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Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.8, No.18, 2017
www.iiste.org

Financial Inclusion and GDP Per Capita in Africa: A Bayesian VAR Model

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Abstract
Can GDP per capita translate into higher financial inclusion in Africa? Our application of a Bayesian VAR model to the World Bank Development Indicators datasets for 15 African countries over the period from 2005 to 2014, provides affirmative evidence to this question. The findings show that GDP per capita has significant impacts on financial inclusion, signifying thereby how increases in GDP per capita can be used to drive the needed financial inclusion in Africa. It is, however, interesting to note that financial inclusion has an insignificant but positive impact on GDP per capita. On the other hand, the evidence suggests that broad money, credit supply, literacy, internet users and servers have positive and significant impacts on financial inclusion. Moreover, the internet is coming out to be a significant variable indicating that more attention is required to be paid to developing internet access in Africa for the advancement of financial inclusion. The findings of this study should be of help to African central banks' policymakers and commercial bankers as they advance innovative approaches to enhance the involvement of excluded poor people in formal finance.
Keywords: Financial inclusion, income, Bayesian VAR

1. Introduction

Does rising GDP per capita translate into higher financial inclusion? In other words, do higher incomes cause people to demand for and utilize higher quantum of formal financial services? Though Kelly and Rhyne (2013) suggest that they do, the connection has not been empirically established, especially in Africa. Our application of a Bayesian VAR model to the World Bank Development datasets for 43 African countries provides affirmative evidence to these questions.

With the increasing clamor among multilateral agencies such as the International Monetary Fund, the World Bank and the African Development Bank, financial inclusion has become a widely-recognized policy issue in the financial and economic arena, transcending into a vital social agenda (Evans and Adeoye, 2016). This stems from the importance of financial inclusion in achieving "sustainable growth, financial stability, and poverty alleviation" (Tatum, 2014, p. 1). Yet, all over the world the level of financial inclusion is as yet not commendable. According to Ardic, Heimann and Mylenko, (2011, p. 16):

> *"Fifty-six percent of adults in the world do not have access to formal financial services. The situation is even worse in the developing world with 64 percent of adults unbanked. Nevertheless, high-income countries also have to worry because approximately one in every five adults is unbanked. On the contrary to conventional wisdom, poor people indeed need and use financial services, albeit in small amounts and usually from informal sources as it is costly for formal providers to provide services for such small amounts. Anecdotal evidence suggests that informal financial services are at least 5-10 times costlier and also less reliable than formal ones. Hence, making formal and affordable financial services available for the unbanked would definitely have positive consequences on the lives of these people. Fortunately, the need for improving access to financial services and building inclusive financial systems are increasingly at the core of policymakers' agendas".*

Particularly, the financial system in Africa has grown tremendously both in volume and complexity in recent decades. Despite the significant improvements, "there are concerns that much-needed banking services have not reached a vast segment of the population, especially the underprivileged sections of the society… The reasons may vary from country to country and hence the strategy could also vary but financial inclusion can truly lift the financial condition and standards of life of the poor and the disadvantaged" (Kumar, 2011, p. 2). According to Kelly and Rhyne (2013, p. 10) "When the Global Findex asked people why they did not have a bank account, nearly two-thirds of the non-banked responded that they did not have enough money, and other responses dovetailed indirectly with not having enough money. A quarter of respondents said that formal services are too costly. Several other responses bear some relation to low incomes. If the service outlet is considered too far away, it may imply that the individual does not have enough money to get there. A lack of necessary documentation could also be related to low income". As a result of this, countries all over Africa now embarks on inclusive growth drive. The importance of financial inclusion has become more obvious and moreover, "economic growth is no longer sufficient, rather a growth that trickles down all the way down to the

bottom of the pyramid is now a necessity" (Tatum, 2014, p. 1). The key objective of this study is therefore to determine the significance of GDP per capita to financial inclusion. It is therefore to ask if the level of income in Africa is appropriate for the needed financial inclusion.

With the objectives enumerated above, the current study attempts to understand the impact of GDP per capita on financial inclusion in Africa. A Bayesian VAR model is employed for the country-wise panel data spanning over the period 2005-2014, in the context of a panel of 43 countries in Africa. The findings corroborate significant impacts of GDP per capita on financial inclusion, signifying thereby how increase in GDP per capita can be used to drive the needed financial inclusion in Africa. It is, however, interesting to note that financial inclusion is having a positive but insignificant impact on GDP per capita. The evidence also suggests that broad money, credit supply, literacy, internet users and servers have positive and significant impacts on financial inclusion. Moreover, the internet is coming out to be a significant variable indicating that more attention is required to be paid to developing internet access in Africa for the advancement of financial inclusion. The findings of this study should be of help to African central banks' policymakers and commercial bankers as they advance innovative approaches to enhance the involvement of excluded poor people in formal finance.

The remainder of this article is organized as follows. Section 2 presents the review of the literature. Section 3 discusses the data, the Bayesian VAR, Im Pesaran and Shin panel unit root tests and the Pedroni Contegration test used. Section 4 discusses the results of the empirical analysis. Section 5 concludes with summary and policy implications.

2. Literature Review

Financial Inclusion is defined as "the delivery of banking services at an affordable cost to the vast sections of disadvantaged and low-income groups. Unrestrained access to public goods and services is the sine qua non of an open and efficient society. As banking services are in the nature of public good, it is essential that availability of banking and payment services to the entire population without discrimination is the prime objective of the public policy" (Kumar, 2013, p. 3). In this contemporary era of achieving economic power, the availability of banking facilities and strong bank branch network are the key facilitators of growth, development, investment, and employment generation (Hartog and Oosterbeek, 1993). Countries with higher GDP per capita are likely to have financial inclusive systems. These countries are more bank literate, save more, and can provide more securities. Accordingly, markets for banking services are more likely to succeed (Ardic, et al, 2011; Evans and Adeoye, 2016). Lack of financial inclusion is more present in countries with high income disparities because income inequality is often the consequence of uneven economic opportunities and monopolized markets leading to the marginalization of the poor (Aridic, et.al, 2011; Hariharan and Marktanner, 2013; Evans and Adeoye, 2016). Examples of such unequal economic development and monopolized markets are African economies relying heavily on natural resources and some rentier states based on authoritarian bargains.

In the literature, the significance of financial development for economic growth has been well-established (i.e. King and Levine, 1993; Levine, 2005; Demirgüç-Kunt, Beck, and Honohan, 2008). The importance of inclusive financial systems, as well, has entered the debate (Beck, Demirgüç-Kunt, and Peria, 2008, Evans, 2016; Evans and Adeoye, 2016; Adeola and Evans, 2017; Evans and Lawanson, 2017) in more recent years. Studies such as Caskey, Duran, and Solo (2006) and Dupas and Robinson (2009) using household data have also shown that financial access in the form of savings, payments and credit can substantially and positively improve poor people's lives. For firms, Schiffer and Weder (2001) and Beck et al., (2005, 2008) also found that financial access is often the major stumbling block to growth, especially in small and medium enterprises.

Particularly, Kumar (2013) utilizes state-wise panel data spanning over a period from 1995 to 2008 determine the behaviour and determinants of financial inclusion in India. The study shows regional economic conditions are important for the betterment of financial inclusion. The factory proportion and employee base are significant variables indicating that "income and employment generating schemes lead the public to be more active, aware, interested with regard to banking activities, which contributes towards financial inclusion. Using test for convergence it is found that the states tend to maintain their respective level of banking activity vis-à-vis the rest with the policy implication that more attention is required to be paid in the low performing regions to enable them to close the gap with respect to better performing regions" (p. 1).

Within the framework of a simple Solow growth model, Hariharan and Marktanner (2013) estimate the impact of financial inclusion on economic growth. The results show that a 10 percent increase in financial inclusion has the potential to increase income per worker on average by 1.34 percent. With regards to social benefits, financial inclusion increases the amount of available savings, the efficiency of financial intermediation, and new business opportunities. According to Hariharan and Marktanner (2013, p. 4) "a main reason for why many European countries introduced universal banks under the auspices of the state was the fear that market based competitive banking would not free the social benefit from comprehensive financial inclusion and instead cause social costs from rural-urban migration. State sponsored universal banking has therefore contributed to greater economic diversification in rural areas than is the case in more competitive banking environments"

Martinez Turegano and Garcia-Herrero (2015) assess empirically whether financial inclusion plays a role in reducing income inequality while controlling for economic development and fiscal policy. They show that financial inclusion reduces income inequality to a significant degree, while the size of the financial sector does not. Park and Mercado (2015) construct financial inclusion indicator to investigate macroeconomic and country-specific factors influencing the degree of financial inclusion in 37 developing Asian economies. The evidence shows that rule of law, GDP per capita, and demographic characteristics significantly influences financial inclusion in Asia. The evidence also shows that financial inclusion lowers poverty and income inequality.

Honohan (2007) tests the significance of financial access in reducing income equality. The evidence shows that higher financial access significantly reduces income, though the link depends on the specification used. Rojas-Suarez (2010) show that economic volatility, regulatory constraints, higher income inequality, weak rule of law, and social underdevelopment significantly lower financial access. Burgess and Pande (2005) show that state-led expansion of rural bank branches in India has significantly reduced poverty. The authors find robust evidence that opening bank branches in rural unbanked locations has reduced poverty rates. Similarly, in rural Malawi, Brune et al. (2011) show that increased financial access through commitment savings account improves the well-being of poor households. Increased financial access provides easy access to their savings for agricultural input use. Allen et al. (2013) also show that commercial banks can significantly enhance financial access of the poor in Kenya by tapping under-privileged households.

Evans and Adeoye (2016) document the determinants of financial inclusion in Africa for the period 2005-2014, using the dynamic panel data approach. The study shows that GDP per capita, broad money (% of GDP), internet access, literacy, and Islamic banking presence are significant factors explaining the level of financial inclusion in Africa. Deposit interest rates, domestic credit provided by financial sector (% of GDP), inflation and population however have insignificant impacts on financial inclusion. Adeola and Evans (2017) examine the impact of financial development and financial inclusion on economic diversification in Nigeria, using CBN Statistical Bulletin and World Development Indicators, for the period 1981-2014 and the fully modified least square (FMOLS). The results show that financial inclusion, in terms of financial access and usage, has positive significant effects on economic diversification, suggesting that financial inclusion can be seen as a potent accelerator of economic diversification. Evans and Lawanson (2017) examined the causal links between financial inclusion and economic output, as well as between financial inclusion and the five sectors of the Nigerian economy using cointegration and Granger causality test. The study found a bi-directional causality between financial inclusion and the aggregate economy, and bi-directional causality between financial inclusion and the sectors of the economy in most cases. The study also shows that financial usage has higher causal links with the economy and its sectors than financial access, suggesting that a responsible pursuit of financial inclusion in Nigeria will emphasize not only creation of access to finance, but most importantly, its usage.

Overall, despite the theoretical and empirical consensus on the importance of financial inclusion (Beck et al, 2008, Evans, 2016; Evans and Adeoye, 2016; Adeola and Evans, 2017; Evans and Lawanson, 2017), the extent to which rising GDP per capita affect financial inclusion, such as in Africa, has remained open to debate (Evans and Adeoye, 2016; Evans and Lawanson, 2017). The need to empirically test the relationship between GDP per capita and financial inclusion is therefore important and obvious for developing economies such as in Africa. The major gap in the literature therefore is to determine if the level of GDP per capita in Africa is appropriate for the needed financial inclusion.

3. Data and Methodology

3.1 Data and Model

Data for this analysis are collected from the World Development Indicators (WDI) on variables such as depositors with commercial banks (per 1,000 adults), per capital income, broad money, deposit interest rate, GDP growth, adult literacy rate, domestic credit provided by financial sector as a % of GDP, internet users per 100 people and secure internet servers. WDI was an appropriate source because it offers a large range of information on the variables. The data span is limited to 2005-2014 because of data availability. Depositors with commercial banks (per 1,000 adults) is our financial inclusion variable (See Demirguc-Kunt, Klapper and Randall, 2014; Mehrotra and Yetman, 2015; Naceur et al, 2015; Evans, 2016; Evans and Adeoye, 2016).

In line with existing studies (i.e. Marshall, 2004; Sarma and Pais, 2011; Laha, Kuri and Kumar, 2011; Mohieldin, Iqbal, Rostom and Fu, 2011; Demirguc-Kunt, Klapper and Randall, 2014; Mehrotra and Yetman, 2015; Naceur et al, 2015; Evans and Adeoye, 2016), the econometric model for the study is given as:

$$FINC_{it} = \tau_0 + \tau_1 GDPC_{it} + \tau_2 MONEY_{it} + \tau_3 CREDIT_{it} + \tau_4 INTEREST_{it} + \tau_5 GROWTH_{it} + \tau_6 LITERACY_{it} + \tau_7 USERS_{it} + \tau_8 SERVER_{it} + \tau_9 POPULATION_{it} + \tau_{10} CAPITAL_{1t} + \xi_{it} \quad (1)$$

Where FINC is financial inclusion (number of depositors with commercial banks per 1,000 adults); GDPC

is GDP per capita; MONEY is broad money; CREDIT is the credit to the private sector (% of GDP); GROWTH is GDP growth; USERS is the number of internet users; SERVER is the number of secure internet servers; LITERACY is adult literacy rate; and POPULATION is the total population; INTEREST is the deposit interest rate; CAPITAL is gross capital formation and ξ are the residuals. The subscript i is the i-th country and the subscript t the t-th year.

Table 1. Description of Variables

Variables	Description
Depositors with commercial banks (per 1,000 adults)	Depositors with commercial banks are the reported number of deposit account holders at commercial banks and other resident banks functioning as commercial banks that are resident nonfinancial corporations (public and private) and households. For many countries data cover the total number of deposit accounts due to lack of information on account holders. The major types of deposits are checking accounts, savings accounts, and time deposits.
GDP per capita (constant 2005 US$)	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
GDP growth (annual %)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2005 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.
Broad money (constant 2005 US$)	Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.
Deposit interest rate (%)	Deposit interest rate is the rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability.
Domestic credit provided by financial sector (% of GDP)	Domestic credit provided by the financial sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The financial sector includes monetary authorities and deposit money banks, as well as other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other financial corporations are finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies.
Internet users (per 100 people)	Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.
Secure internet servers	Number of servers using encryption technology in Internet transactions.
Adult literacy rate	Percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life. Generally, 'literacy' also encompasses 'numeracy', the ability to make simple arithmetic calculations.
Gross capital formation	Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.
Total Population	Number of residents regardless of legal status or citizenship.

Source: World Development Indicators

3.2 Panel Unit Root Tests

This study carries out the Im Pesaran and Shin panel unit root tests on the dependent and independent variables so as establish their unit root properties. Im Pesaran and Shin Test (IPS) is given by

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \phi_{iL} \Delta y_{i,t-L} + z'_{it}\gamma + u_{it} \quad (2)$$

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

And the average of the *t*-statistics for p_i from individual ADF regressions, $t_{iT_i}(p_i)$ is

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i \beta_i) \quad (3)$$

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

The major advantage of the IPS test is the assumption that the unit root can differ across the cross-sections in the model. As well, the alternative hypothesis assumes that at least one individual cross section is stationary. Moreover, the Im, Pesaran and Shin (2003) (IPS) test is used because the countries are heterogeneous. In line with Liew (2004), the Akaike Information Criterion (AIC) is used for the optimal lag selection.

3.3 Pedroni Residual Cointegration Test

The Pedroni (1999) Residual Cointegration Test is used to test for cointegration, since variables exhibiting unit roots in levels may have a linear combination in the long-run. The Engle-Granger based Pedroni (1999) cointegration is heterogeneous (Camarero and Tamarit, 2002), with the same deterministic trend assumptions as used in the IPS (2003) unit root test. The optimal lag selection is by the AIC (Liew, 2004).

Pedroni (1999) proposed a cointegration test that allows for heterogeneous intercepts and trend in coefficients across the cross-sections. Considering,

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \ldots + \beta_{li} x_{li,t} + \varepsilon_{i,t} \quad (4)$$

For t=1... T; i=1... N; l=1... 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, $\frac{\aleph_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0,1)$, where μ and v are produced by the Pedroni via Monte Carlo simulations.

3.4 Bayesian VAR

In Bayesian statistics and econometrics, the *prior*, *likelihood*, and *posterior's* distributional properties are important. Anything uncertain is regarded as a random variable which can be assigned a probability distribution. While the prior is based on knowledge of the parameters of interest, the likelihood is the information in the sample. Using Bayes' theorem, the combination of the prior distribution and the likelihood yields the posterior distribution.

If the parameters of interest are given by θ = (β, ∑), the data by *y*, the prior distribution by π(θ) and the likelihood by *l(y*|θ), then the posterior distribution, π(θ|y) is given by

$$\pi(\theta \mid y) = \frac{\pi(\theta) l(y \mid \theta)}{\int \pi(\theta) l(y \mid \theta) d\theta} \quad (5)$$

To relate this to the general Bayesian VAR framework, if the VAR(p) model is given by

$$y_t = \alpha_0 + \sum_{j=1}^{p} C_j y_{t-j} + \varepsilon_t \qquad t = 1, \ldots, T \quad (6)$$

Where y_t is an n x 1 vectors of n series and ε_t is an n x 1 vectors of errors.

For brevity, (6) may be rewritten as:

$$Y = BC + E \quad (7)$$

Or

$$y = (L_n \otimes B)\theta + e \quad (8)$$

Y and E are T x n matrices while B = (b_1, …., b_t)' is a T x (np + 1) matrix for b_t = (1, y'_{t-1}, …, y'_{t-q}), L_m is the identity matrix of dimension n, θ = vec(C), and e ~ N(0, $\sum_E \otimes L_m$).

The likelihood function, therefore, is

$$l(\theta,\Sigma_t) \propto |\Sigma_t \otimes L_T|^{-1/2} \exp\left\{-\frac{1}{2}(y-(L_n \otimes B)\theta)'(\Sigma_t \otimes L_T)^{-1}(y-(L_n \otimes B)\theta)\right\} \quad (9)$$

Assuming Σ_t is a multivariate normal prior for θ, then

$$\pi(\theta) \propto |V_0|^{-1/2} \exp\left\{-\frac{1}{2}(\theta-\theta_0)'V_0^{-1}(\theta-\theta_0)\right\} \quad (10)$$

Where V_0 is the prior covariance and θ_0 the prior mean.
Combining the prior with the likelihood function in (9), the posterior density becomes

$$\pi(\theta|y) = \exp\left\{\frac{1}{2}.(V_0^{-1/2}(\theta-\theta_0))'V_0^{-1/2}(\theta-\theta_0)+\left\{(\Sigma_t^{-1/2}\otimes L_T)y-(\Sigma_t^{-1/2}\otimes B)\theta\right\}'\left\{(\Sigma_t^{-1/2}\otimes L_T)y-(\Sigma_t^{-1/2}\otimes B)\theta\right\}\right\} \quad (11)$$

(11) is a multivariate normal probability distribution function (pdf).
For simplicity, we do some definitions:

$$w = \begin{bmatrix} V_0^{-1/2}\theta_0 \\ (\Sigma_t^{-1/2} \otimes L_T)y \end{bmatrix} \quad (12)$$

$$w = \begin{bmatrix} V_0^{-1/2}\theta_0 \\ (\Sigma_t^{-1/2} \otimes B) \end{bmatrix} \quad (13)$$

Now, the exponent in (11) can be rewritten as

$$\pi(\theta|y) \propto \exp\left\{-\frac{1}{2}(w-W\theta)'(w-W\theta)\right\} \propto \exp\left\{-\frac{1}{2}(\theta-\bar{\theta})'W'W(\theta-\bar{\theta})+(w-W\bar{\theta})'(w-W\bar{\theta})\right\} \quad (14)$$

The posterior mean, $\bar{\theta}$, is

$$\bar{\theta} = (W'W)^{-1}W'w = \left[V_0^{-1}+(\Sigma_t^{-1/2}\otimes B'B)\right]^{-1}\left[V_0^{-1}\theta_0+(\Sigma_t^{-1/2}\otimes B)'y\right] \quad (15)$$

Since Σ_t is assumed known, the second part of (15) is not random about $\bar{\theta}$. The posterior may therefore be summarized as

$$\pi(\theta|y) \propto \exp\left\{-\frac{1}{2}(\theta-\bar{\theta})'W'W(\theta-\bar{\theta})\right\} \quad (16)$$

In other words,

$$\pi(\theta|y) = \exp\left\{-\frac{1}{2}(\theta-\bar{\theta})'\bar{V}^{-1}(\theta-\bar{\theta})\right\} \quad (17)$$

And the posterior covariance, $\bar{V}$ is

$$\bar{V} = \left[V_0^{-1}+(\Sigma_t^{-1/2}\otimes B'B)\right]^{-1} \quad (18)$$

The incorporation of the prior distribution of the parameters, in order to strengthen inferences about their true value, is proper for Bayesian analysis. While there are different priors popular in the BVAR literature (i.e. Litterman/Minnesota prior, Normal-Wishart prior, Sims-Zha normal-Wishart prior and Sims-Zha normal-flat), this study adopts the Litterman/Minnesota prior which is based on the assumption that Σ_t is known and therefore yields to simplifications in prior elicitation and calculation of the posterior.

Further, out of the three choices of an estimator of Σ_t (i.e. univariate AR, full VAR and diagonal VAR), this study adopts the univariate AR where $\hat{\Sigma}_\varepsilon$ has a diagonal matrix restriction, where $\hat{\sigma}_{ii}^2$ is (i, i) –th element of $\hat{\Sigma}_\varepsilon$, the estimate of the error variance of the *i*-th variable from a univariate AR regression.
The Litterman prior assumes the prior of θ

$$v \sim N(v_0, V_0) \quad (19)$$

$\theta_0 = 0$ and $V_0 \neq 0$.

Since the explanatory variables in any VAR equation consist of own lags of the dependent variable, the constant term, lags of the other dependent variables, and lastly any exogenous variables, the components of V_0 conforming to the exogenous variables are set to infinity. The remainder of V_0 becomes a diagonal matrix with elements ${}_v^l ij$ for $l = 1, \ldots, p$

$$v_{ij}^{l} = \left\{ \frac{\lambda_1}{l^{\lambda_3}} \right\}^2 \quad \text{for (i = j)}$$

$$v_{ij}^{l} = \left\{ \frac{\lambda_1 \lambda_2 \sigma_i}{l^{\lambda_3} \sigma_j} \right\}^2 \quad \text{for (i} \neq \text{j)} \quad (20)$$

Where σ_i^2 is the i-th diagonal element of Σ_ε. λ_1, λ_2 and λ_3 are the three scalars for overall tightness, relative cross-variable weight and the lag decay respectively.

The posterior for θ now takes the form

$$\theta \sim N(\bar{\theta}, \bar{V}) \quad (21)$$

Where

$$\bar{V} = \left[V_0^{-1} + (\hat{\Sigma}_\varepsilon^{-1/2} \otimes B'B) \right]^{-1} \quad (22)$$

And

$$\bar{\theta} = \bar{V} \left[V_0^{-1} \theta_0 + (\hat{\Sigma}_\varepsilon^{-1/2} \otimes B)' y \right] \quad (23)$$

4. Empirical Analysis

The descriptive statistics for depositors with commercial banks (per 1,000 adults) (FINC), GDP per capita (constant 2005 US$) (GDPC), broad money (MONEY), deposit interest rate (INTEREST), adult literacy rate (LITERACY), GDP growth (GROWTH), domestic credit provided by financial sector as a % of GDP (CREDIT), total population (POPULATION), gross capital formation (CAPITAL), secure internet servers (SERVERS) and internet users per 100 people (INTERNET) for the 43 countries are presented in Table 2. The standard deviation is a measure of the amount of variation of a set of data values. Among variables for the 43 countries, gross capital formation and population have the highest variability, meaning the countries vary significantly in terms of capital formation and population. Kurtosis is a measure of "peakedness" of a distribution. For GROWTH, LITERACY, PUPOLATION, and MONEY series for the 43 countries, the Kurtosis statistics is far higher than 3, meaning that the series are leptokurtic relative to the normal. The Jarque-Bera test determines whether the series are normally distributed. The Jarque-Bera statistic of all the series surpass the 5% critical value of 5.99, thus rejecting the null of normal distribution.

Table 2. Descriptive Stats

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.	Obs.
FINC	340.51	256.13	0.49	1.98	11.18	0.00	416
GDPC	2446.84	2447.30	1.18	3.43	31.86	0.00	416
CAPITAL	1.87×10^{10}	2.32×10^{10}	1.40	3.66	46.20	0.00	416
GROWTH	4.10	7.29	-5.93	54.13	15382.18	0.00	416
INTEREST	5.57	3.47	1.51	5.17	77.45	0.00	416
USERS	13.04	13.42	1.67	5.09	86.72	0.00	416
SERVER	1.51	1.20	0.69	1.57	13.35	0.00	416
MONEY	93.12	101.05	2.56	9.66	94.28	0.00	416
CREDIT	31.03	51.07	1.28	6.02	87.31	0.00	416
LITERACY	64.26	10.66	1.87	14.73	71.99	0.00	416
POPULATION	3.03×10^{7}	3.74×10^{7}	2.76	10.15	456.24	0.00	416

Table 2 shows the correlation analysis between financial inclusion and GDP per capitain Africa. The sample correlation coefficient quantifies the direction and strength of the linear association between the two variables. The sample correlation coefficient (0.76) is significant at 1% level of significance. The correlation between the two variables is significantly positive, meaning that higher levels of per capital incomes are associated with higher levels of financial inclusion.

Table 3. Correlation Analysis

	GDPC	FINC
GDPC	1.00	
FINC	0.76	1.00
	(0.00)	

Notes: Prob. value in parenthesis

Table 4 below highlights the results of the IPS panel unit root test. It can be observed that the variables are all non-stationary in levels; specifically, they all exhibit a unit root. This points to the possibility of long-run equilibrium among the variables because the variables, in the long-run, may have a linear combination (Engle and Granger, 1987).

Table 4. IPS Unit Root Test

	I(0)	**I(1)**	**Decision**
FINC	3.84	-2.09*	I(1)
GDPC	2.88	-2.69*	I(1)
MONEY	0.51	-1.91**	I(1)
INTEREST	-0.43	-2.39*	I(1)
GROWTH	-1.02	-4.37*	I(1)
POPULATION	0.45	-2.39*	I(1)
CREDIT	0.54	-3.05*	I(1)
CAPITAL	0.71	-2.49*	I(1)
LITERACY	1.32	-2.68*	I(1)
USERS	-1.42	-1.953*	I(1)
SERVER	-0.39	-3.91**	I(1)

Notes: By Schwarz criterion, the lag length was 1. (*) and (**) indicate stationarity at significance levels of 1% and 5% respectively.

Table 5 presents the Pedroni Residual Cointegration Test results. Largely, the results show the absence of a long-run relationship between financial inclusion and GDP per capita in Africa. Therefore, GDP per capita does not have a long-run relationship with financial inclusion. It demonstrates that, permanent changes in GDP per capita do not affect permanent changes in financial inclusion in the long-run.

Table 5. Pedroni Residual Cointegration Test

Null Hypothesis: No cointegration
Use d.f. corrected Dickey-Fuller residual variances
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.43	0.33	-0.14	0.55
Panel rho-Statistic	0.60	0.72	-0.04	0.48
Panel PP-Statistic	-0.58	0.28	-2.70*	0.00
Panel ADF-Statistic	-0.52	0.30	-1.01	0.16

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	1.77	0.96
Group PP-Statistic	-3.60*	0.00
Group ADF-Statistic	-0.50	0.30

*Notes: * denotes significance at 1% level*

Table 6 indicates lag order 1 as selected by the VAR lag order selection criteria. In other words, lag 1 is the most appropriate for the estimation.

Table 6. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-9148.0	2057.8	7.66e+77	210.5	210.8	210.6
1	-7869.3	2204.5	2.16e+66*	183.9*	187.6*	185.4*
2	-7759.1*	162.1*	3.13e+66	184.1	191.3	187.0

** indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion*

Table 7 shows the BVAR estimates. Only estimates for FINC and GDPC are shown so as to save space. The results suggest that GDPC, MONEY, CREDIT, LITERACY, USERS and SERVER have positive significant impacts on FINC. On the other hand, INTEREST, CAPITAL and POPULATION have insignificant impacts on FINC. In other words, financial inclusion is better explained by GDP per capita, money supply, literacy rates, and the internet infrastructure. However, financial inclusion has insignificant impacts on GDP per capita. This outcome indicates financial inclusion is not significant enough to boost per capital incomes in Africa.

Table 7. Bayesian VAR Estimates

	FINC	GDPC
FINC(-1)	0.96	0.06
	[17.32]	[0.12]
GDPC(-1)	0.01	0.98
	[1.99]	[24.81]
GROWTH(-1)	0.37	2.41
	[0.23]	[1.94]
INTEREST(-1)	0.13	-11.27
	[0.04]	[-0.46]
LITERACY(-1)	0.04	0.06
	[1.82]	[0.46]
CAPITAL(-1)	0.09	0.13
	[0.91]	[0.57]
CREDIT(-1)	0.17	3.46
	[2.06]	[2.44]
MONEY(-1)	0.01	-0.05
	[3.11]	[-0.06]
POPULATION(-1)	0.00	0.00
	[1.06]	[0.53]
SERVER(-1)	2.76	6.82
	[7.92]	[0.46]
USERS(-1)	1.22	-3.69
	[12.30]	[-0.43]
C	-6.98	-92.13
	[-0.27]	[-0.40]
R-squared	0.95	0.95
Adj. R-squared	0.94	0.95
F-statistic	168.68	184.05

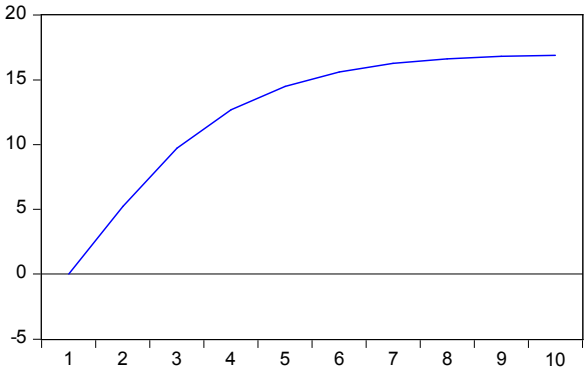
Notes: t-statistics in [ ]. If the t-statistics is more than 1.8, the variable in question has a significant impact on the dependent variable. The prior type is Litterman/Minnesota. The initial residual covariance is univariate AR. The hyper-parameters are Mu: 0, L1: 0.1, L2: 0.99, L3: 1.

Since a shock to the i-th variable not only affects the i-th variable but also all of the other endogenous variables via the dynamic structure of the VAR, an impulse response function can be used to trace the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. Fig. 2a shows the impulse response functions of financial inclusion to GDP per capita and the other endogenous variables. While a unit shock to real GDP per capita, broad money, credit, literacy, internet users and servers produces, to a great extent, a positive effect on financial inclusion, the response of financial inclusion to deposit interest rates growth, capital formation and population is largely insignificant. In other words, GDP per capita has positive significant effects on financial inclusion from the results of the IRFs.

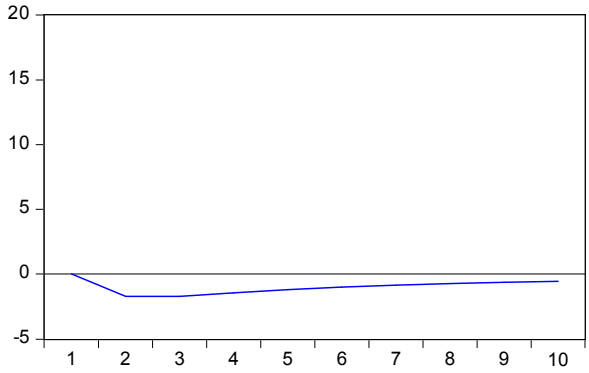
Figure 1. Impulse Response Functions for FINC

Response to Cholesky One S.D. Innovations

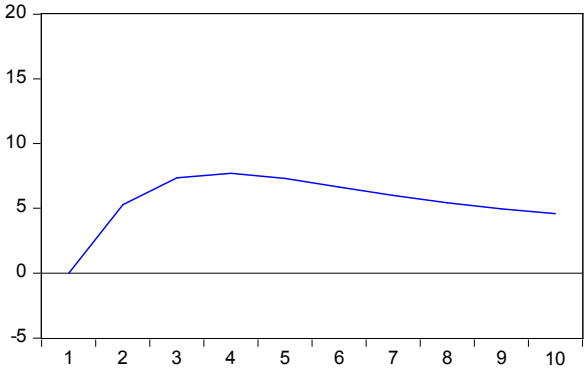
Response of FINC to GDPC



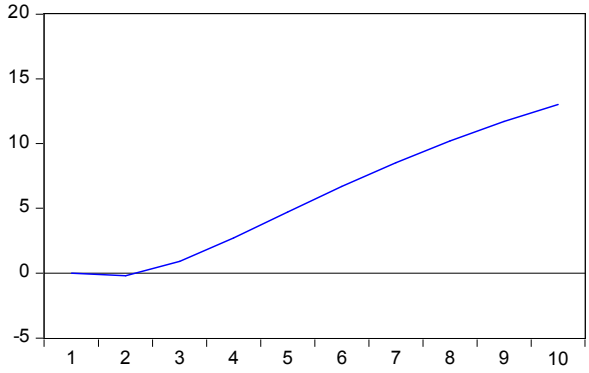
Response of FINC to GROWTH



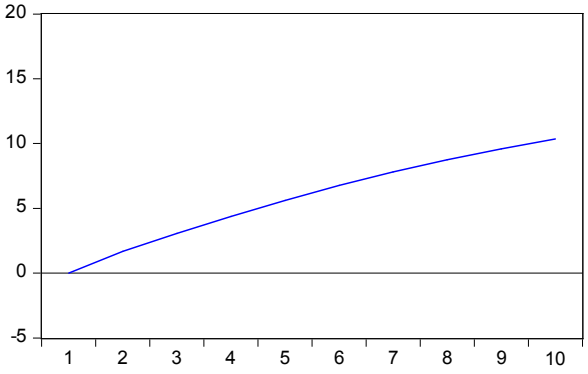
Response of FINC to INTEREST



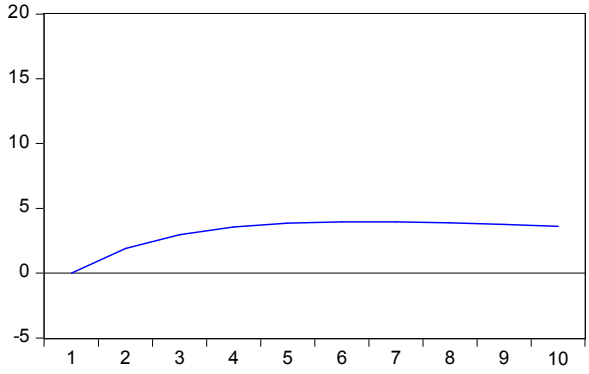
Response of FINC to CREDIT

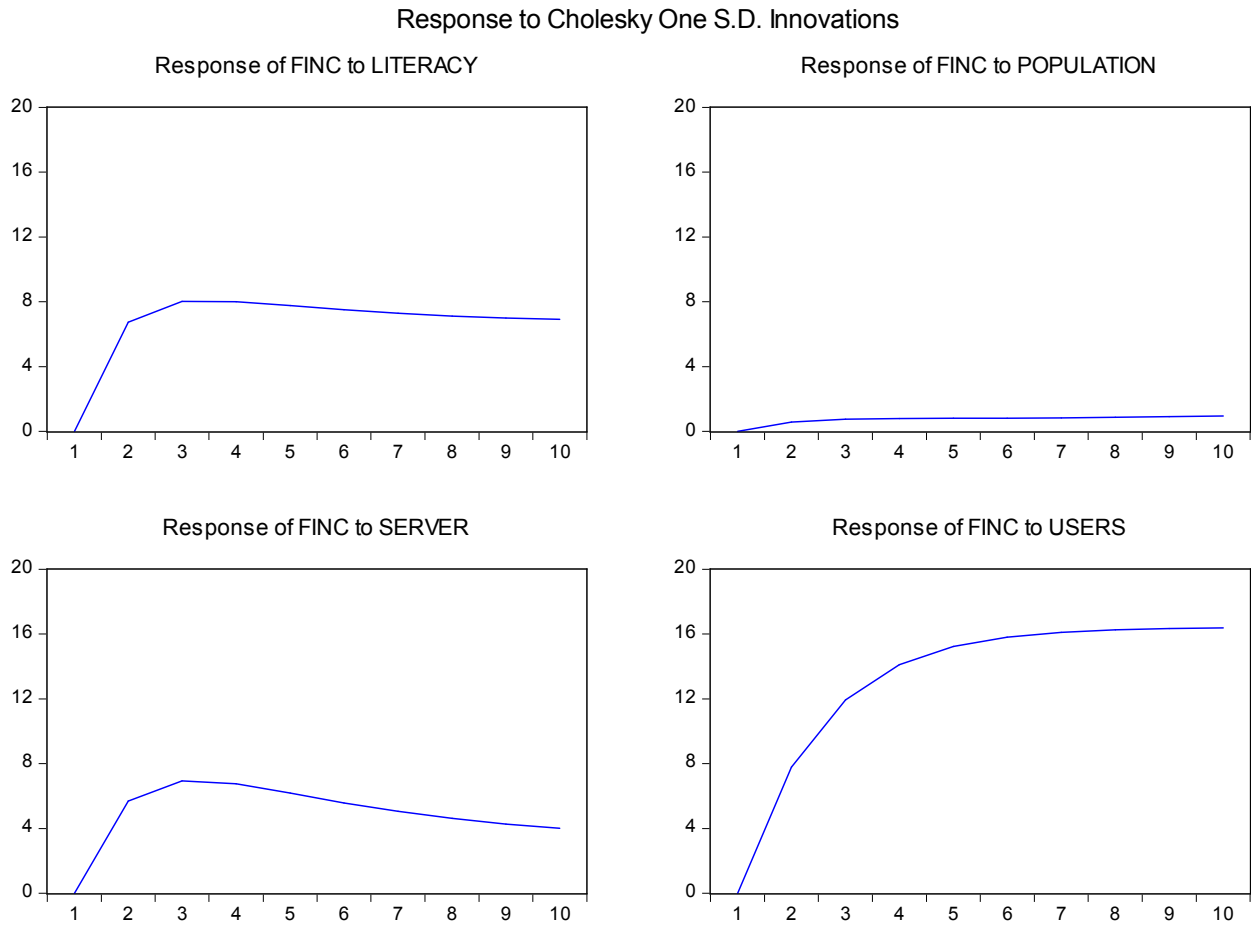


Response of FINC to MONEY



Response of FINC to CAPITAL





Variance decomposition can be used to separate the variation in an endogenous variable into the component shocks to the VAR. in other words, the variance decomposition offers information about the relative importance of each random innovation in influencing the variables in the VAR. In figure 1, the forecast error variance of financial inclusion are better explained by real GDP per capita, broad money, credit, literacy, internet users and servers. However, financial inclusion is not significantly explained by deposit interest rates, growth, capital and population.

Table 7. Variance Decomposition

Period	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
FINC	100.00	97.01	93.03	89.09	85.49	82.26	79.38	76.79	74.46	72.36
GDPC	0.00	0.40	1.35	2.57	3.84	5.03	6.10	7.02	7.79	8.44
GROWTH	0.00	0.04	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06
INTEREST	0.00	0.41	0.91	1.29	1.51	1.63	1.67	1.67	1.64	1.60
CAPITAL	0.00	0.05	0.12	0.19	0.25	0.29	0.31	0.33	0.34	0.33
CREDIT	0.00	0.00	0.01	0.08	0.26	0.55	0.95	1.44	2.01	2.64
LITERACY	0.00	0.66	1.20	1.55	1.78	1.93	2.03	2.10	2.14	2.16
MONEY	0.00	0.06	0.17	0.34	0.57	0.85	1.17	1.50	1.86	2.23
POPULATION	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
SERVER	0.00	0.48	0.89	1.15	1.28	1.33	1.35	1.33	1.30	1.27
USERS	0.00	0.89	2.25	3.65	4.93	6.04	6.96	7.73	8.37	8.89
S.E.	63.4	82.4	95.0	104.8	113.3	120.9	128.1	134.9	141.4	147.8

Cholesky Ordering: FINC GDPC GROWTH INTEREST CREDIT MONEY LITERACY CAPITAL POPULATION SERVER USERS

The results of the BVAR estimates, the impulse response function and the variance decomposition have all shown that real GDP per capita, broad money, credit, literacy, internet users and servers are the major determinants of financial inclusion in Africa. GDPC is statistically significant and positive. This means that countries with high GDP per capita have highly inclusive financial systems. This finding is in line with Honohan (2008), Kumar (2011), Sarma and Pais (2011), Chithra and Selvam (2013), Camara et al. (2014), Tuesta, et al. (2015), Fungáčová and Weill (2015), Park and Mercado (2015) and Evans and Adeoye (2016) who

also found that income is a significant variable for financial inclusion in a country. On the other hand, the current study showed that GDP growth, though positive, has insignificant impacts on financial inclusion. In other words, the high growth rates in African countries has not translated into inclusive financial systems in the continent.

Credit supply has positive and significant impact on financial inclusion. This finding is consistent with Chithra and Selvam (2013) who showed that deposit and credit penetration have significant impacts on financial inclusion in India. On a more distinct note, both the number of micro, small and medium enterprises in Africa and the level of credit extended to these enterprises are still low. For credit to continue to have much impacts in creating inclusive financial systems in the continent, African central banks need to see credit supply as a more potent device for bettering the lives of the poor.

Moreover, deposit interest rate has insignificant impacts on financial inclusion. The low deposit interest rates in Africa are unlikely to significantly impact both existing and potential depositors. Since the official interest rates is often the gauge of other interest rates in the economy, broader access to financial services across Africa is likely to make the interest rates set by African central banks a more potent device for regulating economies. In other words, considering that the rewards for saving are influenced by interest rates, higher financial access bring a bigger share of economic activity under the control of interest rates, making them a more powerful tool for policymakers, but can as well worsen the risk of injurious financial crises.

The impact of population, though positive, is insignificant. This finding conflicts with Chithra and Selvam (2013) who showed that population has significant impact on financial inclusion in India and Allen et al. (2014) who also showed that population has significant impact on financial inclusion in Africa. The impact of population on financial inclusion may have been overstated by these studies. Positive significant effects on financial inclusion are also seen, by way of literacy rate. Literacy, especially financial literacy, has gradually become more important as financial markets become increasingly complex and the illiterate finds it difficult to make informed financial decisions. This evidence is consistent with Sarma and Pais (2011) who, in a cross-country analysis, showed that adult literacy is a significant factor in explaining the level of financial inclusion in a country and Chithra and Selvam (2013) who found that literacy is an important in explaining the level of financial inclusion in India. Additionally, Camara et al (2014) and Tuesta et al (2015) showed that better education is a significant variable for financial inclusion.

As well, the significant impacts of the number of internet users and servers have weighty policy implications for financial inclusion in Africa. While it can be an arduous task, in terms of the investment and cost effectiveness, to cover all the millions of villages in the African continent with brick and mortar branches of financial institutions, high usage of the internet in Africa can broaden the scope of financial inclusion in the continent. Via the mobile and the ATM, the internet can drastically reduce the cost of transactions. Internet can increase the potentials of credit delivery in remote areas of the continent. It can make it possible to provide home banking services where the accounts are operated by illiterate customers using mobiles. According to Hariharan and Marktanner (2013, p.): "For example, in many developing countries, cell phone providers have successfully entered the market for the safe transfer of funds. Cell phone users use their phones to transfer money to other family members or to pay bills to businesses. Cell phone companies have therefore excellent access to data that can be used to build a credit profile of cell phone users. This credit profile could serve as a substitute for the absence of collateral and reduce high transaction costs of gathering information about borrowers... It seems accordingly plausible to assume that a market would evolve in which cell phone companies either use these credit profiles as an input factor for banks willing to expand their credit business, or even enter the market for credit themselves. To which extent this will occur, however, depends substantially on the regulatory quality of the country…" In fact, free access to the internet as a public good and service can be the sine qua non to an open and efficient financial system in Africa. It is vital that the availability of banking and payment services on the internet to the entire African population without discrimination becomes the prime objective of public policies. In other words, the internet should be harnessed as a major financial inclusion enabler in Africa.

4. Conclusion

Can higher GDP per capita translate into higher financial inclusion in Africa? Our application of the Bayesian VAR estimation approach to the World Bank Development Indicators datasets for 43 African countries provides affirmative evidence to this question. The findings show that higher income is associated with higher levels of financial inclusion in Africa. It is, however, interesting to note that financial inclusion is having an insignificant positive impact on GDP per capita. The evidence also suggests that broad money, credit supply, literacy, internet users and servers have positive and significant impacts on financial inclusion. Moreover, the internet is coming out to be a significant variable indicating that more attention is required to be paid to developing internet access in Africa for the advancement of financial inclusion. The results of this study have important policy implications for future policy design in African countries given financial innovations in the continent such as M-Pesa in Kenya.

The most startling and unexpected finding of this study is that financial inclusion has positive but

insignificant impact on GDP per capita. This is very interesting for policy implications. While a strong financial system is "a pillar of economic growth, development and progress of an economy" and "a financial system, which is inherently strong, functionally diverse and displays efficiency and flexibility, is critical to our national objectives of creating a market-driven, productive and competitive economy" (Kumar, 2012, p. 1), the financial system in Africa is not mature enough to support higher quanta of investment and growth with its puny financial depth and coverage. In this contemporary era of attaining economic clout and self-reliance, it is, therefore, imperative for every African regime to create friendly conditions for the delivery of banking services at affordable costs to its vast sections of disadvantaged low-income groups. For these countries, increasing incomes will eliminate many of the arguments supporting low financial inclusion: people with high incomes are likely to save more, be bank-literate, and get more securities (Hariharan and Marktanner, 2013). Accordingly, the financial system is less likely to fail (Ardic, Heimann and Mylenko, 2011).

There are of course limitations to the analysis undertaken in this study. Using proxies such as Depositors with commercial banks per 1,000 adults as a measure of financial inclusion may not be adequate. It would therefore be worthwhile to examine other alternative measures which could enhance access to formal finance for excluded individuals, such as the nature and frequency of transactions that take place in these accounts. As well, what is true for the region may not necessarily be true for a specific country. A noble illustration of this is the evolution of mobile money in countries such as Nigeria, Kenya and South Africa. Further research may be necessary using country case studies to understand specific types of financial innovation proxies.

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APPENDIX: LIST OF THE 43 AFRICAN COUNTRIES IN THE SAMPLE

Algeria, Angola, Cameroon, Chad, Congo, Gabon, Nigeria, Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Libya, Madagascar, Malawi, Mali, Mozambique, Morocco, Niger, Senegal, Tanzania, Uganda, Zambia, Botswana, Cape Verde, Lesotho, Mauritius, Namibia, Seychelles, South Africa, Swaziland, Senegal, Burundi, Central African Rep., Congo, Côte d'Ivoire, The Gambia, Guinea, Liberia, São Tomé and Príncipe, Sierra Leone, Togo, Zimbabwe.