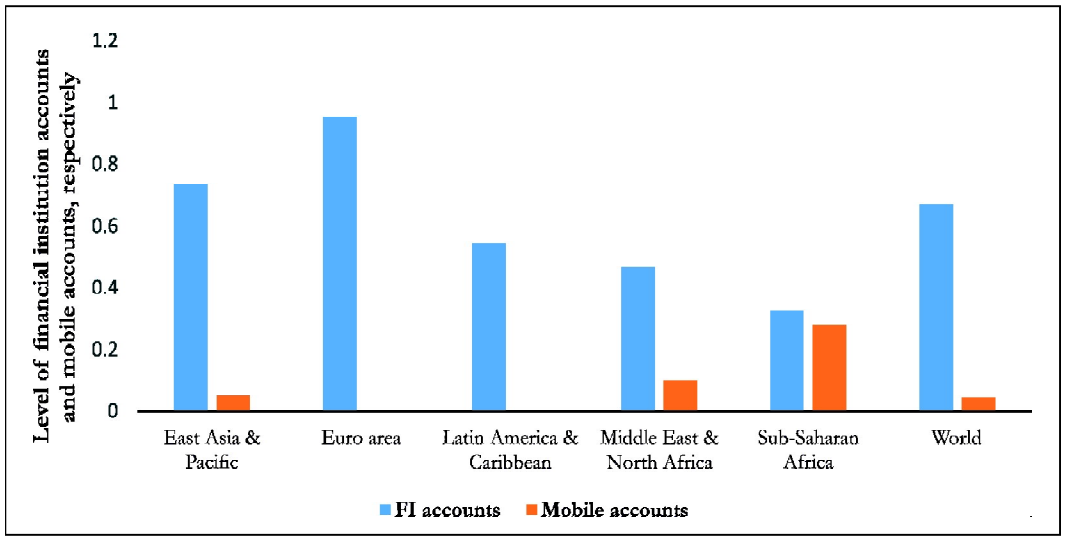

Figure 1 : Banking in Africa compared to the rest of the world in 2017

This graph compares Africa's level of financial inclusion with other regions of the world by looking at FI accounts, which represent the regional average percentage of adults claiming to have a bank account at a traditional financial institution in 2017, and Mobile accounts, which represent the regional average of adults with a mobile account in 2017

Financial exclusion is therefore explained by poverty, gender, and lack of education, but also by regulations that require an excessive amount of administrative documentation to open a bank account, and the lack of infrastructure in rural areas. According to IMF data[7] on financial inclusion (2018), there are only about 8 commercial bank branches per 1,000 kilometers on the African continent.

One result of banking exclusion is credit rationing, which hinders economic growth. Only 7% of adults in SSA were able to borrow from a financial institution in 2017 (Global Findex, 2017). For SMEs, access to the credit market is also constrained (Guérineau & Jacolin 2014, Kone 2019). In 2017, fewer than 23% of them financed their investment through banking institutions while 31% relied on family or friends to finance their activities.

II.2. Digitalization and Financial Inclusion in Africa

While financial inclusion remains a major challenge for the development of African economies (Zins & Weill 2016), access to banking and financial services has improved with the introduction of cell-phone banking (Demirgüç-Kunt 2012).

To gain a better understanding of this improvement, we considered the five economic zones on the continent: Economic Community of West African States (ECOWAS), Economic Community of Central African States (CEMAC), East African Community (EAC), Southern African Development Community (SADC), and North African Countries (Maghreb)(see Figure 2).

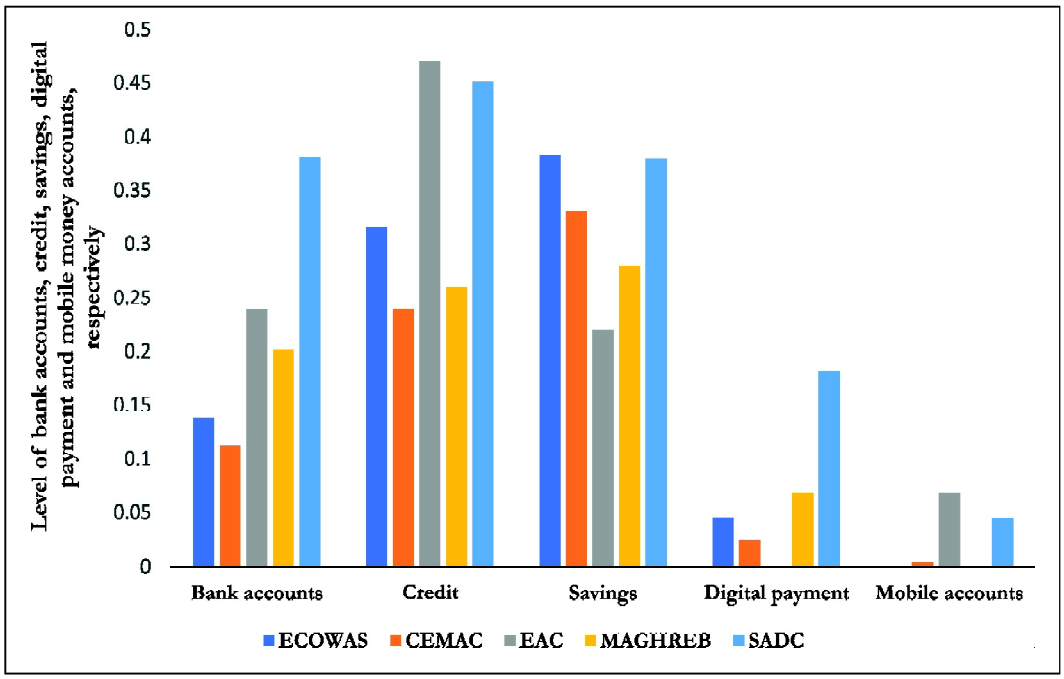

Figure 2: Financial inclusion and financial digitalization in Africa by region in 2017

This graph compares the level of financial inclusion and financial digitalization of different economic regions in Africa in 2017. Bank accounts is the average by economic region as a percentage of adults reporting having a bank account in 2017. Credit is the average by economic region as a percentage of adults who obtained credit in 2017. Savings is the average by region as a percentage of adults who saved money in a financial institution in 2017.Digital payment and Mobile money are the regional average of adults who made a digital payment and the average of adults with a mobile account in 2017, respectively.

— The EAC and SADC zones lead the way for bank accounts, access to credit and financial digitalization;

— Savings increased slightly between 2011 and 2017. The savings rate stood at around 50% in 2014 and 2017, compared to 30% in 2011 at the level of each region; however, it has remained relatively constant for the Maghreb zone.

— For financial digitalization, the EAC and SADC zones are still far ahead of the other regions, especially since 2014. In 2011, the use of mobile money was almost non-existent in the ECOWAS, CEMAC and Maghreb zones. It increased significantly between 2014 and 2017 for the ECOWAS and CEMAC zones but remains low for the EAC and SADC. The Maghreb remains the region with the lowest use of mobile money due to the strong presence of traditional banks.

First introduced in Kenya in 2007, mobile banking has since spread very quickly to all the continent's economies. The populations of Côte d'Ivoire, Senegal, Burkina Faso, Ghana, Tanzania, Uganda and Zimbabwe open more mobile accounts than traditional accounts. A study conducted by the consulting firm FinAfrique (2019),[8] on the digitalization of customer services in 21 countries in SSA, reveals that customers in the banking sectors are better connected and generally use SMS and mobile applications to conduct financial transactions and/or access banking and financial information.

At present, digitalization and mobile money are an effective solution for almost half of adults who still do not have bank accounts in developing countries, especially in Africa. According to Degryse (2016), the digitalization of the economy promotes growth, welfare, and improves the effectiveness of public policies. Digitalization and mobile money facilitate access to banking and financial services for population groups that are traditionally excluded (Donner & Tellez 2008).

Approximately 690 million people in developing countries use digital financial services (DFS), which contributes to the acceleration of financial inclusion (Perlman 2018). For the EIB (EIB 2017), inclusion through digitalization can help accommodate the needs of disadvantaged populations, including women and rural people. And, when studying the impact of telephone coverage on access to DFS, Perlman & Wechsler (2019) concluded that mobile money is a key determinant of access to financial services in rural areas.

From 2011 onwards, governments, with the support of non-governmental organizations (NGOs) and the international community, decided to accelerate digitalization with a view to developing inclusive economies. In SSA, mobile money accounts are more widely used than traditional bank accounts in more than 19 countries, and the adult population using mobile money increased by 10% between 2011 and 2014 (GSMA 2016). Mobile money and financial digitalization are expected to increase revenues and transform finance and the economies of these African countries by boosting local savings and promoting access to credit for SMEs. Today, mobile money is perceived as an indispensable tool to promote economic and social development in SSA. According to GSMA (2019), it accounted for

47% and 62% of GDP in Kenya and Uganda respectively in 2017 and 52% of GDP in Tanzania in 2015.

An exploratory study (Assadi & Cudi 2011) shows that cellular telephones facilitate access to financial services for the unbanked populations in developing economies and provide a sustainable solution to financial exclusion. Andrianaivo & Kpodar (2012b) analyze the impact of telephone penetration in Africa on financial inclusion. Using panel data for 44 African countries between 1988 and 2007, they conclude that cellular mobile penetration has a positive and significant impact on the number of deposits and loan closures at financial institutions, which are regarded as variables of financial inclusion. Cellular mobile penetration therefore has a significant impact on the GDP growth rate.

The adoption of mobile money has also increased in Africa, and its use has developed, ranging from transaction intermediation offerings (cash, payment of bills, money transfers, etc.) through to highly advanced microfinance or insurance operations (Chakroun & Huet 2018, Donovan 2012). According to Mago & Chitokwindo's (2014) findings on the adoption of mobile banking in Zimbabwe, mobile banking usage is driven by its easy access, convenience, cost and security. According to Mbiti & Weil (2015), M-PESA encourages the opening of bank accounts, which facilitates money transfers (P2P or G2P)[9] by individuals and enables them to pay bills or carry out transactions independently of the banks (cash in and cash out). According to Buku & Meredith (2013), the number of bank accounts and electronic transfers has increased greatly in East Africa since the introduction of mobile money. Mobile money attracted 15.2 million users between 2007 and 2012 and electronic money transfers have reached US$1.4 billion, significantly reducing poverty and increasing financial inclusion in rural areas.[10] It has also enabled traditional banks to develop mobile digital services in order to attract new customers who were previously excluded by the banks' traditional access requirements; in 2016, the Ecobank Group launched a mobile app covering the 33 countries in which it operates, to enable its customers to carry out transactions via the telephone (Chakroun & Huet 2018).

Ouma *et al.* (2017) examined the role of mobile finance services in relation to financial inclusion and savings mobilization in SSA countries. Their result shows that the diffusion of mobile finance and banking has had a positive effect on savings in Kenya, Uganda, Malawi, and Zambia, by promoting savings among rural and low-income households that do not have access to traditional financial institutions. Suri *et al.* (2012) and Acquah-Sam & Bugre (2018) pointed out that mobile money has a significant impact on household consumption, savings patterns, and poverty. It helps households avoid unnecessary expenses. Similarly, Demombynes & Thegeya (2012), based on survey data from 2010 in Kenya, concluded that 32% of households were already saving through M-PESA. Moreover, with mobile money, women can save or take out credit without the consent of the spouse or head of household (Morawczynski 2009). Mobile money significantly affects the savings behavior of households in developing countries (Ky *et al.* 2018); it provides opportunities for financing

by domestic resources while also enabling the entire population to participate in the creation of national wealth.

Francis *et al.* (2017) found that digitalization has significantly affected the supply of credit in low-income countries. Digital credit is intended to give households instant and automatic access to credit at lower cost. Oluwatayo & Oluwatayo's (2012) research on cellular telephone usage in southwestern Nigeria shows a positive correlation between mobile banking and credit provision to farmers in rural areas. Mdoe & Kinyanjui (2018) examined the role of cellular mobile telephones in accessing credit for SMEs in Kenya. Their work shows that micro-enterprises and small and medium-sized enterprises that adopt mobile banking and mobile money have an 8.8, a 6.05, and a 1.97 percentage-point chance of obtaining credit by formal means, respectively. They conclude that these types of businesses must now increasingly use mobile banking and money in order to increase their chances of obtaining bank credit. For example, M-PAWA granted credit to

4.9 million people in Tanzania during 2014 (Aglionby 2016). Similarly, Safaricom claims to have extended credit to 2.6 million borrowers in Kenya during its first two years of activity (Cook & McKay 2015).

II. METHODOLOGY AND EMPIRICAL STRATEGIES

Before empirically analyzing the impact of digitalization on financial inclusion in Africa, this section of the paper outlines the data, study variables, and analysis methodology.

II.1. Model Specification and Variables

We defined a global model to successively test our research hypotheses inspired by the models of Andrianaivo & Kpodar (2012b) and Ouma *et al*. (2017), who respectively studied the impact of cellular telephone penetration on financial inclusion and growth, and the impact of mobile financial services on savings mobilization. The following characteristic equation was used:

$$FI_{it} = \alpha_{it} + \beta X_{it} + \sigma \sum_{k=1}^{n} Z_{it} + \varepsilon_{it}$$

Where:

FI_{it} represents the financial inclusion variables (bank account penetration, credit access rate and savings rate) of the country i at the time t.

Z_{it} is a vector of control variables including the urbanization rate (Etim 2014, Ouma *et al.* 2017, Zins & Weill 2016), the interest rate, and the number of commercial bank branches per country. We also considered GDP per capita and the human development index (HDI), which characterize the poverty and living conditions of the populations. Population density

is also taken into account because demographics vary greatly from one country to another. For example, Nigeria has nearly 200 million inhabitants in an area of 923,768 square kilometers, compared to 1.267 million square kilometers and 20 million inhabitants for Niger. We monitored the number of ATMs per country, which is considered by Andrianaivo & Kpodar (2012a) and Fanta & Makina (2019) to have a significant impact on financial inclusion. As in Kendall *et al.* (2010), we also controlled for the impact of inflation on financial inclusion.

X_{it} represents digitalization and, respectively, our variables of interest as measured by mobile money usage, digital payments, cellular mobile penetration and individual Internet use, in the country i on the date t. These are the transmission channels for financial inclusion.

α_{it} and ε_{it} represent the unobserved country specificity and the error term, respectively.

To measure financial inclusion, the literature (Abor *et al*. 2018, Andrianaivo & Kpodar 2012a, Ouma *et al.* 2017, Zins & Weill 2016) primarily defines three variables: the active bank account (account), access to credit (borrowed) and the savings rate (saving). Our empirical study consisted of testing these three models by means of the following equations:

$$account_{it} = \alpha_0 + mobilepen_{it} + digitalpay_{it} + mobileacc_{it} + user\_int_{it} + \sum_{k=1}^{n} Z_{it} + \varepsilon_{it}$$

$$borrowed_{it} = \alpha_0 + mobilepen_{it} + digitalpay_{it} + mobileacc_{it} + user\_int_{it} + \sum_{k=1}^{n} Z_{it} + \varepsilon_{it}$$

$$saving_{it} = \alpha_0 + mobilepen_{it} + digitalpay_{it} + mobileacc_{it} + user\_int_{it} + \sum_{k=1}^{n} Z_{it} + \varepsilon_{it}$$

account is the overall financial services usage rate, corresponding to the percentage of adults who hold an account in banking, savings, microfinance, and e-money institutions (BCEAO 2018). This primary variable of financial inclusion will enable us to evaluate our first research hypothesis.

saving and *borrowed* represent the savings rate and the credit access rate for adults, respectively. These financial inclusion variables are then used to test the second and third hypotheses.

mmoney represents the percentage of people who hold a mobile electronic account or those who use cellular telephones to access financial services such as savings, money transfers, etc. Simply using a telephone to access digital payment enables many excluded people to carry out financial transactions. According to Global Findex (2018), 20.9% of adults in SSA hold mobile accounts with an estimated transaction volume of over *$1.145 billion* in 2017 (GSMA 2018a). The expected sign of this direct variable is positive.

digitalpay represents the digital payments made by adults. These are the financial and/or commercial transactions carried out using a cellular telephone, a computer or a bank card, either using the Internet or offline. It corresponds to the average of payments received and paid out over the corresponding period. As with mobile money, this is a direct variable of financial digitalization. It facilitates access to financial services, especially in areas in which there are no bank branches, thus increasing financial inclusion. The expected sign for financial inclusion variables is positive.

mobilepen is the cellular telephone penetration rate in each country. It is defined by the number of cell phones per 100 inhabitants. This rate is steadily increasing in Africa and was estimated at 72% in 2017 (IMF, 2018), 52% of which is for smartphones according to GSMA (2018b). According to Andrianaivo & Kpodar (2012*b*), it has a significant effect on growth and financial inclusion. We propose to test its significance by considering recent data and bank-account penetration as a financial inclusion variable.[11]

user_int is the number of users of the internet service in percentage in each country. It represents the links between populations and with the rest of the world. It is a key factor in the digital inclusion of populations and the digitalization of the economy as a whole. The expected sign is positive. The mobile penetration rate and the number of servers per capita are our two proxies for digitalization.

II.2. Research Method and Data

According to Global Findex data (2017) on financial inclusion, cellular telephone penetration and the development of mobile financial services have accelerated financial inclusion across the world.

- In a first step, we tested the hypothesis that financial digitalization significantly influences bank account penetration in Africa.
- Access to credit is a key factor for financial inclusion and participation in economic activity, especially for rural households and women. We then tested our second research hypothesis, which postulates that mobile money facilitates access to credit.
- Ouma *et al*. (2017) show that mobile money enables farmers to save and insure their production against natural disasters. In our third research hypothesis, we tested the effect of digitalization on domestic savings mobilization.

We used data from the Global Findex 2017 survey and the IMF over the period 2011 to 2017 (see Table 1). Global Findex data provides more detailed statistics on payment, savings, and lending behavior in Africa (Klapper & Singer 2011). In our study, we considered three financial inclusion variables in a sample of 48 African countries. The data used is an average calculated over four years during three periods (2011, 2014, 2017).

Finally, the variables selected for the empirical analysis take account of gender and rurality. They were integrated in the equations for the respective research hypotheses defined above.

Table 1: Data Sources

Variables	*Sources*
Account, saving, borrowed, digital payment, mobile money	World Bank Global Findex 2017
Electricity, urban population, GDP/h, inflation, internet users, unemployment, transfer cost, mobile penetration, density,	World bank database
Regulation	GSMA
Interest rate, commercial bank branches,ATM,	IMF statistic

II.3. Estimation Procedure

The methodological review of financial inclusion reveals the use of several methods*(see Table 2*).

The estimation strategy consists of a statistical and econometric analysis. In our econometric study, we estimated a fixed-effect model or a random-effect model using the Hausmann Test (Hausman 1978). The small volume of data points toward a random-effect model being appropriate. However, the random-effect model requires a strict exogeneity of the independent variables; otherwise, the model will be biased and inconsistent (Baltagi 2008). For each model in our study, we performed the Hausmann Test before estimating the model that assesses the effect of financial digitalization on financial inclusion in the *48* countries that made up the sample.

III. EMPIRICAL RESULTS

III.1. Descriptive Statistics

According to the three financial inclusion indicators, financial inclusion rates in some countries (Mauritius, South Africa, Kenya and Namibia) are as high as 89.84% for access to accounts, 76.06% for savings and 86.12% for access to credit *(see Table 2)*.

However, considerable efforts in terms of digitalization policy still need to be made in other parts of the continent. Indeed, on average, more than 70% of adults do not have a bank account, and some countries still make little use of digitalization. Even though cellular mobile penetration is high (78.30% on average) for the majority of countries, only 10.32% use mobile money on the continent, on average. Similarly, 22.12% make digital payments. These limitations could be partly explained by the lack of Internet servers on the continent

Table 2: Summary of studies on the determinants of financial inclusion

Author(s)	*Region/Country and time period*	*Methods*	*Link with inclusion financial*
Gebrehiwot and Makina (2019)	27 African countries (2004-2013)	Dynamic GMM to paneldata	Macroeconomic determinants of financial inclusion
Fanta and Makina (2019)	168 countries including 48 African countries (2012-2017)	Cross-section regression	Relationship between technology and financial inclusion
Zins and Weill (2016)	African countries (2011)	Probit linear estimates	Determinants offinancial inclusion
Ouma *et al.* (2017)	Kenya (2013), Malawi (2014), Uganda (2013) and Zambia (2009)	Logit linear estimatesand OLS regression	Mobile financial servicesand financial inclusion (saving mobilization)
Andrianaivo and Kpodar (2012)	44 African countries (1988-2007)	GMM estimates topanel data	Cell phones and financial inclusion
Mago and Chitokwindo (2014)	Zimbabwe Field survey November 2012	Statistical analysis	Mobile banking and financial inclusion
Neba Yah and Mbotta Ntjen (2018)	Cameroon (2014)	OLS regressions	Determinants of inclusion financial development
Demirgüç-Kunt and Klapper (2012)	African countries (Findex 2011)	Statistical analysis	Financial inclusion in African
Allen *et al.* (2014)	37 Sub-Saharan African countries and others developing countries (2007-2011)	OLS regression	Gaps and determinants of financial inclusion in Africa

(853.81 Internet servers for 1 million people on average), hence the low Internet usage rate of 17.31%. Finally, we also note that traditional financial services, characterized by the number of commercial bank branches and ATMs, are highly inadequate (6.64 and 11.29 respectively per 1,000 inhabitants).

Table 3: Descriptive Statistics

Variables	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
account	144	29.59404	19.17592	1.521699	89.84253
borrowed	144	47.47278	14.04877	16.6257	86.1297
saving	144	48.736	14.36974	16.6257	78.32418
mmoney	144	10.32389	14.25123	0	72.93168
digitalpay	144	22.12252	16.62693	.089	78.9628
mobilepen	144	76.30912	38.28238	.2132	163.2901
user_int	144	17.31023	15.66572	.9	61.76221
atm	144	11.29243	15.14432	0	70.21872
branche_cb	144	6.641382	7.110388	0	34.4484

III.2. Econometric Analysis

Empirical results were obtained after estimation of the data. Macroeconomic panel data with a reduced time dimension may contain large differences between estimation methods in the presence of individual effects (Hausman 1978). Indeed, the crucial hypothesis of the random effects model is the lack of correlation between individual specific effects $\acute{a}_i$ and the explanatory variables $xi_{,t}$. This correlation reflects the influence of individual specificities on the determination of the level of the explanatory variables and the non-convergence of the estimator. In the same vein, Mundlak (1978) argues that there is a high probability of this correlation being confirmed. When the non-correlation hypothesis is refuted, it is preferable to use the fixed-effect model. To this end, the Hausman Test (1978) enables us to decide whether to use the fixed-effect or random-effect model.

Table 4: Correlation test

	account	*saving*	*borrowed*	*digitalpay*	*mmoney*	*mobilepen*	*user_int*
account	1.0000						
saving	0.5101	1.0000					
borrowed	0.3037	0.6748	1.0000				
digitalpay	0.9060	0.5681	0.4576	1.0000			
mmoney	0.5674	0.5282	0.5347	0.7535	1.0000		
mobilepen	0.5306	0.2140	0.1105	0.4418	0.1543	1.0000	
user_int	0.5128	0.0367	-0.0429	0.4550	0.0796	0.6526	1.0000

Table 4 shows a significant correlation between the digitalization variables. There is therefore a risk of endogeneity in the estimation of the model. Consequently, we cannot measure the impact of financial digitalization by simultaneously including the digitalization variables. First, we estimated models 1, 2, and 3 presented above, respectively, by

individually taking account of the variables *mmoney*, *mobilepen*, *userint*, and *digitalpay*. We then used the instrumental variables method to solve the problem of double causality between the explained variable and the independent variable in the estimation of model 1:

— To measure the impact of mobile money on the opening of accounts, we used the regulation of money usage and access to electricity as instruments. Indeed, these variables are strongly correlated with mobile money usage but not with account opening.

— As for the impact of digital payments on the opening of bank accounts, we used access to electricity and Internet usage as instruments.

III.3. Estimates

We can now present the main empirical results of the models. The tables below list the empirical results and marginal effects of different digitalization variables on financial inclusion. The following control variables were used: urbanization rate, per capita GDP, population density, human development index, number of commercial bank branches per country, number of ATMs, interest rate, and inflation.

III.3.1 Digitalization and bank-account penetration

Since its launch in 2017, mobile money usage has been booming in Africa, making the continent the world's leading player in this field. Mobile money has taken the place of traditional banks in the financial inclusion process. *Table 5* shows the results of the OLS estimate (columns 1, 2, 3, and 4) and the fixed-effect model (columns 5, 6, 7, and 8), in addition to the respective impacts of mobile money, mobile payments, penetration rates, and Internet usage rates on the opening of bank accounts.

Table 5 shows that the standard financial inclusion variables such as unemployment, MTA and GDP/h are significant. The unemployment rate has a statistically negative and significant sign in relation to the bank-account ownership rate. Unemployment is an important determinant of income deprivation and poverty. Finally, the availability of ATMs and the urbanization rate have significant positive effects on the opening of bank accounts. These results are consistent with the findings of previous studies (Andrianaivo & Kpodar 2012a, Demirgüç-Kunt & Klapper 2012, Leonard 2020, Zins & Weill 2016), which show that people report not having accounts because they are unnecessary if they are poor and lack income.

Our variables of interest, including mobile money, digital payments, and cellular mobile penetration are positive and significant with OLS estimation (Assadi & Cudi 2011, Donovan 2012, Mbiti & Weil 2015). Internet usage is insignificant with OLS estimation (column 4) but becomes positive and significant with the fixed-effect model (column 8). Similarly, mobile money and digital payments remain positive and significant in relation to bank-

Table 5: Digitalization and bank-account penetration with OLS and Fixed Effect

	OLS estimates				FE estimates			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mmoney	0.7879***				0.6825***			
	(0.0660)				(0.0741)			
unemploy	0.2390	0.0578	-0.4434*	-0.3425	-1.7651***	-0.8829	-2.2520***	-2.2639***
	(0.1860)	(0.1228)	(0.2522)	(0.2567)	(0.5839)	(0.5430)	(0.8130)	(0.7954)
atm	0.2300***	-0.0707	0.2911**	0.2689**	0.5612**	0.2074	0.6691*	0.3145
	(0.0805)	(0.0570)	(0.1117)	(0.1222)	(0.2676)	(0.2460)	(0.3785)	(0.3954)
unpop	0.0361	0.0012	-0.2682**	-0.2686**	2.0842***	1.8056***	3.9501***	3.5427***
	(0.0781)	(0.0515)	(0.1032)	(0.1068)	(0.5501)	(0.5036)	(0.7205)	(0.7357)
pibh	0.0000**	0.0000**	0.0000***	0.0000***	-0.0000	-0.0000*	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
hdi	66.3598***	44.2150***	88.7860***	113.5416***	12.2887	-25.7092	47.5068	36.3716
	(15.6580)	(10.7233)	(23.6608)	(23.0190)	(33.3981)	(30.9995)	(51.0846)	(47.0257)
digitalpay		0.9230***				0.7516***		
		(0.0425)				(0.0682)		
mobilepen			0.1486***				0.0508	
			(0.0503)				(0.0669)	
user_int				0.1291				0.2573**
				(0.1277)				(0.1239)
R^2	0.740	0.881	0.498	0.470	0.838	0.867	0.685	0.697
Observations	144	144	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

account penetration. However, cellular mobile penetration becomes insignificant according to the fixed-effect model. Instrumental variables and the time fixed effect model were respectively used to consider the problem of endogeneity and time effects.

Table 6 takes account of endogeneity (columns 1 and 2) and the time fixed effect (columns 3, 4, 5 and 6). Estimates with instrumental variables show more robust results. The mobile money and digital payment variables have a positive and significant impact on the opening of bank accounts. The advantages offered by the latter significantly influence access to financial services.

Cellular mobile subscriptions do not have a significant effect (column 5) on bank account penetration, despite the levels of subscription being among the highest in the world. This statistical non-significance is explained by the gap that exists between the acquisition of a telephone and access to a financial service such as the sending or receiving of money, especially for illiterate, rural households that see the telephone as a means of communication only.

The estimate of individual Internet usage (column 6) shows no significant impact with the fixed-effect model and when we the time fixed effect is taken into account. Although

Table 6: Digitalization and bank-account penetration with Instrumental Variables and Time Fixed Effect

	IV estimates		Time FE estimates			
	(1)	(2)	(3)	(4)	(5)	(6)
mmoney	0.7590***		0.6556***			
	(0.2498)		(0.0727)			
unemploy	-1.7070***	-0.9309				
	(0.5911)	(0.6458)				
atm	0.5542**	0.2216				
	(0.2587)	(0.2617)				
unpop	1.8639**	1.8826**				
	(0.8696)	(0.7801)				
pibh	-0.0000	-0.0000				
	(0.0000)	(0.0000)				
hdi	6.4499	-22.6203				
	(36.9972)	(38.5707)				
inflation	-0.0433	-0.0479				
	(0.0621)	(0.0560)				
density	0.0708	0.0446				
	(0.0643)	(0.0623)				
digitalpay		0.7259***		0.7672***		
		(0.2154)		(0.0804)		
t=2011			0.0000	0.0000	0.0000	0.0000
			(.)	(.)	(.)	(.)
t=2014			5.8215***	2.4395**	8.0109***	7.5244***
			(1.0326)	(1.1575)	(1.7315)	(1.5456)
t=2017			10.3846***	4.3748**	18.5504***	16.7304***
			(1.3945)	(1.8331)	(1.8437)	(2.2234)
mobilepen					0.0376	
					(0.0638)	
user_int						0.1656
						(0.1150)
Constant			17.4234***	10.3500***	17.8711***	18.6423***
			(0.7642)	(1.2410)	(4.1910)	(1.4751)
R^2	0.837	0.866	0.834	0.843	0.690	0.696
Observations	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the Internet is developing rapidly in Africa, its usage remains low at the continental level. World Bank figures show that fewer than 100 Internet servers per million inhabitants are accessible on the continent. Some countries such as Niger, Chad and Ethiopia have fewer than one server per million inhabitants.

III.3.2. Digitalization and access to credit

Access to finance is a major challenge for public and development policies in Africa. The OLS estimation and the fixed-effect model *(see Table 7)* show that mobile money, digital payments and cellular mobile penetration have positive and significant impacts on access to credit (columns 1, 2 and 3). Individual Internet usage has no significant impact (column 6). With the fixed-effect model, only digital payments remain positive and significant. According to Zins & Weill (2016), the barriers to bank-account penetration in Africa are mainly cost, lack of the necessary administrative documentation, and access to branches. Financial digitalization helps to overcome these obstacles, and mobile money alone solves the problems of access, cost and administrative procedures. Furthermore, according to Findex data (2017), most credit is not granted by the formal sector but rather by families and villages. Mobile money thus acts as a bridge between formal and informal credit.

The interest rate has a significant impact on credit. The interest rate does not increase in accordance with the law of supply and demand. An increase in the interest rate increases the supply of credit but does not discourage applicants. The lack of available credit on the continent gives them no choice but to withdraw from the market. This explains the positive sign of the interest rate. Similarly, the urbanization rate has a negative and significant effect on credit, which is explained by the low supply of credit. Indeed, the growth of the population and the accompanying increase in the number of credit applicants reduces the availability of credit.

When the time fixed effect *(see Table 8)* is considered, none of our digitalization variables are significant. Indeed, credit is not the main offering associated with mobile money usage. It is primarily a P2P money transfer network in Africa. Cellular mobile penetration and individual Internet usage do not have a significant impact on credit. The acceleration of cellular mobile penetration in Africa is driven by the working classes and rural areas where women are also the most disadvantaged in terms of the supply of credit due to the access conditions. However, the digitalization of financial services also reduces and streamlines the administrative procedures for accessing credit. The statistical significance of digital payments is therefore explained by the fact that the digitalization of corporate financial transactions reduces information asymmetry and the lack of transparency that characterize the relationship between customers and financial institutions.

III.3.3. Digitalization and access to savings

According to Global Findex data (2017), fewer than 20% of Africans hold a bank account in traditional institutions, which is a barrier to domestic savings mobilization. The OLS

Table 7: Digitalization and access to credit with OLS and Fixed Effect

	OLS estimates				FE estimates			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mmoney	0.4280***				0.0080			
	(0.0762)				(0.1153)			
unemploy	0.3447*	0.0984	-0.0136	0.1107	-1.2565	-0.8330	-1.2165	-0.0814
	(0.1946)	(0.1889)	(0.2032)	(0.2124)	(0.9312)	(0.9361)	(0.9170)	(0.2986)
branche_cb	-0.0241	-0.0905	-0.2426	-0.2620	0.0689	0.1847	0.0996	-0.1713
	(0.1820)	(0.1784)	(0.1872)	(0.2128)	(0.5203)	(0.5015)	(0.5069)	(0.2722)
unpop	-0.2879***	-0.3276***	-0.4655***	-0.4597***	0.4104	-0.2173	0.3731	-0.4331***
	(0.0895)	(0.0866)	(0.0888)	(0.0941)	(0.7905)	(0.7954)	(0.7141)	(0.1406)
interest	0.1852**	0.1770*	0.1951*	0.1555	0.1752	0.1938*	0.1770*	0.1791*
	(0.0934)	(0.0926)	(0.0988)	(0.1037)	(0.1057)	(0.1034)	(0.1043)	(0.0919)
pibh	0.0000	0.0000	0.0000*	0.0000**	0.0000*	0.0000	0.0000*	0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
hdi	16.0957	7.7289	17.0436	55.5360***	-9.7110	-40.2071	-23.2697	53.8821**
	(18.4754)	(18.8579)	(20.6466)	(20.3015)	(49.6726)	(50.5952)	(52.7481)	(27.3417)
inflation	0.0626	0.0233	0.0718	-0.0198	0.0380	0.0544	0.0447	0.0394
	(0.1172)	(0.1157)	(0.1248)	(0.1293)	(0.1242)	(0.1216)	(0.1235)	(0.1105)
density	-0.0097	-0.0231**	-0.0206*	-0.0261**	0.1637*	0.1383	0.1505*	-0.0240
	(0.0108)	(0.0103)	(0.0110)	(0.0115)	(0.0858)	(0.0849)	(0.0874)	(0.0173)
digitalpay		0.3955***				0.1888*		
		(0.0679)				(0.1105)		
mobilepen			0.1679***				0.0460	
			(0.0433)				(0.0708)	
user_int				0.0220				0.0761
				(0.1136)				(0.0903)
Constant	41.4155***	47.2391***	45.0391***	37.2323***	24.3977	61.1766*	30.3869	36.2056***
	(6.1185)	(6.2848)	(6.7438)	(7.4334)	(29.8369)	(31.5018)	(25.2227)	(10.3354)
R^2	0.343	0.352	0.270	0.188	0.174	0.200	0.177	
Observations	144	144	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

estimate *(see Table 9)* shows that mobile money, digital payments, and cellular mobile penetration have a positive and significant impact on savings. Individual Internet usage is not significant for savings (columns 1, 2, 3). According to the estimate produced by the fixed-effect model, only mobile money has a positive and significant impact on savings (column 5). Digital payments, cellular telephones and Internet usage have no significant impact on savings (columns 6, 7, 8).

Similarly, when we take the time fixed effect into account *(see Table 10)*, none of the variables is significant. Digitalization in finance does not enable the broad mobilization of

Table 8: Digitalization and access to credit with Time Fixe Effect

	(1)	(2)	(3)	(4)
mmoney	0.1149			
	(0.1001)			
t=2011	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
t=2014	7.1874***	5.1660***	8.6864***	7.6699***
	(1.4207)	(1.5819)	(1.7483)	(1.5820)
t=2017	2.3601	-2.1227	5.0803***	3.8898*
	(1.9187)	(2.5051)	(1.8616)	(2.2758)
digitalpay		0.3108***		
		(0.1099)		
mobilepen			-0.0586	
			(0.0644)	
user_int				0.0020
				(0.1177)
Constant	41.1798***	37.6582***	45.4275***	41.6598***
	(1.0514)	(1.6960)	(4.2318)	(1.5099)
R^2	0.265	0.314	0.261	0.255
Observations	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

domestic resources. Mobile money is a valuable tool for mobilizing individual savings. However, digital payments and Internet usage have no significant impact on savings mobilization. Although Africa has the world's highest cellular mobile penetration rate, its relationship with household savings is not very significant. It is understandable that communication remains the main reason for acquiring a cellular telephone on the continent. For someone who does not possess a telephone, savings are not a priority when they do acquire one. As for digital payments, the result can be explained by the fact that usage is reserved for purchases, the payment of bills, fund transfers by the government and the payment of taxes to the authorities. Finally, the statistical non-significance of individual Internet usage is explained by the lack of Internet servers in most African countries.

III.3.4. Digitalization and financial inclusion by gender and area of residence

Administrative facilitation through digitalization makes it possible to reach rural populations and women who suffer from the greatest exclusion from the traditional

Table 9: Digitalization and access to savings with OLS and Fixed Effect

	OLS estimates				FE estimates			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mmoney	0.4772***				-0.2752**			
	(0.0818)				(0.1066)			
unemploy	0.1082	-0.1703	-0.2856	-0.1523	-0.8837	-0.4737	-0.4085	-0.4947
	(0.2088)	(0.1886)	(0.2199)	(0.2296)	(0.8607)	(0.9127)	(0.8771)	(0.8765)
branche_cb	-0.2197	-0.2556	-0.4635**	-0.4833**	-0.4281	-0.1215	-0.0682	-0.1607
	(0.1953)	(0.1781)	(0.2026)	(0.2300)	(0.4809)	(0.4889)	(0.4848)	(0.4861)
unpop	0.0042	-0.0082	-0.1934**	-0.1870*	2.0988***	1.2564	1.1809*	1.0480
	(0.0960)	(0.0864)	(0.0961)	(0.1017)	(0.7307)	(0.7755)	(0.6830)	(0.7603)
interest	0.0872	0.0834	0.0964	0.0539	0.0265	0.0654	0.0691	0.0638
	(0.1002)	(0.0925)	(0.1069)	(0.1121)	(0.0977)	(0.1009)	(0.0998)	(0.1000)
pibh	-0.0000	-0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
hdi	7.9491	-13.4030	10.7941	52.0765**	67.2140	35.5131	15.8350	24.2213
	(19.8201)	(18.8249)	(22.3425)	(21.9450)	(45.9116)	(49.3279)	(50.4492)	(49.4223)
inflation	0.0752	0.0417	0.0815	-0.0165	-0.1690	-0.1310	-0.1204	-0.1335
	(0.1257)	(0.1155)	(0.1350)	(0.1398)	(0.1148)	(0.1185)	(0.1181)	(0.1179)
density	0.0097	-0.0045	-0.0026	-0.0086	0.1402*	0.1093	0.0900	0.1102
	(0.0115)	(0.0103)	(0.0119)	(0.0124)	(0.0793)	(0.0828)	(0.0836)	(0.0812)
digitalpay		0.5375***				0.0030		
		(0.0678)				(0.1078)		
mobilepen			0.1797***				0.0641	
			(0.0469)				(0.0677)	
user_int				0.0222				0.0768
				(0.1228)				(0.1203)
Constant	36.3379***	45.4226***	40.0012***	31.6092***	-78.5978***	-31.5091	-21.8698	-17.5981
	(6.5638)	(6.2738)	(7.2977)	(8.0351)	(27.5778)	(30.7126)	(24.1234)	(31.3604)
R^2	0.273	0.380	0.179	0.089	0.290	0.236	0.244	0.239
Observations	144	144	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

financial system. Global Findex (2017) statistics show that there is a significant variation in digitalization and financial inclusion according to one's gender, and whether one resides in an urban or a rural area. To better understand the impact of financial digitalization, we took into account the rural environment and women. According to development statistics in Africa, poverty is rural, and women face the most difficulties in accessing finance. We used data on digital payments and mobile money as a variable of financial digitalization. We then tested the robustness and significance of these variables in relation to bank account penetration.

Table 10: Digitalization and access to savings with Time Fixed Effect

	(1)	(2)	(3)	(4)
mmoney	-0.1055			
	(0.0937)			
t=2011	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
t=2014	9.0664***	7.8766***	8.8934***	7.8342***
	(1.3295)	(1.5363)	(1.6422)	(1.4715)
t=2017	7.7173***	4.5219*	6.6106***	4.5224**
	(1.7955)	(2.4329)	(1.7486)	(2.1168)
digitalpay		0.0906		
		(0.1067)		
mobilepen			-0.0165	
			(0.0605)	
user_int				0.1137
				(0.1095)
Constant	41.9945***	40.3630***	42.5927***	40.4121***
	(0.9839)	(1.6471)	(3.9749)	(1.4044)
R^2	0.353	0.349	0.345	0.352
Observations	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

By considering the place of residence, especially rural households *(see Table 11)*, the OLS estimate, the fixed-effect model, the time fixed effect and endogeneity, mobile money and digital payments are shown to have positive and very significant effects on the main financial inclusion variable, i.e. bank account penetration.

With regard to the control variables, the number of ATMs and the urbanization rate are significant according to both the OLS estimate and the fixed-effect model. Similarly, the estimate for women *(see Table 12)* shows that mobile money and digital payments are positive and highly significant for the opening of bank accounts.

CONCLUSION

Our results are consistent with the literature on financial inclusion (Donner & Tellez 2008, Mago & Chitokwindo 2014, Mbiti & Weil 2015). Digital payments and mobile money

Table 11: Digitalization and financial inclusion by rural

	OLS estimates		FE estimates		IV estimates		Time FE estimates	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mmoney_rural	0.8027***		0.4951***		0.4951***			0.4834***
	(0.0686)		(0.0641)		(0.0613)			(0.0608)
unemploy	0.0839	-0.0730	-1.1888*	-0.3806	-1.1888*	-0.3806		
	(0.1863)	(0.1185)	(0.6770)	(0.6424)	(0.6482)	(0.6150)		
atm	0.3879***	0.1042*	0.6942**	0.3970	0.6942**	0.3970		
	(0.0809)	(0.0547)	(0.3103)	(0.2904)	(0.2971)	(0.2781)		
unpop	-0.0691	0.0563	2.5190***	1.6955***	2.5190***	1.6955***		
	(0.0772)	(0.0510)	(0.6210)	(0.6049)	(0.5946)	(0.5792)		
pibh	0.0000***	0.0000*	0.0000	-0.0000	0.0000	-0.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
hdi	53.3397***	19.6296*	-6.0867	-20.4879	-6.0867	-20.4879		
	(15.6123)	(10.4312)	(38.9297)	(36.3730)	(37.2723)	(34.8245)		
inflation	0.0581	-0.0651	-0.0310	-0.0814	-0.0310	-0.0814		
	(0.0970)	(0.0627)	(0.0746)	(0.0690)	(0.0714)	(0.0660)		
density	0.0333***	0.0303***	0.0493	0.0532	0.0493	0.0532		
	(0.0094)	(0.0060)	(0.0680)	(0.0630)	(0.0651)	(0.0603)		
digitalpay_rural		0.8787***		0.7133***		0.7133***	0.7444***	
		(0.0389)		(0.0782)		(0.0749)	(0.0881)	
t=2011							0.0000	0.0000
							(.)	(.)
t=2014							2.4599*	4.7669***
							(1.2993)	(1.2154)
t=2017							4.9172**	11.1194***
							(1.9607)	(1.4742)
Constant	-14.6041***	-5.9533*	-85.3536***	-53.7820**			9.8806***	16.9396***
	(5.4310)	(3.5628)	(25.0504)	(24.5835)			(1.1452)	(0.8034)
R^2	0.730	0.886	0.785	0.815	0.785	0.815	0.792	0.781
Observations	144	144	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

have a significant and positive impact on financial inclusion. The hypothesis that financial digitalization has a positive influence on bank account penetration is therefore confirmed. However, Africa is lagging a very long way behind the rest of the world in terms of access to Internet servers. In some countries such as Niger and Chad, servers are almost non-existent, which makes it impossible to assess the impact of Internet usage on financial digitalization and on access to credit and household savings. The hypothesis of financial digitalization having a significant impact on access to credit is partially confirmed. Similarly, the hypothesis that financial digitalization positively promotes mobilization is partially confirmed.

Table 12: Digitalization and financial inclusion by female

	OLS estimates		FE estimates		IV estimates		Time FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mmoney_female	0.8040***		0.4797***		0.4797***		0.4759***	
	(0.0672)		(0.0597)		(0.0571)		(0.0580)	
unemploy	0.1149	-0.0374	-1.8650***	-0.8418	-1.8650***	-0.8418		
	(0.1753)	(0.1147)	(0.6148)	(0.6011)	(0.5886)	(0.5755)		
atm	0.4323***	0.1240**	0.7012**	0.3501	0.7012***	0.3501		
	(0.0765)	(0.0537)	(0.2825)	(0.2721)	(0.2704)	(0.2605)		
unpop	-0.0663	0.0165	1.7222***	1.0849*	1.7222***	1.0849**		
	(0.0728)	(0.0489)	(0.5617)	(0.5532)	(0.5378)	(0.5297)		
pibh	0.0000***	0.0000*	0.0000	-0.0000	0.0000	-0.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
hdi	43.5341***	18.7298*	6.4445	-0.3043	6.4445	-0.3043		
	(14.7428)	(10.0095)	(35.3355)	(33.5298)	(33.8312)	(32.1023)		
inflation	0.0508	-0.0811	-0.0294	-0.0733	-0.0294	-0.0733		
	(0.0916)	(0.0609)	(0.0677)	(0.0639)	(0.0648)	(0.0612)		
density	0.0309***	0.0299***	0.0655	0.0349	0.0655	0.0349		
	(0.0089)	(0.0059)	(0.0616)	(0.0587)	(0.0590)	(0.0562)		
digitalpay_female		0.8751***		0.7133***		0.7133***		0.7550***
		(0.0395)		(0.0787)		(0.0753)		(0.0823)
t=2011							0.0000	0.0000
							(.)	(.)
t=2014							4.3878***	2.2859*
							(1.1264)	(1.1609)
t=2017							9.6469***	3.8957**
							(1.3573)	(1.7164)
Constant	-10.4838**	-4.3054	-54.3810**	-32.7146			17.0247***	9.7957***
	(5.1368)	(3.4474)	(22.5272)	(22.2183)			(0.7463)	(1.0613)
R^2	0.743	0.886	0.787	0.809	0.787	0.809	0.773	0.795
Observations	144	144	144	144	144	144	144	144

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

At the country level, financial inclusion is shown to be the main gateway toward inclusive and balanced economic development (Kodan & Chhikara 2013). The ineffectiveness of economic development policies over the past few years can be largely explained part by this exclusion of the population from participating in wealth creation. This is probably the main source of income inequality. To remedy this situation and bridge the gap, technological innovation and financial digitalization are effective tools for development actors. Significant investments must be made in financial inclusion, particularly in terms of access to credit. Firstly, a simple process for granting credit and financing micro-projects for women, young people and rural populations needs to be developed and

incorporated into the operation of mobile money services or the mobile services proposed by traditional banks. Secondly, to overcome the physical and administrative barriers to financial inclusion, governments should connect populations by accelerating the rollout of fiber-optic Internet connections and Internet servers, which have previously been limited to the large cities. Operators must also adapt to digitalization and simplify access procedures while reducing access times for businesses. It should be noted that the virtual monopoly enjoyed by cellular telephone operators in most African countries does nothing to improve the quality of service or reduce transaction costs. In French-speaking Africa, for example, the mobile money market is largely dominated by the operator Orange. As part of our study, we were able to conduct surveys of mobile money customers and some mobile money agencies (in Burkina Faso, Senegal, Mali and Togo). It was found that the closed API (Application Programming Interface), which is controlled solely by the operator, is a major barrier to the adoption of mobile money and digital payments. The API is solely reserved for formal enterprises on a continent in which more than 60% of business sectors are informal. Even for formal companies, the procedures are still very lengthy with many conditions needing to be met. The failure to include SMEs in financial digitalization reduces the scope of the use of digital accounts and does not encourage new entrants to subscribe. The lack of financial digitalization in SMEs in Africa is an obstacle to e-commerce on the continent. Finally, given the role of digitalization in facilitating procedures, there are potential links between digitalization and access to credit for businesses in Africa. Digitalization could also promote trade in Africa, which is confronted with the inadequacy of infrastructure.

Notes

1. M-PESA is a mobile money transfer and finance system, launched for the first time in Africa (Kenya) by Vodafone for the operator Safaricom and Vodacom. The name M-PESA literally means “mobile money” (M for mobile and Pesa for money in Swahili). It is now used in many countries worldwide.
2. West African Economic and Monetary Union (WAEMU).
3. Central Bank of West African States (BCEAO).
4. Benin, Burkina Faso, Burundi, Cameroon, Ivory Cost, Guinea, Madagascar, Mali, Senegal, Democratic Republic of Congo, Congo, Sierra Leone and Rwanda.
5. FinAfrique is a consulting firm with three offices (Paris, Abidjan and Douala), whose objective is to assist governments and financial institutions in Africa with financial development.
6. P2P refers to a person-to-person transfer. G2P refers to a government-to-person transfer.
7. In 2012, 20% of the funds raised by the “Kenyans for Kenya Famine Relief” initiative were mobilized through the M-PESA channel, corresponding to approximately US$8.5 million.
8. In Andrianaivo & Kpodar (2012a), the financial inclusion variables are represented by the number of deposits and loans per capita.

References

Abessolo, Y.A. (2019). ‘Institutions et inclusion financière dans la CEMAC’, *Finance & Finance Internationale*, (15), p. 19.

Abor, J.Y., Amidu, M. and Issahaku, H. (2018). 'Mobile Telephony, Financial Inclusion and Inclusive Growth', *Journal of African Business*, 19(3), pp. 430–453. doi:10.1080/15228916.2017.1419332.

Acemoglu, D. and Zilibotti, F. (1997). 'Was Prometheus Unbound by Chance? Risk, Diversification, and Growth', *Journal of Political Economy*, 105(4), pp. 709–751. doi:10.1086/262091.

Acquah-Sam, E. and Bugre, D. (2018). 'Effects of Mobile Money on Beige Bank, Ghana', *European Scientific Journal*, 14(3), pp. 29–57.

ADA (2019). *Rapport d'activité 2018*. Rapport interne. Luxembourg: ADA, p. 20.

Aglionby, J. (2016). 'Tanzania's fintech and mobile money transform business practice', *Financial Times*, 12.

Allen, F. *et al*. (2014). 'The African Financial Development and Financial Inclusion Gaps', *Journal of African Economies*, 23(5), pp. 614–642. doi:10.1093/jae/eju015.

Amidži, G., Massara, M.A. and Mialou, A. (2014). Assessing Countries' Financial Inclusion Standing - A New Composite Index. *International Monetary Fund*.

Andrianaivo, M. and Kpodar, K. (2012a). *ICT, Financial Inclusion, and Growth: Evidence from African Countries*. (IMF Working Papers, 11).

Andrianaivo, M. and Kpodar, K. (2012b). 'Mobile phones, financial inclusion, and growth', *Review of Economics and Institutions*, 3(2), p. 30.

Asongu, S.A. and Odhiambo, N.M. (2018). 'ICT, financial access and gender inclusion in the formal economic sector: evidence from Africa', *African Finance Journal*, 20(2), pp. 45–65.

Asongu, S.A. and Odhiambo, N.M. (2019). 'Mobile banking usage, quality of growth, inequality and poverty in developing countries', *Information Development*, 35(2), pp. 303–318.

Assadi, D. and Cudi, A. (2011). 'Le potentiel d'inclusion financière du "Mobile Banking". Une étude exploratoire', *Management Avenir*, 46(6), pp. 227–243.

Aterido, R., Beck, T. and Iacovone, L. (2013). 'Access to Finance in Sub-Saharan Africa: Is There a Gender Gap?', *World Development*, 47, pp. 102–120.

Babajide, A.A., Adegboye, F.B. and Omankhanlen, A.E. (2015). 'Financial Inclusion and Economic Growth in Nigeria', *International Journal of Economics and Financial Issues*, 5(3), pp. 629–637.

Baltagi, B. (2008). *Econometric analysis of panel data*. Third edition. Chichester: John Wiley & Sons.

BCEAO (2018). *Rapport annuel sur la situation de l'inclusion financière dans l'UEMOA, au cours de l'année 2017*. Dakar : BCEAO, p. 29.

BCEAO (2019). *Rapport annuel sur l'inclusion financière dans l'UEMOA au cours de l'année 2018*. Dakar, p. 29.

BEI (2017). *Le secteur bancaire en Afrique subsaharienne Rapport intérimaire sur l'inclusion financière numérique*. EIB Africa day 2017. Berlin: Banque Européenne d'Investissement, p. 28.

Bruhn, M. and Love, I. (2014). 'The Real Impact of Improved Access to Finance: Evidence from Mexico', *The Journal of Finance*, 69(3), pp. 1347–1376.

Buku, M.W. and Meredith, M.W. (2013). 'Safaricom and M-PESA in Kenya: Financial Inclusion and Financial Integrity', *Washington Journal of Law, Technology & Arts*, 8(11), p. 375.

Chakroun, F. and Huet, J.-M. (2018). 'Le digital Banking en Afrique'. BearingPoint.

Chibba, M. (2009). 'Financial inclusion, poverty reduction and the millennium development goals', *The European Journal of Development Research*, 21(2), pp. 213–230.

Cook, T. and McKay, C. (2015). *How M-Shwari works: The story so far*. Access to Finance FORUM. CGAP and Its Partners, p. 24.

Degryse, C. (2016). 'Digitalisation of the economy and its impact on labour markets', *ETUI research paper-working paper*, p. 81.

Deloitte (2018). *TMT Predictions Afrique 2018 L'avenir est ici*. Rapport interne. Deloitte SAS, p. 24.

Demirguc-Kunt, A. *et al*. (2018). *The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution*. The World Bank (The Global Findex database 2017).

Demirguc-Kunt, A. and Klapper, L. (2012). *Measuring Financial Inclusion: The Global Findex Database*. Washington, DC.: The World Bank (Policy Research Working Papers). doi:10.1596/1813-9450-6025.

Demirgüç-Kunt, A.K., Leora (2012). *Financial Inclusion in Africa: An Overview*. Washington, DC.: The World Bank (Policy Research Working Papers, 6088). doi:10.1596/1813-9450-6088.

Demombynes, G. and Thegeya, A. (2012). *Kenya's Mobile Revolution and the Promise of Mobile Savings*. World Bank. The World Bank (Policy Research Working Papers). doi:10.1596/1813-9450-5988.

Donovan, K. (2012). 'Mobile money for financial inclusion', *Information and Communications for development*, 61(1), pp. 61–73.

Easterly, W. and Levine, R. (1997). 'Africa's growth tragedy: policies and ethnic divisions', *The quarterly journal of economics*, 112(4), pp. 1203–1250.

Franklin. *et al*. (2012). *The foundations of financial inclusion: Understanding ownership and use of formal accounts*. The World Bank.

Estrada, G.B., Park, D. and Ramayandi, A. (2010). 'Financial development and economic growth in developing Asia', *Asian Development Bank Economics Working Paper*, (233), p. 63.

Etim, A.S. (2014). 'Mobile banking and mobile money adoption for financial inclusion', *Research in Business and Economics Journal*, 9, p. 1.

Evans, O. (2015). 'The effects of economic and financial development on financial inclusion in Africa', *Review of Economic and Development Studies*, 1(1), pp. 17–25.

Evans, O. (2016). 'The effectiveness of monetary policy in Africa: modeling the impact of financial inclusion', *Iranian Economic Review*, 20(3), pp. 327–337.

Evans, O. (2018). 'Connecting the poor: the internet, mobile phones and financial inclusion in Africa', *Digital Policy, Regulation and Governance*, 20(6), pp. 568–581.

Fanta, A.B. and Makina, D. (2019). 'The Relationship Between Technology and Financial Inclusion: Cross-Sectional Evidence', in Makina, D. (ed.) *Extending Financial Inclusion in Africa*. Academic Press, pp. 211–230. doi:10.1016/B978-0-12-814164-9.00010-4.

FinAfrique (2019). 'État des lieux chiffré de la digitalisation des services à la clientèle dans la banque et l'assurance/ : Focus sur 21 pays d'Afrique Subsaharienne'.

Francis, E., Blumenstock, J. and Robinson, J. (2017). 'Digital credit: A snapshot of the current landscape and open research questions', *CEGA White Paper*, pp. 1739–1776.

Furusawa, M. (2016). 'Financial Inclusion: Bridging Economic Opportunities and Outcomes.'

Gebrehiwot, K.G. and Makina, D. (2019). 'Macroeconomic Determinants of Financial Inclusion: Evidence Using Dynamic Panel Data Analysis', in Makina, D. (ed.) *Extending Financial Inclusion in Africa*. Academic Press, pp. 167–191. doi:10.1016/B978-0-12-814164-9.00008-6.

GSMA (2018a). *2017 State of the Industry Report on Mobile Money*. London: GSMA.

GSMA (2018b). *L'économie mobile/ : L'Afrique de l'Ouest*. London: GSMA, p. 36.

GSMA (2019). *L'économie mobile Afrique Subsaharienne*. London, p. 42.

Guérineau, S. and Jacolin, L. (2014). 'L'inclusion financière en Afrique subsaharienne/ : faits stylisés et déterminants', *Revue d'economie financiere*, 116(4), pp. 57–80.

Hausman, J.A. (1978). 'Specification Tests in Econometrics', *Econometrica*, 46(6), pp. 1251–1271. doi:10.2307/1913827.

Jack, W. *et al*. (2016). *Borrowing Requirements, Credit Access, and Adverse Selection: Evidence from Kenya*. w22686. Massachusetts: National Bureau of Economic Research, p. 80. doi:10.3386/w22686.

Jack, W. and Suri, T. (2014). 'Risk Sharing and Transactions Costs: Evidence from Kenya's Mobile Money Revolution', *American Economic Review*, 104(1), pp. 183–223. doi:10.1257/aer.104.1.183.

Kablana, A.S.K. and Chhikara, K.S. (2013). 'A Theoretical and Quantitative Analysis of Financial Inclusion and Economic Growth', *Management and Labour Studies*, 38(1–2), pp. 103–133. doi:10.1177/0258042X13498009.

Kempson, E. and Whyley, C. (1999). 'Kept out or opted out Understanding and combating financial exclusion', *Policy Press, London*, p. 56.

Kendall, J., Ponce, A. and Mylenko, N. (2010). *Measuring Financial Access Around The World*. The World Bank (Policy Research Working Papers). doi:10.1596/1813-9450-5253.

Kim, D.-W., Yu, J.-S. and Hassan, M.K. (2018). 'Financial inclusion and economic growth in OIC countries', *Research in International Business and Finance*, 43, pp. 1–14. doi:10.1016/j.ribaf.2017.07.178.

Klapper, L. and Singer, D. (2015). 'The Role of Informal Financial Services in Africa†', *Journal of African Economies*, 24(suppl_1), pp. i12–i31. doi:10.1093/jae/eju027.

Kone, R.M. (2019). *Accélérer l'inclusion financière dans les pays africains: Nouvelles approches des stratégies d'inclusion financière*. Éditions EMS.

Kpodar, K. (2005). 'Le Développement Financier et la Croissance: L'Afrique Subsaharienne est-elle Marginalisée?', *African Development Review*, 17(1), pp. 106–137.

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), pp. 285–320. doi:10.1093/jafeco/ejx028.

Leonard, N.S. (2020). 'Theme/ : Inclusion Financiere:Verification Empirique Aupres Des Menages Au Congo-Brazzaville', *Global Journal of Management And Business Research*, 20(1–C), p. 13.

Levine, R. (1997). 'Financial Development and Economic Growth: Views and Agenda', *Journal of Economic Literature*, 35(2), pp. 688–726.

Li, Y. *et al*. (2020). *La transformation numérique en Afrique subsaharienne*. Perspectives Economiques régionales/ : Afrique subsaharienne. Washington, DC.: FMI, p. 22.

Mago, S. and Chitokwindo, S. (2014). 'The Impact of Mobile Banking on Financial Inclusion In Zimbabwe: A Case for Masvingo Province', *Mediterranean Journal of Social Sciences*, 5(9), p. 221.

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*, 103(3), pp. 369–374. doi:10.1257/aer.103.3.369.

Mbiti, I. and Weil, D.N. (2015). 'Mobile banking: The impact of M-Pesa in Kenya', in *African Successes, Volume III: Modernization and Development*. University of Chicago Press, pp. 247–293.

Mdoe, I.J. and Kinyanjui, G.K. (2018). 'Mobile telephony, social networks and credit access: Evidence from MSMEs in Kenya', *Cogent Economics & Finance*, 6(1), p. 1459339.

Mehrotra, A.N. and Yetman, J. (2015). 'Financial inclusion-Issues for Central Banks', *BIS Quarterly Review March*, p. 14.

Migap, J.P., Okwanya, I. and Ojeka, G. (2015). 'Financial inclusion for inclusive growth: The Nigerian perspective', *International Journal of Information Technology and Business Management*, 37(1), pp. 1–8.

Morawczynski, O. (2009) 'Exploring the usage and impact of "transformational" mobile financial services: the case of M-PESA in Kenya', *Journal of Eastern African Studies*, 3(3), pp. 509–525. doi:10.1080/17531050903273768.

Mundlak, Y. (1978). 'On the Pooling of Time Series and Cross Section Data', *Econometrica*, 46(1), pp. 69–85. doi:10.2307/1913646.

Mvogo, G. (2020). 'Effet de l'innovation financière sur la stabilité de la demande de monnaie: une évidence en Afrique subsaharienne', *Revue Marocaine d'Economie*, (3), pp. 60–80.

Naceur, S.B., Barajas, A. and Massara, A. (2017). 'Can Islamic banking increase financial inclusion?', *Handbook of Empirical Research on Islam and Economic Life*, pp. 213–252.

Ngono, J.F.L. (2020). 'L'Indice d'inclusion financière à l'heure du mobile money', *Journal of Academic Finance*, 11(1), pp. 33–44.

Oji, C.K. (2015). 'Promoting financial inclusion for inclusive growth in Africa', *Occasional Paper*, 210, p. 18.

Olaka, H. and Osoro, J. (2015). 'Banking in East Africa–formal integration following cross-border expansion', *Recent Trends in Banking in sub-Saharan Africa*, p. 55.

Oluwatayo, I.B. and Oluwatayo, T.B. (2012). 'Small ruminants as a source of financial security: a case study of women in rural Southwest Nigeria', *Institute for Money, Technology and Financial Inclusion (IMTFI), Working Paper*, 1, p. 21.

Ouma, S.A., Odongo, T.M. and Were, M. (2017). 'Mobile financial services and financial inclusion: Is it a boon for savings mobilization?', *Review of Development Finance*, 7(1), pp. 29–35. doi:10.1016/j.rdf.2017.01.001.

Perlman, L. (2018). *An Introduction to Digital Financial Services (DFS)*. SSRN Scholarly Paper ID 3370667. Rochester, NY: Social Science Research Network, p. 40. doi:10.2139/ssrn.3370667.

Perlman, L. and Wechsler, M. (2019). *Mobile Coverage and its Impact on Digital Financial Services*. SSRN Scholarly Paper ID 3370669. Rochester: Social Science Research Network, p. 95. doi:10.2139/ssrn.3370669.

Postel-Vinay, K. (2011). 'Thématiques des sommets du G20, de 2008 à 2011', *Nouveaux Debats*, pp. 159–159.

Robert, T.S. (2019). 'L'inclusion Financiere Et Le Paiement Mobile En Zone CEMAC', *European Scientific Journal*, 15(7), pp. 101–120.

Sarma, M. and Pais, J. (2011). 'Financial Inclusion and Development', *Journal of International Development*, 23(5), pp. 613–628. doi:https://doi.org/10.1002/jid.1698.

Shirono, K., Chhabra, E. and Das, B. (2018). *Mobile Money Note 2019*. Satistics. Washington, DC.: IMF, p. 8.

Suri, T., Jack, W. and Stoker, T.M. (2012). 'Documenting the birth of a financial economy', *Proceedings of the National Academy of Sciences*, 109(26), pp. 10257–10262. doi:10.1073/pnas.1115843109.

Triki, T. and Faye, I. (2013). 'Financial inclusion in Africa', *African Development Bank*, p. 146.

YAH, N.C. and Chamberlain, M.N.E. (2018). 'Determinants of Inclusive Financial Development in Africa', *Journal of Economics*, 6(3), pp. 36–46.

Zins, A. and Weill, L. (2016). 'The determinants of financial inclusion in Africa', *Review of Development Finance*, 6(1), pp. 46–57.

