Connecting the poor: the internet, mobile phones and financial inclusion in Africa

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Abstract

Purpose – *The increased adoption of internet-enabled phones in Africa has caused much speculation and optimism concerning its effects on financial inclusion. Policymakers, the media and various studies have all flaunted the potentials of internet and mobile phones for financial inclusion. An important question therefore is "Can the internet and mobile phones spur the inclusion of the financially excluded poor? This study therefore aims to examine the relationship and causality between internet, mobile phones and financial inclusion in Africa for the 2000-2016 period.*

Design/methodology/approach – *The empirical analysis followed these three steps: examination of the stationarity of the variables; testing for the cointegration; and evaluation of the effects of the internet and mobile phones on financial inclusion in Africa for the 2000-2016 period using three outcomes of panel FMOLS approach and Granger causality tests.*

Findings – *The empirical evidence shows that internet and mobile phones have significant positive relationship with financial inclusion, meaning that rising levels of internet and mobile phones are associated with increased financial inclusion. There is also uni-directional causality from internet and mobile phones to financial inclusion, implying that internet and mobile phones cause financial inclusion. The study also shows that macroeconomic factors such as capital formation, primary enrollment, bank credit, broad money, population growth, remittances, agriculture and interest rate, as well as institutional factors such as regulatory quality are important underlying factors for financial inclusion in Africa.*

Originality/value – *In the literature, there is a dearth of research on the internet, mobile phones and financial inclusion, especially in Africa. Most of the related studies are conceptual and micro-based, with little empirical attention to the relationship and causality between internet, mobile phones and financial inclusion. In fact, this dearth of rigorous empirical studies has been attributed as the main cause of inadequate policy guidance in enhancing information communication technologies (Roycroft and Anantho, 2003), despite saturation levels in developed economies. This study fills the gap by evaluating the effects of the Internet and mobile phones on financial inclusion for 44 African countries for the 2000-2016 period.*

Keywords *Internet, Africa, Financial inclusion, Mobile phones*

Paper type *Research paper*

1. Introduction

Can the internet and mobile phones spur the inclusion of the financially excluded poor? Generally, banking has document requirements and also cost to maintain. In Africa, where more than 33 per cent of the population live in extreme poverty and 36 per cent are illiterates, opening a bank account is hard and not available for a large number of people (World Bank, 2017). However, Africa has recently witnessed growing mobile broadband networks, which has the potential to boost access to a broad spectrum of financial services and to better the lives of individuals across the continent. Anyone can within a few minutes get a prepaid SIM card, and start using mobile broadband and mobile money[1]. This dramatic rise in mobile internet calls for an investigation of its potentials. One facet of such potentials is its ability to spur financial inclusion.

Financial inclusion means that individuals and businesses have access to affordable financial products and services – payments, transactions, savings, credit and insurance

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(Evans, 2016; Sarma, 2016). There are three broad categories of technology-based financial services model in Africa: bank-focused models, bank-led models and non-bank-led models. Bank-focused models use non-traditional low-cost delivery channels to connect to the customers. The channels are ATMs, internet banking and mobile money for increased financial inclusion. Bank-led models give the customers a whole range of financial transactions using retail agents or mobile phones. For example, in Kenya, Equity Bank has developed a network of banking agents such as lottery outlets, supermarkets, post offices and petrol stations to reach the unbanked. In non-bank-led models, the bank's role is in the form of the safe-keeping of funds while account management functions are carried out by a telecom operator. Arrangements such as "Orange Money" in Mali, Senegal, Cameroun and Niger are led by telecom operators. The non-bank-led models have the potential to reach particularly those that have been excluded from orthodox financial systems.

The increased adoption of internet-enabled phones has also brought Internet access to many across the African region. The continent is leading the trend in mobile money with more than 56 arrangements in place. Examples are M-Pesa in Kenya and Wizzit in South Africa. M-Pesa accounts for over 27,000 agents handling more than 30 million transactions daily in Kenya. In South Africa, there are mobile money arrangements such as "First National Bank (FNB) with around 2 million customers, Wizzit with over 250,000 subscribers, Flash Mobile Cash by Eezi with a network of 42,000 home shops, MTN Mobile Money and finally Vodacom, in partnership with Nedbank offering M-Pesa" (Faye and Triki, 2013, p. 110). According to GSMA Intelligence (2014, p. 29), by 2013, there were more than 150 million people using mobile devices to access internet across Africa, over 60 per cent of which were doing so over 2G devices. This is equivalent to a total penetration rate of only 17 per cent of the total population, compared to a global average figure of over 30 per cent. In Nigeria, MTN had 2G coverage standing at 87 per cent and 3G at 49 per cent of the population in 2013. In Kenya, Safaricom had 2G and 3G coverage at 91 and 67 per cent, respectively, for Q1 2014.

The increased adoption of internet-enabled phones in the continent has caused much speculation and optimism concerning its effects on financial inclusion. Policymakers, the media and various studies have all flaunted the potentials of internet and mobile phones for financial inclusion (The Economist, 2008; Friedline, 2017; Lenka and Barik, 2018). For example, in the article, *Halfway There*, The Economist (2008) quipped that: "A device that was a yuppie toy not so long ago has now become a potent force for economic development in the world's poorest countries." In another article that features on *Huffington Post*, Friedline (2017) said that: "Financial inclusion in the 21st century economy depends on affordable, reliable Internet." An important question therefore is "Do such sentiments and mantras actually reflect the reality of the effects of the Internet and mobile phones for financial inclusion, especially in Africa?" It is important to note that, despite the progress to date, a significant proportion of the African population does not have adequate access to the internet. Africa is still far away from appreciating the full power of the internet. While mobile phones are the major internet devices used in Africa, the involvedness and robustness of the applications are as yet not as splendid as in the developed economies. Moreover, while internet access and mobile money seems like a shortcut to financial inclusion in the continent, numerous challenges abound, including stringent regulations, limited interoperability, scarcity of qualified agents and low levels of digital and financial literacy and income. While mobile broadband has more potential to boost financial access, high speed mobile broadband network coverage is more restricted to urban areas in Africa. Another major challenge is that regulators have not been able to strike the right balance between supporting innovations and effecting regulations.

Moreover, in the literature, there is a dearth of research on the relationship between internet, mobile phones and financial inclusion, especially in Africa. Most of the related studies are conceptual and micro-based, with little empirical attention to the relationship and causality between internet, mobile phones and financial inclusion. In fact, this dearth of rigorous

empirical studies has been attributed as the main cause of inadequate policy guidance in enhancing information communication technologies (ICT) (Roycroft and Anantho, 2003), despite saturation levels in developed economies. This study fills the gap by evaluating the relationship between internet, mobile phones and financial inclusion for 44 African countries for the 2000-2016 period. In Section 2 of this study, the literature review is presented. The econometric methodology is briefly discussed in Section 3. The empirical results are presented in Section 4. Section 5 concludes the study.

2. Theory and review of literature

The technology acceptance model, an information systems theory, models how users accept and use a technology (Marangunić and Granić, 2015; Wingo *et al.*, 2017). According to the model, a number of factors influence a users' decision about how and when to use a new technology. In contrast, the theory of diffusion of innovations explains how, why and at what rate new ideas and technology gains momentum and diffuses (or spreads) through a specific population or social system (Aizstrauta *et al.*, 2015; Dearing and Cox, 2018). In line with these theories, the diffusion of internet and mobile devices has accelerated in many contexts because satisfactory levels of ICT influence the ranges and depths of economic activities, economic productivity, standards of living and access to social development factors such as health care, education and good governance (ITU, 2002; Meso and Duncan, 2000).

Financial inclusion has been defined as the provision of access to formal financial services at an affordable cost (De Koker and Jentzsch, 2012; Evans, 2017a) to the large segment of the vulnerable and low-income groups (Mahendra, 2006). In other words, financial inclusion means access to formal financial services such as savings, credit and insurance opportunities (Hariharan and Marktanner, 2012; Evans, 2017b). Financial inclusion can thus have multiplier effects on the economy in the form of higher disposable income for rural households, more savings and a more robust deposit base for financial service providers. Financial inclusion can ensure different segments of the society are involved in the formal financial sector, thereby increasing the reach of monetary policy and thus monetary policy effectiveness (Evans, 2016).

The existing studies on financial inclusion have mostly focused on the measurement and promotion of financial inclusion (Marshall, 2004; Treasury, 2004; Dev, 2006; Sarma, 2008; Hannig and Jansen, 2010; Ardic, Heimann and Mylenko, 2011; Demirgüç-Kunt and Klapper, 2012; Allen *et al.*, 2016) as well as the impact on poverty reduction, income inequality and growth (Thorat, 2006; Sarma and Pais, 2008; Chibba, 2009; Kpodar and Andrianaivo, 2011; Dabla-Norris, Ji, Townsend and Unsal, 2015; Johal, 2016; Sharma, 2016). The available cross-country evidence mostly emphasizes the benefits of financial depth rather than financial inclusion (King and Levine, 1993; Khan and Semlali, 2000; Asongu and De Moor, 2015; Valickova *et al.*, 2015; Goodhart, 2016). The problem with this approach is that "deep financial systems are not necessarily inclusive ones, especially when financial access is heavily skewed toward the wealthy" (CGAP, 2012, as cited in Mbutor and Uba, 2013, p. 319).

The literature, in developed countries, is replete with studies of the macroeconomic impacts of mobile phones. Studies such as Chowdhury (2006) and Donner (2006) focus on the micro-economic effects of mobile phones on SMEs. Jensen (2007) found positive impacts of mobile telephony, establishing that through the provision of information, mobile phones lessen price volatility and grow fishing businesses' responsiveness. Roller and Waverman (2001), Sridhar and Sridhar (2004) and Lee *et al.* (2009) all found that ICT development, especially mobile phone penetration, influences economic growth. Roller and Waverman (2001) and Waverman *et al.* (2005) showed that the impact of mobiles is greater in lower-income countries. Interestingly, a part of this effect goes through financial inclusion as demonstrated by Kpodar and Andrianaivo (2011) who found that mobile phone

development improves the growth effects of financial inclusion, particularly when mobile financial services are readily available. Chakraborty and Mukerji (2017) found that the compulsory routing of wage payments through bank and post offices have enabled inclusion in the banking process in India. McHenry *et al.* (2017) showed that a strong relationship exists between the un(der)banked and the level of internet activity, as measured both through internet service(s) and devices used by the households.

Similarly, Siddik *et al.* (2017) found that e-banking had a positive impact on the performance of the banks in Bangladesh. Lenka and Barik (2018) found a positive and significant relationship between the growth of financial inclusion and expansion of both mobile phone and internet services in SAARC countries. They also found a unidirectional causal flow from the growth of mobile and internet services to expanded financial inclusion. Kabakova and Plaksenkov (2018) showed that three configurations of factors affect financial inclusion: social, technological and economic factors. Chai *et al.* (2018) found that social networks significantly increase the probability of households' participation in the informal financial market, amplify the size of informal financial transactions and raise the ratio of informal lending to total household assets.

A few studies have emanated from Africa. For example, Mago and Chitokwindo (2014) found that economically disadvantaged people in Zimbabwe have adopted mobile banking because it is accessible, fast and secure. Ouma *et al.* (2017) found that the use of mobile phones increases savings among low-income households in Sub-Saharan Africa. To the best of knowledge of the researcher, the literature has scarcely analyzed the relationship between internet, mobile phones and financial inclusion, especially in Africa. Most of the studies in the literature are conceptual and micro-based, with little empirical attention to the relationship and causality between internet, mobile phones and financial inclusion. In fact, this dearth of rigorous empirical studies has been attributed as the main cause of inadequate policy guidance in enhancing ICT (Roycroft and Anantho, 2003), despite saturation levels in developed economies. This study fills the gap by evaluating the effects of internet and mobile phones on financial inclusion in Africa.

3. Data and methodology

3.1 Data

This study uses a panel of 44 selected African countries for the period 2000-2016. The data are collected from World Bank (2017) database except corruption which is sourced from transparency International (2016), and regulatory quality which is sourced from Economist Intelligence Unit (EIU) (2016). The countries in the sample are Algeria, Angola, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Democratic Republic of the Congo, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo (Brazzaville), Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe.

3.2 Model

Based on the objectives of this study, the technology acceptance model and the literature on internet, mobile phones and financial inclusion (Evans and Adeoye, 2016; Ouma *et al.*, 2017; Lenka and Barik, 2018), the baseline model for the study is stated as:

$$Finc_{it} = \varphi_0 + \varphi_1 Intt_{it} + \varphi_2 Phon_{it} + \mu_{it} \quad (1)$$

where i and t are indices for individual countries and time. *Finc* is depositors with commercial banks (per 1,000 adults) (a proxy for financial inclusion), *Intt* is the number of

internet users (per cent of population) and *Phon* is mobile cellular subscriptions (per cent of population).

In the literature, the omission of relevant variables in a regression model may lead to bias (Gujarati, 2003). To preclude this bias, the model follows the literature and include other macroeconomic variables such as capital formation/gross domestic product (GDP), primary enrollment, inflation, broad money, interest rate, private credit/GDP, agriculture value added, population growth and remittances which are important for financial inclusion (Mago and Chitokwindo, 2014; Evans and Adeoye, 2016; Evans, 2017a; Evans, 2017b; Ouma *et al.*, 2017). Model (1) is therefore augmented with the macroeconomic variables:

$$Finc_{it} = \rho_0 + \rho_1 Intt_{it} + \rho_2 Phon_{it} + \rho_3 Cred_{it} + \rho_4 Gcf_{it} + \rho_5 Cpi_{it} + \rho_6 Intr_{it} + \rho_7 M2_{it} + \rho_8 Penr_{it} + \rho_9 Agric_{it} + \rho_{10} Remit_{it} + \rho_{11} Popl_{it} + \epsilon_{it} \quad (2)$$

where *Gcf* is capital formation/GDP, *Penr* is primary enrollment, *Cred* is Private Credit/GDP, *Cpi* is Inflation, *Intr* is interest rate, *Agric* is Agriculture value added/GDP, *M2* is broad money/GDP, *Popl* is population growth and *Remit* is remittances/GDP.

Further, the literature has shown that institutional variables such as the levels of corruption and regulatory quality are important factors for financial inclusion (Demirguc-Kunt *et al.*, 2014; Demirgüç-Kunt *et al.* 2015). Model (2) is therefore augmented with institutional variables:

$$Finc_{it} = \kappa_0 + \kappa_1 Intt_{it} + \kappa_2 Phon_{it} + \kappa_3 Cred_{it} + \kappa_4 Gcf_{it} + \kappa_5 Cpi_{it} + \kappa_6 Intr_{it} + \kappa_7 M2_{it} + \kappa_8 Penr_{it} + \kappa_9 Agric_{it} + \kappa_{10} Remit_{it} + \kappa_{11} Popl_{it} + \kappa_{12} Cor_{it} + \kappa_{13} Regq_{it} + \epsilon_{it} \quad (3)$$

where *Cor* is corruption and *Regq* is *r*egulatory quality.

To test the impact of the internet and mobile phones on financial inclusion while precluding any spurious results, the empirical analysis follows the three steps: unit root test for non-stationarity in the variables, cointegration test for long run relation using the Pedroni (1995, 1999) panel cointegration test and evaluation of the causal links between the variables.

3.3 Panel unit root tests

Following the methods used in earlier literature, this study uses the Im *et al.* (2003) panel unit root tests on the two variables to establish their unit root properties. Im Pesaran and Shin Test (IPS) is given by:

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \phi_{iL} \Delta y_{i,t-L} + z_{it}^{'} \gamma + u_{it} \quad (4)$$

where $i = 1 \ldots N$ and $t = 1, \ldots, T$

The mean of the *t*-statistics for P_1 from individual ADF regressions, $t_i T_i (P_i)$ is:

$$\bar{t}_{NT} = \frac{1}{N} \sum_{i=1}^{N} t_{iT}(p_i \beta_i) \quad (5)$$

which converges to the standard normal distribution as N and T $\rightarrow \infty$.

There are a few reasons why IPS is the most appropriate for this study. The major advantage of the IPS test is that the alternative hypothesis assumes that at least one

individual cross section is stationary. Moreover, the IPS allows autoregressive parameters to vary freely across the cross-sections. This is necessary because the countries in Africa are heterogeneous. In addition, the Akaike Information Criterion (AIC) is used for the optimal lag selection in line with Liew (2004).

3.4 Pedroni residual cointegration test

If two variables have unit roots in levels, they may also have a possible linear combination in the long-run. The Pedroni (1995, 1999) residual cointegration test is used to test for the long run relationship between the variables. The Engle–Granger-based Pedroni cointegration test is suitable for this study because it is heterogeneous (Camarero and Tamarit, 2002), with same deterministic trend assumptions as in the IPS (2003) unit root test. The optimal lag is chosen by the AIC (Liew, 2004).

Pedroni proposed a cointegration test which allows for heterogeneous intercepts and trend in coefficients across the cross-sections. Considering:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \ldots + \beta_{li} x_{li,t} + \varepsilon_{i,t} \tag{6}$$

For $t = 1 \ldots T$; $i = 1 \ldots N$; $l = 1 \ldots L$; where x and y are integrated of order one. α_i and δ_i are individual and trend effects. The test has the null hypothesis of no cointegration and the assumption that the residuals have unit root, with the standardized statistic asymptotically normally distributed of the form, $\frac{N_{NT} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0,1)$, where μ and v are produced by the Pedroni via Monte Carlo simulations.

3.5 Fully modified Least Square (FMOLS)

Fully modified least squares (FMOLS) is used in the estimations. The merit of the FMOLS is that it adjusts the least squares for serial correlation and endogeneity of the regressors to attain asymptotic efficiency (Phillips and Hansen, 1990; Hansen and Kim, 1995). The FMOLS estimator uses initial estimates of the symmetric and one-sided long run covariance matrices of the residuals (Pedroni, 1995, 2000).

4. Empirical analysis

In the literature, it has been established that it is necessary to ascertain the unit properties of variables before estimation. As a starting point for the analysis, therefore, this study applies the IPS panel unit root test which assumes individual unit processes. Table I shows the results of the unit root tests. As the null of a unit root cannot be rejected, there is the possibility of a long-run equilibrium among the variables (Engle and Granger, 1987).

To test the possibility of a long-run equilibrium among the variables, the Pedroni residual cointegration test is used. Out of 11 statistics, six reject the null hypothesis of no cointegration (Table II). Therefore, there is a long-run relationship among the variables. This demonstrates that, in the long-run, permanent changes in the variables affect permanent changes in financial inclusion.

The FMOLS estimates for the panel of African countries are presented in Table III. Three outcomes of the FMOLS regression are provided. This allows checking for the robustness of the findings to alternative specifications. The three outcomes provide similar results in terms of the statistical significance of the internet and mobile phone variables. First, in line with the economic rationale, the results show that internet has significant positive relationship with financial inclusion, meaning that rising levels of the internet are associated with increased financial inclusion. It also implies that increasing internet usage plays significant roles in increasing financial inclusion. In the same vein, the results from the three estimations show positive and significant coefficient of the mobile phone variable. This suggests that

Table I IPS Panel unit root test

Variable	*I(0)*	*I(1)*
Finc	1.85	−18.32*
Intt	−1.51	−1.79**
Phon	1.80	−17.49*
Cred	1.17	−1.94*
Gcf	2.33	−14.21*
Cpi	2.33	−1.78**
Intr	1.38	−2.17*
M2	−1.05	−20.10*
Penr	1.16	−1.68***
Agric	−1.21	−3.58*
Remit	2.38	−4.14*
Popl	2.09	−14.26*
Regq	2.35	−1.70***
Cor	−1.29	−5.92*
Critical values	1% level	−1.82
	5% level	−1.73
	10% level	−1.68

Notes: *, ** and *** denotes significance at 1, 5 and 10%; optimal lags are chosen with the Schwarz Info criterion

Table II Pedroni residual cointegration test

Automatic lag length selection based on SIC with a max lag of 1
Newey–West automatic bandwidth selection and Bartlett kernel

	Statistic	*Prob.*	*Weighted Statistic*	*Prob.*
Alternative hypothesis: common AR coefs. (within-dimension)				
Panel v-Statistic	1.08	0.13	1.18	0.11
Panel rho-Statistic	−0.25	0.40	−0.85	0.19
Panel PP-Statistic	−1.70	0.04**	−3.92	0.00*
Panel ADF-Statistic	−1.86	0.03**	−4.17	0.00*
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group rho-Statistic	1.20	0.88		
Group PP-Statistic	−4.03	0.00*		
Group ADF-Statistic	−4.66	0.00*		

Notes: * and ** denote significance at 1 and 5%. Optimal lags are chosen with the Schwarz Info Criterion (SIC)

countries with higher number of mobile subscriptions have higher financial inclusion, meaning that rising levels of mobile subscriptions are associated with increased financial inclusion. It also implies that increasing mobile subscriptions play significant roles in increasing financial inclusion.

In the second and third estimations (II and III), similar significant positive relationship with financial inclusion are found for macroeconomic variables such as capital formation, primary enrollment, bank credit, broad money, population growth, remittance and agricultural value added. Only interest rate has significant negative relationship with financial inclusion. This implies that macroeconomic factors play significant roles in increasing financial inclusion. The third estimation (III) shows that, among the institutional variables, only regulatory quality has significant relationship with financial inclusion. This indicates that institutional factors play significant roles in increasing financial inclusion. On the whole, these findings imply that capital formation, primary enrollment, bank credit,

Table III Panel FMOLS estimates

Variable	Coeff.	t-Stat.	Coeff.	t-Stat.	Coeff.	t-Stat.
	I		II		III	
Number of internet users/population (*Intt)*	0.64*	4.81	0.44*	3.02	0.42**	2.81
Mobile cellular subscriptions/population (*Phon)*	0.31*	9.43	0.03	0.79	0.08**	2.16
Bank credit/GDP *(Cred)*			0.06***	1.77	0.10**	2.34
Capital formation/GDP (*Gcf*)			0.22	1.52	0.15	1.07
Inflation *(Cpi)*			−0.04	−0.28	−0.02	−0.13
Interest rate *(Intr)*			−0.26*	−3.09	−0.31*	−3.31
M2/GDP *(M2)*			0.21*	4.51	0.10***	1.78
Primary enrollment (*Penr*)			0.36*	10.59	0.36*	8.81
Agriculture value added/ GDP *(Agric)*			0.82*	9.68	0.87*	8.76
Remittances/GDP *(Remit)*			1.26*	7.53	1.11*	6.54
Population growth (*Popl*)			3.51**	2.76	4.13*	2.82
Regulatory quality (*Regq*)					−0.10**	−0.31
Corruption (*Cor*)					3.80	0.55
Adjusted R-squared	0.87		0.97		0.98	
Breusch–Godfrey serial correlation LM Test	0.51		0.70		0.85	
Heteroskedasticity test: Breusch–Pagan–Godfrey	2.47		1.49		2.11	

Notes: Dependent Variable: Finc; *, ** and *** indicate statistical significance at 1, 5 and 10% level of significance, respectively. Long-run covariance estimate (Prewhitening with lags = 1, Bartlett kernel, Newey–West fixed bandwidth = 4.0000)

broad money, population growth, remittances, agriculture, interest rate and regulatory quality are important underlying factors for financial inclusion in Africa. These findings are consistent with the literature on the determinants of financial inclusion (Laha *et al.*, 2011; Singh and Singh Kondan, 2011; Adeyemi *et al.*, 2012; Akudugu, 2013; Pena *et al.*, 2014; Siddik *et al.*, 2015; Tuesta *et al.*, 2015; Evans and Adeoye, 2016; Sathiyan and Panda, 2016).

The primary objective of the study is to assess the relationship between internet, mobile phones and financial inclusion. It is therefore necessary to determine the causality between internet, mobile phones and financial inclusion. This will reinforce the finding that internet and mobile phones have significant positive relationship with financial inclusion as found in the FMOLS estimations. The results of the Granger causality analysis are shown in Table IV. The causality analyses suggest the existence of uni-directional causality from internet and mobile phones to financial inclusion. The causality analysis shows that internet and mobile phones cause financial inclusion. The results therefore provide evidence that internet and mobile phones play significant roles in financial inclusion in Africa.

This study therefore has found evidence of a significant positive relationship between internet, mobile phones and financial inclusion. That is, internet and mobile phones are important factors for financial inclusion. This evidence is supported by a few studies (Kpodar and Andrianaivo, 2011; Lenka and Barik, 2018) which found a significant positive connection between internet, mobile phones and financial inclusion. This specific result is in line with Kpodar and Andrianaivo (2011) which emphasized the role of ICT, especially mobile phone rollout, as a necessary input for financial inclusion. This evidence is similarly

Table IV Panel granger causality test results

Direction of causality	F-stat	Prob.
Finc → Intt	1.16	0.31
Intt → Finc	15.30	0.00**
Finc → Phon	1.84	0.16
Phon → Finc	8.86	0.02**

Notes: * and ** indicate statistical significance at 1 and 5% level of significance; the optimal lag length was selected using the Schwarz information criteria

buttressed by Lenka and Barik (2018) who found a positive and significant relationship between the growth of financial inclusion and expansion of both mobile phone and internet services in SAARC countries.

5. Summary and policy implications

This study has examined the relationship between internet, mobile phones and financial inclusion in Africa. The empirical analysis followed these three steps: examination of the integration order of the variables; testing for cointegration; and evaluation of the effects of internet and mobile phones on financial inclusion using panel FMOLS approach and Granger causality tests. The findings show that internet and mobile phones are significant factors for financial inclusion in Africa, meaning that increased Internet usage and mobile subscriptions have boosted financial inclusion. Similar significant positive relationship with financial inclusion are found for macroeconomic variables such as capital formation, primary enrollment, bank credit, broad money, population growth, remittance and agricultural value added. Interestingly, interest rate and regulatory quality have significant negative relationship with financial inclusion. The causality analyses suggest also the existence of uni-directional causality from internet and mobile phones to financial inclusion. The results therefore provide evidence that internet and mobile phones play significant roles in financial inclusion.

Policy implications are important. The empirical evidence has shown that internet and mobile phones are significant factors for financial inclusion. In line with this finding, successful experiences in Kenya and South Africa have also established that mobile financial services have the ample potential to increase financial inclusion in Africa significantly. In this fast-moving and digital age, internet and mobile phones are potential and useful tools to increase financial inclusion in many African countries. For example, in many African poor rural areas, internet and mobile phones can reduce access costs for banks because the banks can do away with large fixed infrastructure costs. Internet and mobile phones can make banking especially cost-efficient for poor customers because they can reduce the expenses associated with banking. As transactions are initiated remotely through internet and mobile phones, then banking transactions can safely be taken outside of bank branches and into rural areas or right into customer hands (with mobile money). M-PESA in Kenya is a success story which should be replicated in all parts of Africa.

Given the few numbers of brick and mortar banks in rural areas, internet and mobile technology can be a welcome game-changer. The internet and mobile phone penetration can reduce the costs of transaction for financial services providers across Africa, thus expanding financial inclusion. Therefore, strategies to grow financial inclusion in Africa must take into account incentives that can accelerate the diffusion of internet and mobile devices so that the unbanked are brought into banks networks. Easier access to the internet and mobile phones may contribute significantly towards greater financial inclusion. An effective approach would be to encourage more people to use the internet and mobile phones to grow financial inclusion within the continent.

The empirical evidence has also shown that primary enrollment is a significant factor for financial inclusion, meaning that higher enrollments is associated with higher financial inclusion. Higher enrollments may contribute to financial inclusion in form of higher financial literacy. Consistent with this finding, Klühs *et al.* (2017) show that adults with education use their accounts more frequently. Financial literacy is a necessary ingredient to make full use of available financial infrastructure. From a policy perspective, improving financial literacy is a boost for financial inclusion. This may necessitate intensive education. As Africa has the lowest literacy rates in the world, the population's ability to fathom internet-based financial services may not be optimal. Therefore, financial literacy programs are necessary to inform the unbanked and show them how the services work.

The study has also shown that regulatory quality is a significant factor for financial inclusion. Poor regulation is one of the major stumbling blocks to financial inclusion. An enabling regulatory environment is therefore important for both mobile money and financial inclusion. Regulatory changes will be necessary to enable the successful adoption and adaptation of the internet and mobile phones in digital finance, so that the new technologies can benefit the poor. Policymakers of different countries should consider the removal of regulatory barriers that hinder the usage of the internet and mobile phones. This should improve financial service processes and reduce costs while at the same time promoting financial inclusion.

The study has shown that broad money and interest rate are significant factors for financial inclusion, meaning that monetary policy is a significant factor for financial inclusion. Therefore, heightened effectiveness of monetary policy will be required for increased financial inclusion in the continent. Financial inclusion policies for harder-to-reach rural and remote populations should therefore be the focus of monetary policy in Africa.

The study has also shown that bank credit is important for financial inclusion. This result must be interpreted with caution because in most cases it is difficult for individuals and small businesses to obtain loans from financial institutions. Most depend on personal savings or reinvested profits for financing. There is therefore a great need to deepen access to finance for the poor and Africa's small businesses. The National Collateral Registry in Nigeria is a good example; it offers access to finance and encourages a modern credit reporting system.

This study also shows that remittances are a significant factor for financial inclusion. Digitization of remittances can help overcome costs and physical barriers that hinder financial inclusion because sending remittances using mobile internet are cheaper and are also able to reach rural areas. Mobile remittances can improve remittance processes by reducing transaction time and costs. The EcoCash Diaspora service in Zimbabwe is an example; it provides convenient means of sending remittances, especially to rural areas.

Surprisingly, the study has also shown that agriculture is a significant factor for financial inclusion. Agriculture is the bedrock of the economy for many African countries, using substantial populations of people and contributing heavily to GDP. Though agricultural workers tend to be poorer and less financially included than the overall population; however, in many countries such as Kenya, farmers are as likely to be financially included as the rest of the population. This study has therefore shown that the higher the level of agricultural value added, the higher the level of financial inclusion.

The findings therefore affirm that creating a suitable macroeconomic and regulatory environment is significantly and positively related to financial inclusion. Macroeconomic and regulatory environment of African countries should therefore be fully integrated in development planning and policy development for financial inclusion of these countries. African policymakers should realize that a policy to pursue financial inclusion using the internet and mobile phones in isolation can be problematic. A policy for enhancing financial inclusion in Africa should, *inter alia*, be integral to policies aimed at the macroeconomic and regulatory environment, the internet and mobile phones.

This study has its limitations. The study was limited to only 44 countries within Africa. Extending this study to all the developing countries in Asia, the Caribbean and South America may provide a better understanding of the way internet and mobile phones influence financial inclusion and the implications for financial inclusion in other contexts. Future studies could also include mobile money and the rise of mobile broadband into the analysis to achieve a deeper understanding of how the use of internet and mobile phones influence financial inclusion in Africa. It must be noted that while mobile broadband has more potential to boost financial inclusion, high speed mobile broadband network coverage is more restricted to urban areas in Africa. Moreover, current available data on mobile

broadband in Africa is too scanty to carry out the large-scale estimations done in this study. Notwithstanding the limitations, the findings of this study are enriching.

Note

1. Mobile Money is a payment solution that enables financial transactions with mobile phones.

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