Financial, Public and Regional Economics

Financial Inclusion and per Capita Income in Africa: Bayesian Var Estimates

Raymond Osi Alenoghena[1]

Abstract: Do higher per capita incomes translate into higher financial inclusion in Africa? Our application of the Bayesian VAR estimation approach to the World Bank Development Indicators datasets for 15 African countries provides affirmative evidence to this question. Using a Bayesian VAR approach for a panel of 15 countries in Africa over the period from 2005 to 2014, the findings show that per capital incomes, deposit interest rate and the internet has positive and significant impact on financial inclusion. That is, higher per capital incomes is associated with higher levels of financial inclusion in Africa. It is, however, interesting to note that financial inclusion is having a positive but insignificant impact on per capita income. 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; per capita income; Bayesian VAR

JEL Classification: G21; C23

1. Introduction

Do higher per capita incomes 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 & Rhyne (2013) suggest that they do, the connection has not been empirically established, especially in Africa. Our application of the Bayesian VAR estimation approach to the Worldbank Development datasets for 15 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. This stems from the

[1] Economics and M Phil/PhD Student, Corresponding author: raymondalen@hotmail.com.

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 & 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 more costly 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".

Most importantly, 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). 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).

In the literature, the significance of financial development for economic growth has been well-established (i.e. King & Levine, 1993; Levine, 2005; Demirgüç-Kunt, Beck, & Honohan, 2008). The importance of inclusive financial systems, as well, has entered the debate (Beck, Demirgüç-Kunt, & Peria, 2008) in more recent years. Studies such as Caskey, Duran, & Solo (2006) and Dupas & 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 & 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. The major gap in the literature, therefore, is to look at the significance of income to financial access.

It is therefore to ask if the level of income in Africa is appropriate for the needed financial inclusion. According to Kelly & 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".

With the objectives enumerated above, the current study is an attempt to understand the impact of per capita income on financial inclusion in Africa. A Bayesian VAR approach is employed for the country-wise panel data spanning over a period from 2005 to 2014, in the context of a panel of 15 countries in Africa. The findings corroborate significant impacts of per capita income on financial inclusion, signifying thereby how increase in incomes 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 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 discusses the data, the Bayesian VAR, Im Pesaran & Shin panel unit root tests and the Pedroni Contegration test used. Section 3 discusses the results of the empirical analysis. Section 4 concludes with summary and key findings.

2. Data & Methodology

2.1. Data

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, domestic credit provided by financial sector as a% of GDP, and internet users per 100 people. 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.

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$)	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2005 U.S. dollars.
Broad money (constant 2005 US$)	Broad money (IFS line 35L..ZK) 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.

Source: World Development Indicators

2.2. Panel Unit Root Tests

This study carries out the Im Pesaran & 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

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

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

And the average of the t-statistics for p_1 from individual ADF regressions, $t_{iT_i}(p_i)$ is

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i\beta_i) \quad (2)$$

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

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.

2.3. 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 & 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,

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \ldots + \beta_{li} x_{li,t} + \varepsilon_{i,t} \quad (3)$$

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, $\frac{\aleph_{N,T}-\mu\sqrt{N}}{\sqrt{v}} \to N(0,1)$, where μ and v are produced by the Pedroni via Monte Carlo simulations.

2.4. Bayesian VAR

In Bayesian statistics and econometrics, the *prior*, *likelihood*, and *posterior's* distributional properties are important. Anything uncertain is a random variable which is 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

$$\pi(\theta \mid y) = \frac{\pi(\theta) l(y \mid \theta)}{\int \pi(\theta) l(y \mid \theta) d\theta} \tag{4}$$

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

$$y_t = \alpha_0 + \sum_{j=1}^{p} C_j y_{t-j} + \varepsilon_t \qquad t = 1, \ldots, T \tag{5}$$

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, (2) may be rewritten as:

$$Y = BC + E \tag{6}$$

Or

$$y = (L_n \otimes B)\theta + e \tag{7}$$

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

$$l(\theta, \Sigma_t) \propto |\Sigma_t \otimes L_T|^{-1/2} \exp\left\{-\frac{1}{2}(y-(L_n \otimes B)\theta)'(\Sigma_t \otimes L_T)^{-1}(y-(L_n \otimes B)\theta)\right\} \tag{8}$$

Assuming Σ_t is a multivariate normal prior for θ, then

$$\pi(\theta) \propto |V_0|^{-1/2} \exp\left\{-\frac{1}{2}(\theta-\theta_0)'V_0^{-1}(\theta-\theta_0)\right\} \tag{9}$$

Where V_0 is the prior covariance and θ_0 the prior mean.

Combining the prior with the likelihood function in (5), the posterior density becomes

$$\pi(\theta \mid y) = \exp\left\{-\frac{1}{2}.((V_0^{-1/2}(\theta-\theta_0))'V_0^{-1/2}(\theta-\theta_0) + \left\{(\Sigma_t^{-1/2}\otimes L_T)y - (\Sigma_t^{-1/2}\otimes B)\theta\right\}'\left\{(\Sigma_t^{-1/2}\otimes L_T)y - (\Sigma_t^{-1/2}\otimes B)\theta\right\}\right\} \tag{10}$$

(7) is a multivariate normal probability distribution function (pdf).

For simplicity, we do some definitions:

$$w = \begin{bmatrix} V_0^{-1/2}\theta_0 \\ \\ \\ \\ (\Sigma_t^{-1/2}\otimes L_T)y \end{bmatrix} \tag{11}$$

$$W = \begin{bmatrix} V_0^{-1/2}\theta_0 \\ \\ \\ \\ (\Sigma_t^{-1/2}\otimes B) \end{bmatrix} \tag{12}$$

Now, the exponent in (7) can be rewritten as

$$\pi(\theta \mid y) \propto \exp\left\{-\frac{1}{2}(w-W\theta)'(w-W\theta)\right\} \propto \exp\left\{-\frac{1}{2}(\theta-\bar{\theta})'W'W(\theta-\bar{\theta}) + (w-W\bar{\theta})'(w-W\bar{\theta})\right\} \tag{13}$$

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

$$\bar{\theta} = (W'W)^{-1}W'w = \left[V_0^{-1} + (\Sigma_t^{-1/2} \otimes B'B)\right]^{-1}\left[V_0^{-1}\theta_0 + (\Sigma_t^{-1/2} \otimes B)'y\right] \quad (14)$$

Since Σ_t is assumed known, the second part of (10) is not random about $\bar{\theta}$. The posterior may therefore be summarized as

$$\pi(\theta \mid y) \propto \exp\left\{-\frac{1}{2}(\theta - \bar{\theta})'W'W(\theta - \bar{\theta})\right\} \quad (15)$$

In other words,

$$\pi(\theta \mid y) = \exp\left\{-\frac{1}{2}(\theta - \bar{\theta})'\bar{V}^{-1}(\theta - \bar{\theta})\right\} \quad (16)$$

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

$$\bar{V} = \left[V_0^{-1} + (\Sigma_t^{-1/2} \otimes B'B)\right]^{-1} \quad (17)$$

2.5. Litterman or Minnesota Prior

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

$$v \sim N(v_0, V_0) \quad (18)$$

$\theta_0 = 0$ 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 $l = 1, \dots, p$

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

$$v_{ij}^l = \left\{ \frac{\lambda_1 \lambda_2 \sigma_i}{l^{\lambda_3} \sigma_j} \right\}^2 \text{ for } (i \neq j) \tag{19}$$

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

$$\theta \sim N(\bar{\theta}, \bar{V}) \tag{20}$$

Where

$$\bar{V} = \left[V_0^{-1} + (\hat{\Sigma}_\varepsilon^{-1/2} \otimes B' B) \right]^{-1} \tag{21}$$

And

$$\bar{\theta} = \bar{V} \left[V_0^{-1} \theta_0 + (\hat{\Sigma}_\varepsilon^{-1/2} \otimes B)' y \right] \tag{22}$$

3. 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), domestic credit provided by financial sector as a% of GDP (CREDIT), and internet users per 100 people (INTERNET) for the 15 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 15 countries, per capita income is the most volatile. Kurtosis is a measure of "peakedness" of a distribution. For GDPC, CREDIT, INTERNET and INTEREST series for the 15 countries, the Kurtosis statistics is more than 3, meaning that the distributions are leptokurtic relative to the normal. The Jarque-Bera test determines whether the series are normally distributed. The J-B statistic of all the series surpass the 5% critical value of 5.99, thus rejecting the null of normal distribution.

Table 2. Descriptive Stats

	FINC	GDPC	MONEY	CREDIT	INTEREST	INTERNET
Mean	340.5080	2446.836	27.12722	31.03451	5.566371	13.04333
Median	286.5703	1005.748	27.64236	21.57777	3.903333	8.032688
Maximum	940.7300	9494.280	30.53428	192.6601	18.40972	56.80000
Minimum	13.87084	211.2941	22.19383	-114.6937	1.750000	0.294034
Std. Dev.	256.1285	2447.303	2.048238	51.07377	3.469951	13.42446
Skewness	0.489082	1.175058	-0.519370	1.275751	1.514876	1.669177
Kurtosis	1.977365	3.428268	2.193872	6.021274	5.166079	5.094441
Jarque-Bera	11.18110	31.86104	9.652606	87.31362	77.44808	86.71635
Probability	0.003733	0.000000	0.008016	0.000000	0.000000	0.000000
Sum	45628.07	327876.1	3635.047	4158.624	745.8938	1747.806
Sum Sq. Dev.	8725044.	7.97E+08	557.9719	346934.5	1601.395	23968.74
Observations	134	134	134	134	134	134

Table 3 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 & Granger, 1987).

Table 3. IPS Panel unit root test

	I(0)	I(1)
FINC	3.864	-2.630*
GDPC	2.838	-2.696*
INTEREST	-0.418	-2.349*
MONEY	0.928	-10.001*
CREDIT	-0.613	-4.434*
INTERNET	2.819	-4.827*

*Notes: * denote significance at 1%. Optimal lags are chosen with the AIC.*

Table 4 presents the Pedroni Residual Cointegration Test results. Largely, the results show the absence of a long-run relationship between financial inclusion and per capita income in sub-Saharan Africa. Therefore, per capita income does not have a long-run relationship with financial inclusion. It demonstrates that, permanent changes in per capita income do not affect permanent changes in financial inclusion in the long-run.

Table 4. 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)					
				Weighted	
		Statistic	Prob.	Statistic	Prob.
Panel v-Statistic		0.429865	0.3336	-0.141593	0.5563
Panel rho-Statistic		0.596781	0.7247	-0.038566	0.4846
Panel PP-Statistic		-0.580164	0.2809	-2.698408	0.0035
Panel ADF-Statistic		-0.515456	0.3031	-1.012549	0.1556
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.774640	0.9620		
Group PP-Statistic		-3.602082	0.0002		
Group ADF-Statistic		-0.501898	0.3079		

The BVAR estimates in Table 5 shows that while GDPC, INTERNET and INTEREST has positive significant impact on FINC while only CREDIT has positive and significant impact on GDPC. MONEY has negative but insignificant impact on both GDPC and FINC. In other words, financial inclusion is better explained by per capita income, deposit interest rate and the internet. However, per capita income is not explained by any of the endogenous variables except CREDIT. This outcome indicates per capital income has not been large enough to boost financial inclusion in Africa.

Table 5. Bayesian VAR Estimates

Prior type: Litterman/Minnesota						
Initial residual covariance: Univariate AR						
Hyper-parameters: Mu: 0, L1: 0.1, L2: 0.99, L3: 1						
Standard errors in ( ) & t-statistics in [ ]						
	FINC	GDPC	MONEY	CREDIT	INTEREST	INTERNET
FINC(-1)	0.808090	0.486176	-5.89E-05	0.005828	0.002684	0.011019
	(0.04299)	(0.39170)	(7.9E-05)	(0.00858)	(0.00141)	(0.00191)
	[18.7959]	[1.24118]	[-0.74216]	[0.67932]	[1.90260]	[5.77865]
GDPC(-1)	0.010426	0.882216	-4.29E-06	-0.001221	-0.000338	-0.000229
	(0.00309)	(0.02823)	(5.7E-06)	(0.00062)	(0.00010)	(0.00014)
	[3.37152]	[31.2563]	[-0.74998]	[-1.97597]	[-3.32559]	[-1.66704]
MONEY(-1)	-2.511125	-19.77633	0.986677	0.062258	-0.265694	0.525722
	(3.39849)	(31.0126)	(0.00629)	(0.67934)	(0.11172)	(0.15092)
	[-0.73889]	[-0.63769]	[156.867]	[0.09164]	[-2.37822]	[3.48342]
CREDIT(-1)	0.015084	3.018802	-0.000257	0.899425	0.009914	0.020779
	(0.13018)	(1.18791)	(0.00024)	(0.02604)	(0.00428)	(0.00578)
	[0.11588]	[2.54128]	[-1.06602]	[34.5401]	[2.31668]	[3.59414]
INTEREST(-1)	3.495374	-8.162343	0.006140	0.079086	0.554782	0.048321
	(1.60424)	(14.6399)	(0.00297)	(0.32070)	(0.05288)	(0.07123)
	[2.17883]	[-0.55754]	[2.06784]	[0.24661]	[10.4920]	[0.67833]
INTERNET(-1)	3.154760	-9.056205	-0.001040	-0.032059	-0.034998	0.839148
	(0.79491)	(7.24732)	(0.00147)	(0.15877)	(0.02610)	(0.03531)
	[3.96872]	[-1.24959]	[-0.70747]	[-0.20193]	[-1.34076]	[23.7666]
C	84.93859	714.9876	0.529481	2.885662	9.737883	-13.93257
	(96.1510)	(877.424)	(0.17795)	(19.2200)	(3.16124)	(4.26979)
	[0.88339]	[0.81487]	[2.97538]	[0.15014]	[3.08040]	[-3.26306]

R-squared	0.937344	0.944723	0.997248	0.938741	0.655347	0.965919
Adj. R-squared	0.933958	0.941735	0.997099	0.935429	0.636717	0.964077
Sum sq. resids	483364.4	38103999	1.317014	18088.14	508.9887	768.1006
S.E. equation	65.98965	585.9004	0.108927	12.76543	2.141374	2.630556
F-statistic	276.7648	316.1785	6703.065	283.4951	35.17715	524.3304
Mean dependent	353.0546	2424.098	27.23733	32.55798	5.585330	14.04036
S.D. dependent	256.7819	2427.283	2.022328	50.23636	3.552794	13.87913

Standard errors in ( ) & t-statistics in [ ]. If the t-statistics is more than 2, the variable in question has a significant impact on the dependent variable.

Figure 1 reports the inverse roots of the characteristic AR polynomial (see Lütkepohl,1991) and shows that the estimated VAR is stable since all roots have modulus less than one and are in the unit circle. Stability of the VAR ensures that certain results, such as impulse response standard errors, are valid.

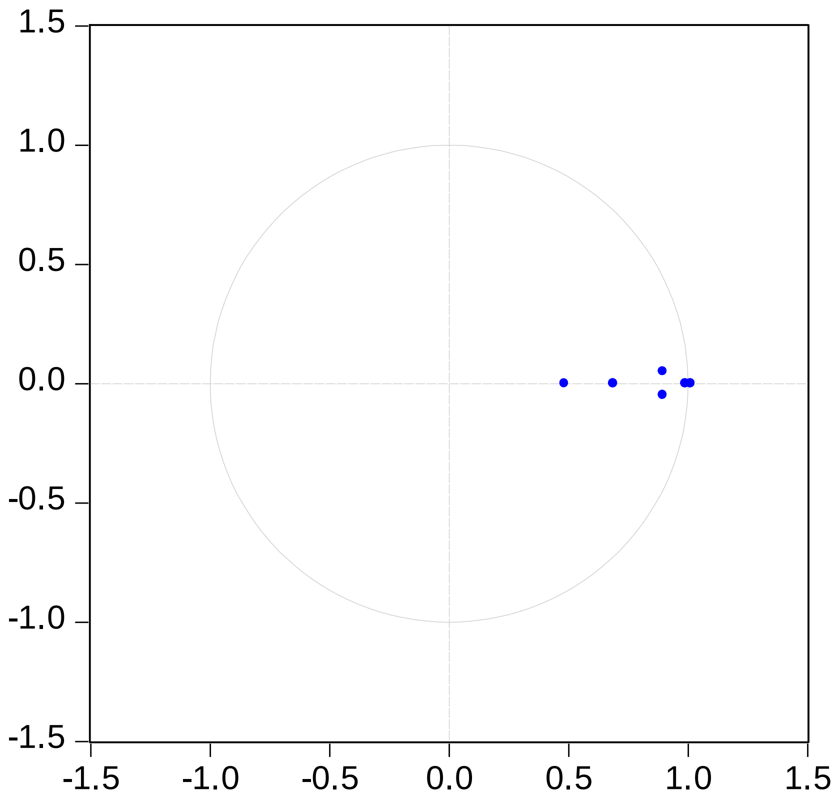

Figure 1. Inverse Roots of AR Characteristic Polynomial

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	-2982.449	NA	1.13e+18	58.59705	58.75146	58.65957
1	-2120.901	1604.845	1.06e+11*	42.40983*	43.49070*	42.84751*
2	-2085.096	62.48356*	1.07e+11	42.41365	44.42098	43.22648
* 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						

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 per capita income and the other endogenous variables. While a unit shock to real per capita income, interest and internet produces, to a great extent, a positive effect on financial inclusion, the response of financial inclusion to money supply is largely insignificant. Per capita income has positive significant effects on financial inclusion from the results of the IRFs.

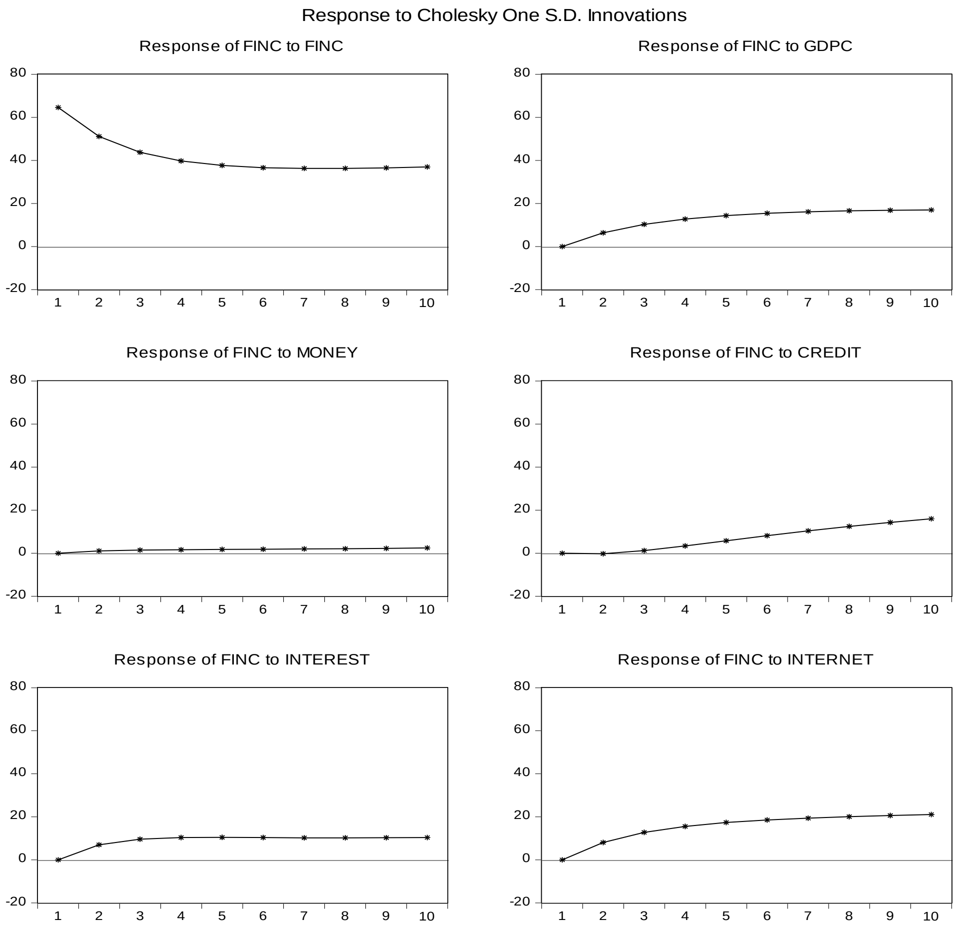

Figure 2a. Impulse Response Functions for FINC

Figure 2b shows the impulse response functions of per capita income to financial inclusion and the other endogenous variables. A unit shock to financial inclusion, and the other endogenous variables produces insignificant effects on financial inclusion. Financial inclusion has insignificant effects on per capita income from the results of the IRFs.

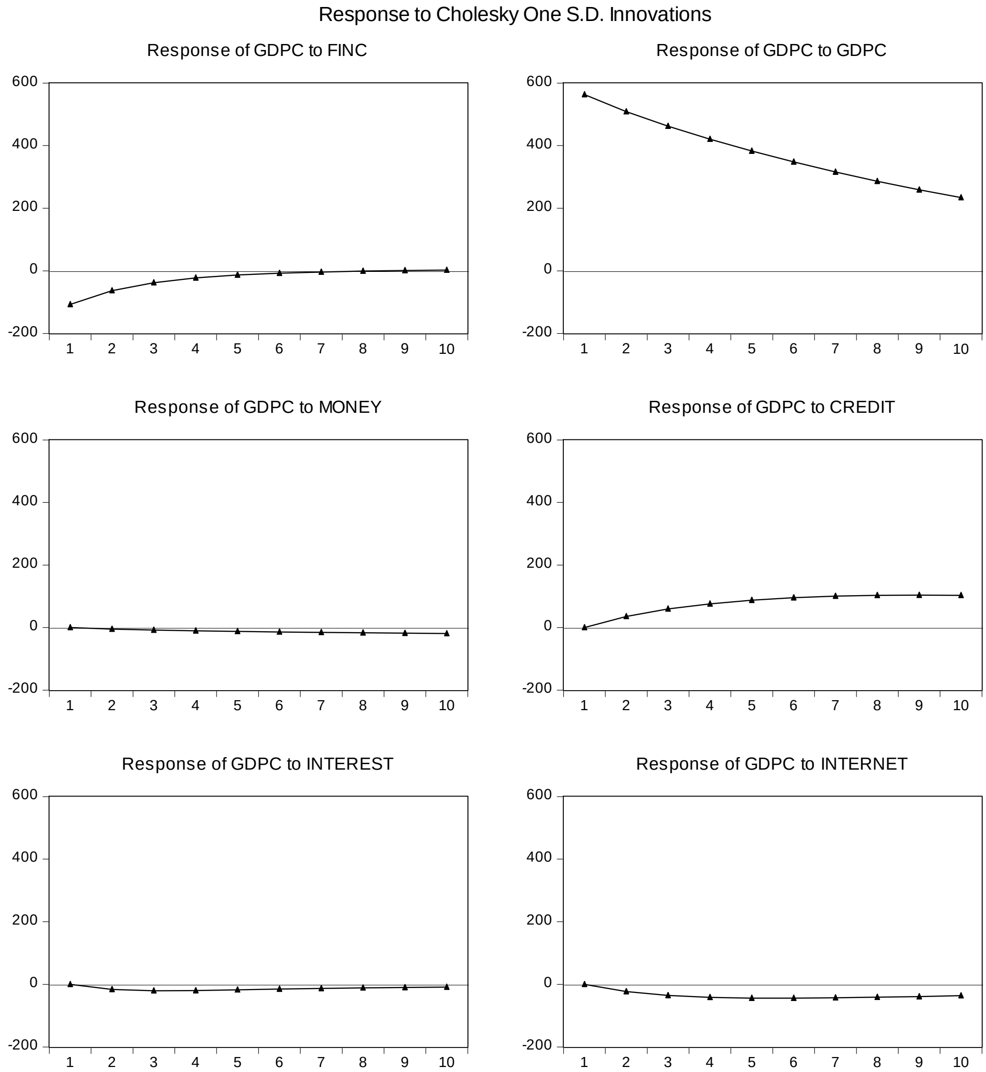

Figure 2b. Impulse Response Functions for GDPC

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 fig. 4, the forecast error variance of financial inclusion are better explained per capita income and internet. For per capital income, the rates of increase are very minimal. However, per capita income is not explained better by any of the endogenous variables except itself. This outcome indicates per capital income has not large enough to in boost financial inclusion in Africa.

Table 7. Variance Decomposition

Variance Decomposition of FINC:							
Period	S.E.	FINC	GDPC	MONEY	CREDIT	INTEREST	INTERNET
1	64.55180	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	83.26073	97.75622	0.581994	0.014926	0.001187	0.707970	0.937706
3	95.96174	94.37402	1.574800	0.033415	0.016241	1.534454	2.467067
4	106.3653	90.78334	2.707195	0.050037	0.113742	2.198866	4.146824
5	115.6775	87.34251	3.820570	0.064242	0.344197	2.674943	5.753537
6	124.4133	84.16836	4.833201	0.076750	0.723654	3.003496	7.194544
7	132.8273	81.28623	5.709202	0.088370	1.242044	3.229559	8.444593
8	141.0555	78.68837	6.438821	0.099727	1.875175	3.387730	9.510173
9	149.1738	76.35544	7.026650	0.111247	2.593867	3.501837	10.41096
10	157.2258	74.26454	7.484619	0.123205	3.369483	3.587596	11.17056
Variance Decomposition of GDPC:							
Period	S.E.	FINC	GDPC	MONEY	CREDIT	INTEREST	INTERNET
1	573.1341	3.512876	96.48712	0.000000	0.000000	0.000000	0.000000
2	770.1136	2.623718	97.02790	0.004163	0.209440	0.044454	0.090323
3	901.6868	2.091129	97.00946	0.011054	0.584757	0.083706	0.219893
4	999.1215	1.755082	96.71217	0.019746	1.054298	0.107562	0.351144
5	1074.662	1.532589	96.27213	0.030083	1.574878	0.120029	0.470288
6	1134.692	1.379064	95.76089	0.042131	2.118720	0.125839	0.573358
7	1183.098	1.269458	95.21921	0.055981	2.666905	0.128155	0.660287
8	1222.487	1.189040	94.67197	0.071691	3.206074	0.128788	0.732439
9	1254.728	1.128757	94.13498	0.089266	3.726696	0.128703	0.791596
10	1281.219	1.082824	93.61851	0.108662	4.222068	0.128392	0.839547
Cholesky Ordering: FINC GDPC MONEY CREDIT INTEREST INTERNET							

The results of the BVAR estimates, the impulse response function and the variance decomposition have all shown that per capita income, the internet and the deposit interest rate are the major determinants of financial inclusion in sub-Saharan Africa. Our findings are consistent with Park & Mercado (2015) which found that per capita income is the main determinant for financial inclusion and Kumar (2011) which found that income has a positive and significant impact on the level of financial inclusion. Honohan (2008) also found that there is a correlation between the two, though not able to establish if it is causal.

The finding that financial inclusion has positive but insignificant impact on per capita income in Africa 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 sub-Saharan 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 per capita 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 & Marktanner, 2013). Accordingly, the financial system is less likely to fail (Ardic, Heimann & Mylenko, 2011).

CREDIT has positive but insignificant impact on financial inclusion. 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 abysmally low, as a result of weak asset base and poor credit profile information and therefore may not make much impact in creating inclusive financial systems in the continent.

As well, the significant impacts of INTERNET 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, with high usage of the internet in Africa, financial inclusion can be broadened. 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 & 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.

As well, deposit interest rates have positive and significant impacts on financial inclusion. If the deposit interest rates are high, it is likely to significantly induce both existing and potential depositors. African central banks can therefore use interest rates as a more potent device for enhancing financial inclusion in Africa. Considering that the rewards for saving are influenced by interest rates, higher financial access brings a bigger share of economic activity under the control of interest rates, making them a more powerful tool for policymakers.

4. Conclusion

Do higher per capita incomes translate into higher financial inclusion in Africa? Our application of the Bayesian VAR estimation approach to the Worldbank Development Indicators datasets for 15 African countries provides affirmative evidence to this question. Using a Bayesian VAR approach for a panel of 15 countries in Africa over the period from 2005 to 2014, the findings show that per capital incomes, deposit interest rate and the internet has positive and significant impact on financial inclusion. That is, higher per capital incomes is associated with higher levels of financial inclusion in Africa. It is, however, interesting to note that financial inclusion is having a positive but insignificant impact on per capita income. 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 mobile money. 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.

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.

5. Bibliography

Ardic, O.P.; Heimann, M. & Mylenko, N. (2011). Access to financial services and the financial inclusion agenda around the world: a cross-country analysis with a new data set. *World Bank Policy Research Working Paper Series*, Vol. 2011.

Ardic, O.P.; Heimann, M. & Mylenko, N. (2011). Access to financial services and the financial inclusion agenda around the world: a cross-country analysis with a new data set. *World Bank Policy Research Working Paper Series*, Vol.

Beck, T.A.; Demirgüç-Kunt & Martinez, Peria M.S. (2008). Banking Services for Everyone? Barriers to Bank Access and Use around the World. *World Bank Economic Review*, 22(3), pp. 397-430.

Beck, T.; Demirgüç-Kunt, A. & Maksimovic, V. (2005). Financial and Legal Constraints to Firm Growth: Does Firm Size Matter?. *Journal of Finance,* 60, pp. 137–7.

Camarero, M. & Tamarit, C. (2002). A panel cointegration approach to the estimation of the peseta real exchange rate. *Journal of Macroeconomics*. 24, pp. 371-393.

Caskey, J., C. R. Duran, and T. M. Solo (2006). The Urban Unbanked in Mexico and the United States. *Policy Research Working Paper 3835*. World Bank, Washington, DC.

Demirgüç-Kunt, A; Thorsten, B. & Honohan P. (2008). *Finance for All? Policies and Pitfalls in Expanding Access*. Washington, DC: World Bank.

Dupas, P. & Robinson, J. (2009). Savings Constraints and Microenterprise Development: Evidence from a Field Experiment in Kenya. *NBER Working*, Paper 14693. National Bureau of Economic Research, Cambridge, MA.

Hariharan, G. & Marktanner, M. (2013). *The growth potential from financial inclusion*.

Honohan, Patrick (2008). Cross-country variation in household access to financial services. *Journal of Banking & Finance,* 32, no. 11, pp. 2493-2500.

Im, K.S.; Pesaran, M.H. & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*. 115, pp. 53-74.

Kelly, S. & Rhyne, E. (2013). *Growing Income, Growing Inclusion: How Rising Incomes at the Base of the Pyramid Will Shape Financial Inclusion Financial Inclusion 2020 Project*. Mapping the Invisible Market, Centre for Financial Inclusion, 19.

Kumar, N. (2011). Financial Inclusion and its determinants: Evidence from state level empirical analysis in India. In Proceedings of the 13th Annual *Conference on Money and Finance in the Indian Economy*, Indira Gandhi Institute of Development Research, Mumbai, India.

Levine, R. (2005).Finance and Growth: Theory and Evidence. In Aghion, P. & Durlauf, S.N. (eds.) *Handbook of Economic Growth*, Vol 1A, pp. 865-934.

Liew, V.K. (2004). Which lag selection criteria should we employ?. *Economics Bulletin*, 3(33), pp. 1-9.

Lütkepohl, H. (1991). *New introduction to multiple time series analysis*. Berlin: Springer Science & Business Media.

Park, C.Y. & Mercado Jr. R. (2015). Financial Inclusion, Poverty, and Income Inequality in Developing Asia. *Asian Development Bank Economics Working Paper Series*, (426).

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels withmultiple regressors. *Oxford Bulletin of Economics and Statistics*, Special Issue, pp. 653-670.

Schiffer, M. & Weder, B. (2001). Firm Size and the Business Environment: Worldwide Survey Results. Discussion Paper 43, *International Finance Corporation*, Washington, DC.

Tatum, B. (2014) *Financial Inclusion in the Philippines: A Regional Assessment*. Institute of Social Sciences The University of Tokyo.

APPENDIX: LIST OF THE 15 AFRICAN COUNTRIES IN THE SAMPLE

Algeria;

Angola;

Botswana;

Ghana;

Kenya;

Libya;

Malawi;

Mali;

Morocco;

Namibia;

Nigeria;

Niger;

South Africa;

Senegals;

Cameroon.