SSRG International Journal of Economics and Management Studies
ISSN: 2393 – 9125 / https://doi.org/10.14445/23939125/IJEMS-V7I9P106

Volume 7 Issue 9, 48-55, September 2020

Original Article

Determinants of ICT Adoption in the Financial Sector in Subsaharan Africa

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Received Date: 29 July 2020
Revised Date: 11 September 2020
Accepted Date: 17 September 2020

Abstract *- This paper seeks to capture the determinants of ICT adoption in the financial sector. Estimating the client ICT adoption model using the fixed effect estimator reveals that people's access to electricity and school education influence ICT adoption by SSA populations. For ICT adoption by financial institutions, we used a simultaneous equation model. For the estimation of this model, we used two estimation techniques. These are the 3SLS and SURE estimators. The consistent results of these two estimators highlight the determinant effect of the adoption of ICT by clients on the adoption of these technologies by financial institutions. This positive effect of individual adoption of ICTs is even reinforced by people's access to electricity and education. Similarly, ICTs are an important tool for large banks to increase their market power and improve their efficiency in delivering clients' financial services.*

Keywords *- ICT, adoption, banks, financial sector.*

I. INTRODUCTION

In the financial field, growth and development are accompanied by financial globalization. The decompartmentalization of activities in connection with a profound deregulation process has allowed the emergence of banking activity on a global scale. With this globalization, banks are becoming multinational and operate in various countries. Technological advances facilitate the efficient management of large databases of banking information from various countries, allowing for better services and effective management of risk due to geographical and demographic disparities.

In Sub-Saharan Africa (SSA), recent years have been marked by an interruption in the process of financial deepening. Although significant progress has been made since 2011 in terms of access to financial services in SSA, a large part of the population still does not benefit from banking services (EIB, 2018). In 2017, it was estimated that 43% of the adult population had an account[1]compared to only 23% in 2011 (Global Findex, 2018). This rapid change is due, in part, to the rapid penetration of mobile payment services.

The extension of telecommunication operators' services in the most remote localities has made it possible to popularize the means of communication in sub-Saharan Africa. These tools are used to carry out financial operations. Some African countries, such as Kenya, Tanzania, and Uganda, have already had positive experiences with M-Banking. Also, sub-Saharan Africa is the world leader in mobile money accounts, where the number of adults with mobile money accounts has increased by ten percentage points in three years, from 24% in 2011 to 34% in 2014 (GSMA). At the end of 2018, 395.7 million mobile money accounts were active in the region, representing almost half of the total mobile money accounts worldwide. Information and Communication Technologies (ICTs) are, therefore, key enablers for the burgeoning financial system in SSA.

From a theoretical point of view, ICTs enable service-based innovations, the sophistication of the financial system's gains in-depth, and the provision of services at a reduced cost. Empirical work that has addressed the issue of ICT integration in the financial sector has found that ICTs play a key role in the delivery of financial services (Chaix, 2013; Assadji and Cudi, 2011). However, in order for the financial sector in SSA to capitalize on the strengths of technological innovations (ICT) for its development, these must be adequately adopted by clients and financial institutions (Couchoro, 2011; Assogba, 2010).

In view of the popularization of ICTs in SSA and their benefits in the provision of financial services, in order to maximize the effect of ICTs on the financial sector, it is important to answer the following fundamental question: What are the determinants of ICT adoption in the supply and demand of financial services in SSA?

The objective of this paper is to capture the macroeconomic determinants of ICT adoption and diffusion in the financial sector. To do so, we use macroeconomic panel data on SSA countries over the period 2004 to 2017. The results of the fixed-effect method estimation of the customer adoption model of ICT show

[1]. Global Findex defines account holding as holding an individual account with a financial institution or through a mobile banking provider

that education and electricity are determinants of ICT adoption. In addition, the results of our3SLS and SURE model estimates show the importance of customer ICT adoption in explaining the adoption of ICT by financial institutions.

The rest of the work is subdivided into 3 sections. In the first section, we review the main theories on the determinants of ICT in the financial sector. The methodology for analyzing the determinants of ICT in SSA's financial sector is outlined in the second section. The final section discusses the analysis and interpretation of the results.

II. A THEORETICAL FRAMEWORK FOR THE ANALYSIS OF ICTS IN FINANCIAL SERVICE DELIVERY

A. ICTs in the banking sector: electronic banking

E-banking is generally defined as the use of electronic means to carry out financial transactions. It is a component of e-commerce that can be defined as exchanging goods and products via electronic transactions carried out on the Internet. E-banking refers to the various services a customer can obtain via ATMs, the Internet, mobile phones, and others without necessarily having physical contact with bank agents. Internet banking and mobile banking (M-banking) are the facets of e-banking on which several studies have focused.

Internetbanking is a banking system that uses the Internet as a distribution channel, in which the provision of banking services to customers is made online by traditional banks or specialized third-party institutions. However, internet banking requires the provision of banking services and the possibility of authentic financial transactions on the web. Sayar and Wolfe (2007) point out that e-banking is more attractive to the customer when it allows banking transactions to be conducted anywhere, faster, and with more flexible fees than those offered in branches. The use of ATMs and magnetic cards addresses the problem of access to liquidity.

Economists generally define M-banking as an M-commerce application that allows customers to access bank accounts through mobile devices to conduct transactions such as checking accounts, transferring money, making payments, or selling reserves. According to Zhou (2012), M-banking is the use of mobile terminals such as mobile phones and personal digital assistants (PDAs) to access the banking network via the wireless application protocol (WAP). Crul et al. (2010) highlight the difference between M-banking and M-payment, arguing that if a bank is not directly involved in the instruments for providing the services offered, it is usually referred to as mobile payment (M-payment). But there is a tendency to think of M-payment as M-banking because of its development in recent years, especially in developing countries. Shaikh and Karjaluoto (2015) instead focus on the characteristics of mobile devices used to perform transactions when they define M-banking as a product or service offered by a bank or microfinance institution (banking model) or other financial providers (non-banking model) allowing financial and non-financial transactions using mobile devices such as mobile phones, smartphones or tablets.

B. The adoption and dissemination of e-banking

The literature on ICT in the financial sector is fundamentally based on two main theories: the theory of diffusion of innovation and the theory of technology adoption.

The diffusion of innovations is a process of transmission of innovation (a new idea or a new product) within a social system. This transmission follows a path from the innovation source to the ultimate "adopters" (Rogers 1962, 1983). According to Robertson (1971), the process of diffusion of innovations is the progressive adoption of a design within a spatial and temporal framework that moves from the producer, who emits the product or service, to the consumer, the ultimate adopter. According to the approach developed by Roger (1995), the rate of adoption of a new technology depends on five characteristics of the innovation: *relative advantage* (the perceived value of the new product compared to the old one); *compatibility (i.e., the* degree of coherence of the innovation with the system in which it will be housed); *complexity (the* degree to which the innovation is understood or rejected); experimentation (the ease with which the innovation can be tested); and, finally, *observation of the impact of the innovation on the* "adopters." A high adoption rate indicates a perfect adoption of the innovation. The stratification of adopters in Roger's (1962, 1983) time approach is based on the speed of adoption of innovations.

Adoption is the continuous and permanent use of an innovation or new product. Thong (1999) distinguishes three phases in the adoption of an innovation: *initiation* (evaluation of product information), *adoption* (decision to adopt the innovation), and *implementation* (highlighting of the innovation). But Roger (1983) was the first to develop the theoretical architecture of the process of individual adoption of a new product and the variables that influence it. This process is in five stages: *knowledge, persuasion, decision, trial or implementation, and confirmation.*

However, it is important to underline the difference between the process of adoption and that of diffusion of innovation. The adoption process is an individual phenomenon that revolves around the adoption of an innovation by an individual, whereas the diffusion process is a social phenomenon that revolves around an innovation diffused within a social system. (Rogers 1962,1983 and Robertson, 1971).

Concerning the factors influencing the adoption and diffusion of innovation, the theoretical framework distinguishes between *individual variables* (age, education, taste, income, etc.), *organizational variables (*size of firm, industry, personnel, etc.), and *structural variables* (types of product/service, social system, competition, etc.).

With specific reference to e-banking, two major groups of work can be distinguished in the literature. The first group analyses the role of socio-economic and cultural factors on the adoption of e-banking. This work analyses the impact of individual, social and environmental characteristics (gender, level of education, age, income level, place of residence, etc.) on the ability and willingness to adopt e-banking. The second group analyses the impact of technological traits on the decision to adopt. This latter work is generally based on the technology acceptance model (Rogers, 1983; Thong, 1999) and Rogers' theory of diffusion of innovation (1995) as their analytical frameworks.

Fall et al. (2015) distinguish three stages in the adoption of e-banking. In the first stage, we know e-banking (M-banking, internet-banking, ATM, or M-payment). At this stage, the individual must know the product and its uses. In the second stage, technology or e-banking is available to test the product. If the product is accessible and its advantages are observable, the individual can finally adopt it in the last stage of the process. While noting the limitations of the mobile money adoption model of Fall et al. (2015), Afawubo et al. (2017) propose a 5-step adoption model highlighting the importance of mobile cellular phone ownership in the mobile money adoption process. Thus, the stages of adoption of M-money are respectively as follows: mobile phone ownership, product knowledge, product testing, account opening, product trust.

III. METHODOLOGY FOR ANALYZING THE DETERMINANTS OF ICTS IN THE FINANCIAL SECTOR IN SSA

ICTs are continuously improving the performance of banks and other financial institutions. In addition, they reduce costs, contribute to innovation and the development of new production processes, and boost competition in the sector. However, for ICTs to make a significant contribution to the development of the financial sector, they would need to be adequately adopted on both the supply and demand side of financial services. Thus, it becomes imperative to identify the factors determining the adoption of ICTs by financial institutions and their clients (population).

A. Econometrics models specifications

A single econometric equation cannot capture the adoption of ICTs by financial institutions. Since it could be influenced by the level of customer adoption, which also depends on several other factors, we opt for a model of simultaneous system equations.

First, the specification of the model of ICT adoption by populations (clients), drawing on the work of Touati (2010) and Chinn and Fairlie (2007), is as follows:

$$ICT_{it} = \alpha + \lambda_1 Elec + \lambda_2 Edu + \lambda_3 Gdp + \lambda_4 Infla + \lambda_5 Trade + \lambda_6 Change + \varepsilon_{it} \quad (1)$$

Where *ICT* represents ICT variables, the ICT variables selected to capture the determinants of ICT adoption by customers of financial institutions are mobile telephony (PSP), Internet (Isp), and fixed telephony (Tel). As a proxy for mobile telephony, we use mobile penetration measured by the number of subscribers out of 100 to a public mobile telephony service. Internet penetration is captured by the number of people per 100 with access to the global Internet. Fixed-line penetration is approximated by the number of telephone lines per 100 inhabitants in a country.

For the selected explanatory variables, we used the GDP per capita growth rate measured by the ratio of GDP per capita to proxy GDP per capita income (Gdp). Access to electricity (Elec) is captured as the rate of access of the population to electrical energy. As a proxy for education (Edu), we used the secondary school enrolment rate. Trade openness (Trade) is captured by the ratio of imports and exports to GDP. To capture inflation (Infla) and the exchange rate (Exchange), we used the GDP deflator and the official exchange rate of national currencies against the U.S. dollar. ε_{it} The disturbance error or error term of individual I at date t.

Thus, we assume that using ICTs as a service delivery channel by financial institutions is a function of the degree of adoption and diffusion of ICTs among populations. As a proxy for the ICTs adopted by financial institutions to deliver services to customers, we use bank ATMs captured by the number of ATMs per 100,000 inhabitants. Following the work of Roller and Waverman (2001), we specify our model:

$$\begin{cases} Atm_{i,t} = \delta + \beta_1 Ict_{i,t} + \beta_2 Inst_{i,t} + \beta_3 Pop_{i,t} + \beta_4 Ide_{i,t} \\ \qquad + \beta_5 Con + Conc + \xi_{i,t} \\ Ict_{i,t} = \alpha + \lambda_1 Elec + \lambda_2 Edu_{i,t} + \lambda_3 Gdp_{i,t} + \lambda_4 Infla_{i,t} \\ \qquad + \lambda_5 Trade_{i,t} + \lambda_6 Change_{i,t} + \varepsilon_{i,t} \end{cases} \quad (2)$$

With:

- *Atm*= ATM penetration. It is captured by the number of ATMs per 100,000 inhabitants; •*Ict*= The three ICT proxies adopted by customers;
- *Inst*= Indicator of institutional quality in the financial sector as measured by financial development as captured by the Financial Freedom Index, which is an overall score on a scale of 0 to 100;
- *Pop* = The number of clients of financial institutions captured by the number of bank deposit accounts per 1000 adults;
- *Ide*= Foreign Direct Investment;
- *Con*= Banking competition index captured by the Lerner and Boone indices
- *Conc*=, the bank concentration index, captured by the assets of the three largest commercial banks as a percentage of total commercial bank assets, and
- ξ = the term for errors.

B. Strategy for estimating macroeconomic ICT adoption models in SSA

Before adopting the appropriate regression for estimating the macroeconomic ICT adoption model by SSA clients, we conduct preliminary tests to find the appropriate estimator. To do so, we disregard unit root tests to check the stationarity of our series. This is due to the small-time dimension of our panel data. Indeed, unit root tests' very validity is questioned in panels with weak time dimensions (Wooldridge, 2010). However, we proceed to the multicollinearity test between independent variables and then to the heteroskedasticity test. To this end, the VIF statistic values of the variables, which are all below the critical value 10, indicate a lack of multicollinearity in the model. On the other hand, the Brush-Pagan test of heteroskedasticity confirms the presence of heteroskedasticity. We also use the Hausman test to choose between the fixed effects model and the random-effects model. The Hausman test probability lower than 10% allowed us to choose the fixed effects model for the estimation of our three respective adoption equations of fixed telephony; mobile telephony and Internet.

When estimating the macroeconomic model of ICT adoption by financial institutions, it is important to take into account simultaneity and endogeneity issues in the estimates. Several estimation methods such as Double Least Squares (2SLS), Generalized Moment Method (GMM), Triple Least Squares (3SLS), and Seemingly Unrelated Regression (SURE) are available to take these problems into account. But according to Holtz-Eakin et al. (1988), the use of triple least squares (3SLS) is an effective way of solving the simultaneity bias.

The basic mechanism of this method (3SLS) consists of simultaneously estimating the system equations. In this sense, the 3SLS is a systemic method in which all system parameters are estimated jointly. It proceeds in three steps: First, estimates each equation using the 2SLS; second, generates the residuals from the results of the first step, then uses them to estimate the link between the hazards of the different equations and finally, applies generalized double least squares to estimate the overall model taking into account the information derived in the second step.

In our specification, we have made a restrictive assumption that clients' adoption of ICTs determines their adoption by institutions. If we let go of this assumption, ambiguity arises in the relationship between the adoption of ICTs by customers and by financial institutions. The SURE method is more appropriate to solve this problem. The SURE estimation procedure consists of applying generalized least squares (GCM) to the system of equations.

We then use two estimation techniques for our estimates. To effectively address endogeneity and simultaneity problems, we use triple least squares (3SLS) in cross-sections applied to an unrolled panel of 30 countries. However, to take into account the likely problem of ambiguity in the relationship between ICT adoption by clients and banks, we use the SURE method.

C. Data sources and description of variables

We basically use data from the World Bank. With the exception of data on financial freedom from the Heritage Foundation (2019) and data on bank concentration and bank competition from Worldwide Governance Indicators (WGI, 2019), data on other variables are from the World Development Indicator (WDI, 2019).

IV. Analysis and interpretation of results

The descriptive statistics of the variables used in this paper are summarized in the appendix tables. We briefly discuss the analysis and interpretation of the results of the model of ICT adoption by clients and the analysis and interpretation of the model of ICT adoption by financial institutions.

A. Results of the ICT adoption model by customers

For each ICT-proxy, we sought to capture the variables that explain its adoption. Thus, using the fixed-effect method, we estimated three equations succinctly. The results of our estimates are summarized in the following table 1:

Table 1. Results of Estimating The Model of ICT Adoption by Clients

VARIABLES	Internet	Téléphone mobile	Téléphone fixe
Elec	**0,560*** **	**1,998*** **	**-0,0317*** **
	(0,0642)	(0,170)	(0,00960)
Lr	**0,346*** **	**1,677*** **	**0,0193** **
	(0,0543)	(0,144)	(0,00812)
Rev	-0,0805	-0,189	0,00751
	(0,0792)	(0,208)	(0,0118)
Infla	-0,0332	**-0,286*** **	0,00183
	(0,0340)	(0,0892)	(0,00505)
Chang	-0,000656	-0,000778	-0,000162
	(0,00120)	(0,00317)	(0,000180)
Trade	**-0,0931*** **	**0,166** **	0,00565
	(0,0253)	(0,0661)	(0,00374)
Constant	**-19,05*** **	**-110,6*** **	**3,837*** **
	(2,988)	(7,883)	(0,446)
Observations	418	420	420
Number of id	39	39	39
R-squared	0,526	0,706	0,042

*Standard errors in parentheses*** p< 0,01; ** p<0,05; p<0,1*

Estimating the three equations shows that the level of education is a key determinant in adopting ICTs by SSA populations. The positive and significant effect at 1% for Internet and mobile telephony and 5% for fixed telephony reflects the need for cognitive skills in technological innovations. Improving the level of education of the population could improve their comfort level in the use of ICTs and thus increase the level of adoption. Therefore, it is important for African countries to prioritize education by increasing the share of the budget allocated to this sector. Furthermore, the digitization of this sector could reduce the significant digital divide that prevails on the continent to take full advantage of the benefits of ICTs, especially in the provision of financial services.

In addition to education, the level of electrification is a determining variable in using ICTs by populations. It is significant at 1% for all three equations. Thus, its positive effect on the Internet and telephony reveals the positive effect of electricity on the adoption of the Internet and mobile telephony. Indeed, mobile phones and all ICT devices such as computers that enable the use of theInternet undeniably require the presence of electricity. These electronic tools use electrical energy for their operation. Improving the access of the population to electric power could contribute enormously to the adoption of ICTs in SSA. In addition, the comparative advantage of African countries in solar energy should be exploited to expand the electrification of the continent. This should encourage the adoption of ICTs, which are likely to be a driver of financial inclusion and growth in SSA. However, the negative sign of the effect of electric power on fixed-line telephone adoption could be explained by the fact that fixed-line telephony is an almost decadent technology increasingly being abandoned in favour of mobile telephony. This could also justify the weak explanation of the fixed telephony model (R^2=0.042).

As for the other control variables, the effect of inflation is only significant on mobile telephony. The results show a negative effect of inflation on mobile phone adoption. The increase in the general price level has the effect of driving up ICT prices and discourages the purchase or adoption of mobile telephony. As for the commercial opening, according to our results, it supports the adoption of mobile telephony while having a negative effect on the Internet. The development of trade with the rest of the world has made it possible to popularize mobile phones, which are nowadays easily accessible at reduced costs. However, as the telecommunications market in SSA is not yet fully liberalized, Internet service providers still have monopoly power over the provision of services and, therefore, influence InternetInternet costs to their advantage. As a result, the high prices of internet services can only discourage the use of this service.

B. Results of the model of ICT adoption by financial institutions

The results of our estimates are summarized in Table 2 below. We used as proxies for customer ICT adoption, fixed-line penetration, mobile penetration, and Internet penetration in equations 1, equation 2, and equation Our results show that customers' adoption of ICT is a key determinant of the adoption of ICT by financial institutions. For example, fixed-line, mobile, and Internet technologies are required at various levels in adopting and diffusion of ATM technology. Fixed-line operators have long been incumbent providers of telecommunication services in most African countries. To this end, they possess most of the telecommunications infrastructure necessary for the expansion of ATM innovation, which cannot operate without an Internet connection. Similarly, banks' provision of financial services to customers through ATMs is coupled with mobile phone notification and messaging services. Thus, fixed telephone, mobile telephone, and internet technologies are needed at various levels in adopting and diffusion of ATM technology. This fully justifies the key role of these technologies, which are spreading among the population, in adopting automated teller machines (ATMs) by banks.

The positive effect of electricity and education on the adoption of ICTs by customers boosts the decisive effect of fixed telephony, mobile telephony, and the Internet on the spread of ATMs. Electricity is also fundamental to the operation of ATMs. Similarly, the use of ATMs by customers requires cognitive skills that are only acquired through school education. Furthermore, the results of our simultaneous equation estimates show a positive effect of trade openness on individual adoption of telephony, fixed-line, mobile telephony, and the Internet. In this logic, the development of trade with the rest of the world reinforces these technologies' positive effects on ATMs' popularization. However, inflation, which has a perverse effect on individual adoption of ICTs, mitigates the positive effect of adopting ICTs by customers on their adoption by financial institutions.

Moreover, banking concentration has a positive effect on the adoption of ICTs by banking institutions. In contrast, the degree of competition in the banking sector and institutional quality and FDI seem not to affect. The strengthening of monopoly power in the banking market encourages large banks to adopt ICTs by increasing investment spending on new technologies to strengthen their hegemony. Furthermore, the positive and significant effect of the banking population on the adoption of ICTs by banking institutions highlights the efficiency of ICTs in improving the delivery of financial services. Banks with a large share of customers have the greatest incentive to adopt ICTs to serve their customers better.

Table 2. Results of The ICT Adoption Model by Financial Institutions

	Equation 1		Equation 2		Equation 3	
Variables	3SLS	SURE	3SLS	SURE	3SLS	SURE
Tel	**1.416*** **	**1.388*** **				
	(0.295)	(0.121)				
Conc	**0.0928*** **	**0.0804*** **	**0.128*** **	**0.132*** **	**0.130*** **	**0.129*** **
	(0.0276)	(0.0235)	(0.0271)	(0.0262)	(0.0259)	(0.0251)
Pop	**0.0167*** **	**0.0146*** **	**0.0183*** **	**0.0229*** **	**0.0183*** **	**0.0180*** **
	(0.00343)	(0.00171)	(0.00143)	(0.00126)	(0.00283)	(0.00179)
Con	-0.419	-1.289	-0.791	-1.105	-0.340	-0.757
	(1.326)	(1.181)	(1.270)	(1.316)	(1.281)	(1.272)
Ide	0.0312	0.0300	0.101	0.176**	0.121	0.152*
	(0.0926)	(0.0743)	(0.0811)	(0.0805)	(0.0799)	(0.0779)
Inst	-0.0332	-0.00631	-0.0284	-0.00314	0.00859	0.0412
	(0.0386)	(0.0347)	(0.0378)	(0.0388)	(0.0394)	(0.0380)
Elec	**0.0597*** **	**0.0639*** **	**0.515*** **	**0.646*** **	**0.231*** **	**0.251*** **
	(0.0131)	(0.0147)	(0.0987)	(0.111)	(0.0287)	(0.0297)
Lr	**0.117*** **	**0.118*** **	**0.667*** **	**0.576*** **	**0.174*** **	**0.157*** **
	(0.0170)	(0.0192)	(0.128)	(0.146)	(0.0364)	(0.0388)
Gdp	-0.0585	-0.0554	-0.645	-0.670	-0.0515	-0.0357
	(0.0654)	(0.0759)	(0.496)	(0.582)	(0.142)	(0.154)
Infla	-0.0305	-0.0303	**-0.667*** **	**-0.897*** **	**-0.138** **	**-0.143** **
	(0.0259)	(0.0302)	(0.202)	(0.232)	(0.0580)	(0.0626)
Change	-0.000245	-0.000214	-0.000840	0.000488	-0.000432	-0.000316
	(0.000163)	(0.000190)	(0.00125)	(0.00146)	(0.000351)	(0.000381)
Trade	**0.0531*** **	**0.0549*** **	**0.183*** **	**0.146** **	**0.0520*** **	**0.0470*** **
	(0.00721)	(0.00765)	(0.0514)	(0.0575)	(0.0148)	(0.0157)
Cel			**0.207*** **	**0.119*** **		
			(0.0229)	(0.0138)		
Isp					**0.561*** **	**0.519*** **
					(0.115)	(0.0618)
Constant	**-5.725***	**-5.295***	**-16.72*** **	**-14.78*** **	**-12.28*** **	**-13.33*** **
	(3.178)	(2.727)	(3.310)	(3.082)	(3.171)	(2.957)
Constant	**-7.738*** **	**-8.119*** **	1.336	4.335	**-9.114*** **	**-8.818*** **
	(0.762)	(0.800)	(5.461)	(6.006)	(1.522)	(1.605)
Observations	207	207	207	207	206	206
R^2	0.802	0.817	0.729	0.800	0.791	0.800
R^2	0.678	0.678	0.575	0.589	0.679	0.684

V. CONCLUSION

In this chapter, the focus has been on capturing ICT determinants in the SSA financial sector. Since this thesis's overall objective is to see the contribution of ICTs to financial inclusion, we start from the premise that for ICTs to influence financial inclusion, they would need to be adequately adopted by clients and financial institutions. With this logic in mind, we have developed two models. The first model allowed us to capture the determinants of ICT adoption by clients. The second model allowed us to identify the determinants of ICT adoption by financial institutions. In this second model, we retained the adoption of ICT by clients as a relevant explanatory variable that could influence their financial institutions' adoption.

Estimating the model of ICT adoption by bank customers using the fixed effect estimator reveals that people's access to electricity and school education influence ICT adoption by SSA populations. To this end, any effective policy to reduce the digital divide should encourage expanding the electricity grid and improved schooling.

For the adoption of ICTs by financial institutions, we used a simultaneous equation model. For the estimation of this model, we used two estimation techniques. These are the 3SLS and SURE estimators. The consistent results of these three estimators highlight the decisive effect of client adoption of ICT on the adoption of ICT by financial institutions. This positive effect of individual ICT adoption is even reinforced by the populations' access to electricity and education. Similarly, ICTs are an important tool for large banks to increase their market power and improve their efficiency in delivering clients' financial services. Intentional quality and FDI do not affect the adoption of ICTs by banks in SSA.

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Appendix

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Tel	420	3.588259	6.933036	0	32.65257
Mpsp	420	52.52867	39.10815	.2084224	176.5751
Isp	419	10.37787	12.56307	.1553345	58.76981
Elec	420	37.04117	25.57446	3.207317	100
Lr	355	43.81001	21.68403	8.7743	99.90385
Rev	420	2.651884	3.530871	-9.442019	28.67596
Infla	420	7.88249	10.04335	-16.76108	100.6265
Change	420	678.8845	1224.333	.8994948	9088.319
Trade	419	77.65121	35.3751	20.72252	225.0231
Atm	355	11.62196	15.98341	0	79.16377
Conc	375	75.55852	18.42614	27.77889	125.3504
Con	359	-.0667163	.2798364	-3.2	1.13
Ide	420	4.151961	5.105598	-6.057209	57.83755
Pop	376	286.1563	418.3715	.4731027	2050.668
Inst	409	45.64792	12.66589	20	70