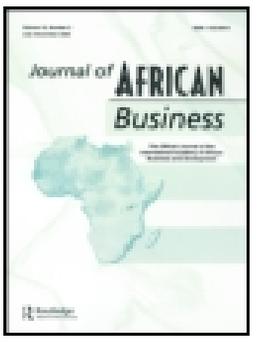

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Monetary Policy and Financial Inclusion in Sub-Sahara Africa: A Panel VAR Approach

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ABSTRACT

This article investigates the dynamic and bi-causal link between monetary policy and financial inclusion in sub-Saharan Africa using a panel VAR framework. The researcher obtained data from World Development Indicators (WDI) spanning from 1990 to 2014 for 48 sub-Saharan African economies. The findings suggest that a bi-causal relationship exists between monetary policy and financial inclusion. Specifically, it is evident that monetary policy affects financial inclusion, and financial inclusion is also influenced by monetary policy. The policy implication of this study is that the effectiveness of monetary policy depends on financial inclusion. Hence, the efforts of governments in sub-Saharan African countries should aim at policies that enhance financial inclusion for effective implementation of monetary policy. Also, promoting financial inclusion will require governments in sub-Saharan Africa to reduce their monetary policy rates.

KEYWORDS

Monetary policy; financial inclusion; GDP growth rate; inflation rate; real; effective exchange rate

Introduction

Inadequate access to financial instruments and services has become a common phenomenon of the economic environment of most emerging markets and less-developed countries. According to statistics from the World Bank (based on a households survey in 148 countries), 50% of adults globally did not own accounts at formal financial institutions as at 2011 (Demirgüç-Kunt & Klapper, 2012). People who are financially excluded do not have access to financial instruments that promote and enhance borrowing and saving. As a result, there is a limited impact on their intertemporal consumption decisions when the monetary policy rate changes, thereby reducing the effectiveness of monetary policy.

The issue of financial inclusion has engaged the attention of scholars, researchers and policymakers in recent times. This is because financial inclusion has greater implications for monetary policy effectiveness. Thus, monetary policy transmission greatly depends on the level of financial inclusion. Increases in financial inclusion can have monetary policy and macroeconomic implications because monetary policy effectiveness in an economy depends on the number of people that have access to finance. This

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study examines the extent to which financial inclusion affects monetary policy and the extent to which monetary policy also affects financial inclusion.

Most previous empirical studies have investigated the implications of financial inclusion for certain central banks' policy parameters' rule and model stability (Bilbiie, 2008; Colciago, 2011; Galí, López-Salido, & Vallés, 2004). Others have discussed the efficacy of monetary policy (Di Bartolomeo & Rossi, 2007) and the policy implications for the decision to use the price index as central banks' target (Anand & Prasad, 2012). Some empirical studies have also examined the relationship between monetary policy and financial inclusion (Evans, 2016; Lapukeni, 2015; Lenka & Bairwa, 2016; Mbutor & Uba, 2013; Mehrotra & Nadhanael, 2016). However, the problem with some of these empirical studies is that they fail to address the issue of endogeneity that might exist between monetary policy and financial inclusion (Lapukeni, 2015; Lenka & Bairwa, 2016; Mehrotra & Nadhanael, 2016). This implies that there could be a bi-directional or reverse causality between monetary policy and financial inclusion. Lack of knowledge of this reverse causality could make policymakers pursue either monetary policy or financial inclusion as a policy objective when it could be an outcome variable. This suggests that monetary policy should not only be pursued as a policy objective. It can also be an outcome variable of financial inclusion and vice versa.

Other studies have addressed the issue of endogeneity, though they used inappropriate proxies for monetary policy and financial inclusion (Evans, 2016; Mbutor & Uba, 2013). One of the major problems besetting the study of monetary policy–financial inclusion nexus is the use of weak proxies for monetary policy and financial inclusion. Some studies have used inflation rate to proxy monetary policy (Evans, 2016; Lenka & Bairwa, 2016; Mbutor & Uba, 2013). Inflation rate is an outcome variable of monetary policy and should not be used to measure monetary policy when monetary policy can be measured directly using central bank monetary policy rate. We believe that using central bank monetary policy rate, which is a direct measure of monetary policy, is more laudable and results generated using this measure are more reliable and devoid of any bias.

Financial inclusion is also often proxied by single variable measures such as number of ATMs per hundred thousand adults, number of depositors with commercial banks per thousand adults, and number of bank branches per thousand adults (see Evans, 2016; Mbutor & Uba, 2013). We argue that the financial inclusion proxies listed above do not adequately mirror the other key functions of the financial system, such as making bank accounts opening much easier and making credit available to borrowers. Conclusions drawn from such studies that use inappropriate financial inclusion proxies can be misleading and may not be important for the purposes of policy. Not that past studies do not recognize the problems embedded in the use of single-variable proxies; they normally deal with the issue by using many of these single-variable-based measures to carry out what they term robustness checks. This solution, though commendable, is not adequate, as the different proxies themselves may be measuring different dimensions or just one dimension of financial inclusion.

It is now being recognized that financial inclusion has at least two main dimensions – demand-side factors (usage) and supply-side factors (access). Therefore, it is imperative that measures of financial inclusion reflect the multidimensional nature of financial inclusion. We address the gap in measuring financial inclusion by constructing a composite index for financial inclusion after deriving the weights (factor loadings)

from a panel principal component analysis (PCA). Unlike previous proxies, our composite measure is able to capture the two key dimensions of financial inclusion – usage and access. By employing these multidimensional measures, we are able to assess the link between monetary policy and financial inclusion from a holistic standpoint.

It is for this reason that this study investigates the bi-directional relationship between monetary policy and financial inclusion from the sub-Saharan African perspective using a panel vector auto-regression (PVAR) estimation technique. The use of a PVAR estimation approach enables us to address the problem of endogeneity in order to establish the causality between monetary policy and financial inclusion. The use of PVAR also helps us to generate the generalized impulse response functions and the variance decomposition of the variables. Generalized impulse response functions enable us to recognize the effect of shocks of monetary policy on financial inclusion and vice versa. Using generalized impulse responses functions enables one to produce shocks that do not change with the ordering of the variables compared to the usual Cholesky impulse responses (Issahaku, Harvey, & Abor, 2016). We also analyzed the variance decomposition of monetary policy and financial inclusion and the controlled variables in order to express the magnitude of the overall effect of a shock, unlike impulse response functions that look at the future direction of the variables following a shock.

Lenka and Bairwa (2016) investigated the link between monetary policy and financial inclusion using South Asian Association for Regional Cooperation (SAARC) economies, and concluded that financial inclusion negatively impacts monetary policy. Mbutor and Uba (2013) assert that increasing financial inclusion does not only have the potency to enhance economic growth, but that it also influences monetary policy by enhancing the sensitivity of aggregate demand to changes in interest rates. Ma and Lin (2016), for instance, note that the continuous growth of financial systems in most economies could have direct effects on monetary policies instituted by an economy's central bank. This suggests that in an environment where the financial excluded lacks access to formal financial services, monetary policy will not yield the desired results.

In an overview of trends of financial exclusion in Africa and around the globe, Demirgüç-Kunt and Klapper (2012) conclude that financial systems in Africa lag behind, although they have experienced tremendous improvements over the last few decades. They support their assertion with statistics from the World Bank (2012) that indicates that the ratio of credit to the private sector and credit to GDP averages 24% in sub-Saharan Africa, compared with 39% in North Africa, 77% for other developing countries, and 172% in developed countries. Furthermore, according to Allen et al. (2016), based on the Global Financial Inclusion Database, account penetration (defined as the proportion of persons over 15 years of age who own an account) stood at 24% in sub-Saharan Africa, relative to 33% in South Asia, 39% in Latin America and the Caribbean, 45% in Europe and Central Asia, 55% in East Asia and Pacific, and 89% in high-income countries. Further evidence from Gallup World Poll (2012) shows that 60% of adults living under $2 per day do not have access to banking services, and sub-Saharan Africa was ranked the highest in terms of the number of people not having an account. The importance placed on financial inclusion by policymakers today, and its benefits, coupled with low levels of financial inclusion in developing countries, implies that there is an aggressive effort by policymakers in developing countries to pursue financial inclusion.

Despite the empirical evidence that there is a relationship between financial inclusion and monetary policy, researchers know little about the possible endogeneity problems that could exist between financial inclusion and monetary policy in the sub-Saharan African context. As a consequence, there is a yawning gap in the extant literature regarding the relationship between financial inclusion and monetary policy from the sub-Saharan African perspective. This study therefore seeks to add to the literature by investigating the potential endogeneity that may exist between monetary policy and financial inclusion from the sub-Saharan African perspective. Thus, the bi-causal linkages between monetary policy and financial inclusion appear to have escaped the attention of policymakers and researchers, and this has led to a limited understanding of the link between monetary policy and financial inclusion.

However, for policymakers in both emerging and developing economies, having a grasp of the reverse causality relationship between monetary policy and financial inclusion is key if they are to put their countries and economies on the path of accelerated pro-poor growth. This is to say that they will not only focus on monetary policy as a policy objective, but it could also be an outcome variable of financial inclusion and vice versa. Discovering the theoretical underpinnings of this reverse causality will enable sub-Saharan African economies' policymakers to formulate policies in their respective economies to get the optimum results of monetary policy and financial inclusion for economic development and growth. This study provides policy prescriptions that can guide policymakers in their effort to alleviate poverty and achieve sustainable growth in sub-Saharan Africa through monetary policy and financial inclusion.

Macroeconomic variables such as inflation rate, real effective exchange rate, and economic growth were controlled because these variables, according to the literature, could influence both monetary policy and financial inclusion (Mbutor & Uba, 2013). As a result, we treat inflation rate, real effective exchange rate, and economic growth as endogenous variables in the system of equations. This study sought to address the following research questions: (1) Does financial inclusion affect monetary policy in sub-Saharan Africa? (2) Does monetary policy affect financial inclusion in sub-Saharan Africa?

Our study contributes in a number of respects to the discipline of finance and economics. First, this article, unlike others in the literature, employs an alternative methodology by using PVAR. The use of PVAR helps us to analyze the dynamic link between monetary policy and financial inclusion together with country-specific fixed effects simultaneously. Second, using orthogonalized impulse responses enables one to specifically single out the effect of each of the variable shocks in the system on the other variables, one at a time. This study also addresses a gap in the literature by presenting more recent and detailed evidence on the extent to which financial inclusion and monetary policy are connected, which, to the best of our knowledge, has not been empirically investigated by previous studies from the sub-Saharan African perspective.

Besides, this study is the first to examine the causal relationship between monetary policy and financial inclusion from the sub-Saharan African perspective. The results concur with the notion that there is a reverse causality between monetary policy and financial inclusion.

Our article further broadens the knowledge frontiers in the economics and finance literature by providing new insights indicating that there is a bi-causal link between monetary policy and financial inclusion. Some new insights on the monetary policy–

financial inclusion nexus are presented by considering the effect of macroeconomic variable such as inflation rate, real effective exchange rate, and economic growth rate on financial inclusion and monetary policy. Other contributions of this article are that we overcome the use of inadequate proxies for financial inclusion by constructing multi-dimensional index of financial inclusion based on a panel principal component analysis (PCA). Compared to previous studies, we use an array of econometric techniques which enable us to overcome endogeneity, model selection bias, and to contribute to panel estimation procedure.

This study uses standard panel econometrics to assess the dynamic and causal links between monetary policy and financial inclusion (1) controlling for potential endogeneity, (2) controlling for other variables known to influence the interaction between monetary policy and financial inclusion, and (3) performing a number of robustness checks by splitting the sample into two based on sub-Saharan African countries and the full sample of all countries to see if the story in sub-Sahara African countries differ from the rest of the world.

The main results from the study show that there is a reverse causality between monetary policy and financial inclusion. It is evident that monetary policy affects financial inclusion and financial inclusion also affects monetary policy significantly. It is also evident that financial inclusion impacts real effective exchange rate. The rest of this study is organized as follows: the next section presents both the theoretical and empirical literature review., We then discuss the empirical models and methodology. Next we present the data analysis and discuss the results, estimation of PVAR results and the generalized impulse responses. Finally we present the summary, conclusions and implications of the findings.

Literature review

The theoretical literature

Conventionally, monetary policy has been theorized as being transmitted through two channels: direct monetary transmission and interest rate channels (de Bondt, 1999). By the direct monetary transmission channel, the use of an expansionary or contractionary monetary policy to directly increase or decrease the supply of money within an economy results in surplus or adverse cash balances which would eventually increase or reduce aggregate spending in the economy, thereby affecting economic growth. The goal of monetary policy is to boost economic growth and aggregate demand. However, the effectiveness of monetary policy in achieving the objective of affecting aggregate demand and economic growth depends on the level of financial inclusion.

Another monetary transmission channel is the interest rate channel. Controlling interest rates by either decreasing or increasing real interest rates affects the money markets lending and borrowing rates. A reduction in real interest rates reduces capital costs, which tends to result in an increase in current consumption and the propensity to save falls. However, where real interest rates are increased, this drives up borrowing costs, thereby causing the level of consumption and investment to fall; hence, aggregate demand will fall. This implies that monetary policy objective of affecting interest rates will not be effective with low levels of financial inclusion.

Another theory that underlies the link between monetary policy and financial inclusion is the bank lending channel. According to Khan, Binti, and Gee (2016), the impact of monetary policy through the bank lending channel is considered a well-established concept in the banking-economics literature. This assertion is supported by Ma and Lin (2016), who posit that recent empirical studies have examined the link between financial development and monetary policy, focusing on the credit channel theory propounded by Bernanker and Gertler (1995). According to Bernanker and Gertler (1995), the credit channel theory contributes significantly as a tool for the monetary policy transmission mechanism. They posit that monetary policy shocks tend to be amplified by financial market imperfections, known as financial accelerator effect. They note that restrictions on credit markets result in substitution between different sources of financing (self-funding and credit) which are not perfectly aligned, which they call the external finance premium. From the credit channel theory point of view, a shock to the external finance premium influences the activities and actions of borrowers in one of two ways: the balance sheet channel and banking lending channel (Ma & Lin, 2016).

The banking lending channel focuses on bank loans which households and small businesses rely on as their major source of funding. Where monetary policy is tightened and as a result decreases in money supply, banks are forced to readjust their portfolios, thus adversely affecting the quantum of loans they can offer. Given that bank loans have no perfect substitutes, and with the loan supply falling, banks will increase their lending rates. As a result, borrowers who depend on banks have access to reduced loans but at a higher cost of capital, which increases the external finance premium. This has the tendency of reducing financial inclusion due to a rise in borrowing cost. This adversely affects activities of bank borrowers either through high lending rates or through credit rationing. Hence, fewer people will be financially included (Morgan, 1998).

The transmission channels of monetary policy, therefore, clearly hypothesize an effect of monetary policy on financial inclusion. For instance, Loutskina and Strahan (2009) investigated the dwindling influence of the bank lending channel as a monetary policy transmission channel in the face of mortgages, and found evidence that financial securitization weakened the impact of the banking lending channel. However, studies by Aysun and Hepp (2011) and Ashcraft and Campello (2007) have found evidence that securitization reinforces the balance sheet channel under the credit channel theory. In their study, Aysun and Hepp (2011) have proven that bank securitization is more responsive to the balance sheets of borrowers and therefore, in the face of financial securitization, the transmission channel of the balance sheet of credit channel theory becomes more prominent.

Empirical literature

Most empirical papers on financial inclusion are largely focused on how to promote and measure financial inclusion (Ardic, Heimann & Mylenko, 2011; Marshall, 2004; Treasury, 2004; Demirgüç-Kunt & Klapper, 2012; Allen et al., 2016; Sarma, 2008; Hanning & Jansen, 2010). Other studies also focused on the impact of financial inclusion on economic growth, poverty reduction, and income inequality (Chibba, 2009; Thorat, 2006; Dabla-Norris, Ji, Townsend, & Unsal, 2015; Sarma & Pais, 2008;

Kpodar & Andrianaivo, 2011; Sharma, 2016). However, few studies have looked at how financial inclusion affects monetary policy effectiveness (Lenka & Bairwa, 2016; Mbutor & Uba, 2013). Using data spanning the period 1980 to 2012 in Nigeria, Mbutor and Uba (2013) concluded that increases in financial inclusion enhance monetary policy effectiveness. Lenka and Bairwa (2016), in a study of the South Asian Association for Regional Cooperation (SAARC) countries, found that financial inclusion influences monetary policy, suggesting that access to finance in an economy enhances monetary policy effectiveness.

With the quest for financial inclusion at all levels, it has been suggested that financial inclusion could widen the overall impact of monetary policy (Khan, 2011; Mbutor & Uba, 2013). If this were to be true, then it would imply that monetary policy could have an impact on the poor and vulnerable who previously would have been cushioned from external shocks because they do not have access to finance and hence they are not part of the financial system.

Mehrotra and Yetman (2014) found that in an economy where there is limited access to finance, the central bank has to increase the monetary policy rate for the economy to be stabilized after a shock. They also find that for inflation rate to be stabilized in an economy without affecting economic activities, greater financial inclusion is the key. Mehrotra and Yetman (2015) suggest several ways which, by increasing access to finance, impacts central bank policies aimed at maintaining financial and monetary stability. They posit that access to finance smoothens consumption of households, since they have access to financial services for saving and borrowing.

Standard economic theory suggests a link between monetary policy and financial inclusion. A country's monetary policy essentially revolves around controlling monetary supply in an economy based on underlying macroeconomic conditions. However, these actions have ramifications on the savings and loans functions of banks and other financial institutions. Basically, a country's monetary policy may use open market operations, discount rates, and the required reserve ratio to influence the amount of money and credit in an economy with the overarching objectives of controlling inflation and interest rate spreads in order to enhance growth (Sulaiman & Migiro, 2014). Though these policy actions tend to influence the cost of credit within the economy, they affect the way and manner the financial sector, particularly banks, operate (Balfoussia, Brissimis, & Delis, 2011).

The fact that monetary policy affects the banking system suggests that it could influence directly or indirectly, to some extent, the degree of financial inclusion within a country's economy. The issue of financial inclusion has gained considerable attention amongst researchers and policymakers, particularly after it was noted that the high degree of financial exclusion worldwide was a major reason for the global financial crisis in 2007 (Hanning & Jansen, 2010). As Chakrabarty (2012) posits, achieving financial inclusion has become a global goal.

Khan (2011) emphasizes the relevance of financial inclusion in today's global economy; he posits that financial inclusion is not just another policy tool, but a way to accelerate financial inclusion for all. As a result, increasing financial services (mainly access to savings and credits from the banking sector) for the less privileged is a priority in both developed and developing countries. To this effect, Ma and Lin (2016) argue that developing the financial systems globally in today's economic environment raises

concerns which include the direct effect such improvements may have on monetary policies.

Mahendra (2006) defines financial inclusion as access to financial services at low cost to the wider segment of the marginalized and low-income people in society. He notes that financial inclusion is an embodiment of all financial services such as payment, insurance, savings, and remittances, but that the most important aspect is credit facility. This concurs with Hariharan and Marktanner (2012), who define financial inclusion as the access to formal financial services like insurance, savings, and credit for the marginalized. They further allude to potential economic benefits of financial inclusion which include economic growth and development, increase in the total factor productivity of a country, and its capacity to provide capital for investment. They also found evidence that financial inclusion can increase the savings portfolio of the financial sector and enhance efficiency of financial intermediation. Khan (2011) also argues that financial inclusion allows greater involvement of all groups in a society. Consequently, this enhances the effectiveness of monetary policy. In his submission, Khan (2011) argues that the informal sector, which represents a larger portion of developing economies, tends to impede the transmission of monetary policy because those in the informal sector are not financially included. This is owing to the fact that financial decisions form a major part of the excluded segment who are independent and are not affected by monetary policy actions. Therefore, including such persons and groups in the overall financial system, he notes, could lead to positive externalities which could translate into a more effective monetary policy.

Consequently, if, by improving inclusion and access to financial services, monetary policy transmissions could be enhanced, does it mean that financial inclusion could probably influence monetary policy effectiveness? Despite Khan's (2011) assertion regarding the link between monetary policy and financial inclusion, there is yet to be an empirical study that examines the nature of the relationship in sub-Saharan Africa using a PVAR approach. To the best of the authors' knowledge, the only study that investigates this relationship in Africa was undertaken by Mbutor and Uba (2013) in Nigeria. They found evidence to support Khan's (2011) assertion that financial inclusion would enhance monetary policy effectiveness. However, their conclusions have limited applicability, since it was conducted as a one-country study, and it also failed to address the possibility of endogeneity between monetary policy and financial inclusion which might lead to bias and spurious results. This study sought to examine the possible endogeneity between monetary policy and financial inclusion using a much broader dataset from sub-Saharan Africa.

The question, therefore, is that if financial systems and monetary policy are directly related, could efforts made to expand financial services to the marginalized influence the effectiveness of monetary policy? Moreover, it is also worth investigating whether the very policies that make up the fabric of an economy's monetary policy drive or restrict inclusive finance. It is for this reason that this study investigates the dynamic and causal link between monetary policy and financial inclusion from the sub-Saharan African perspective. Figure 1 presents the conceptual framework between monetary policy and financial inclusion. The conceptual framework demonstrates the transmission mechanisms by which the two variables are connected. The diagram shows that financial inclusion improves the sensitivity of

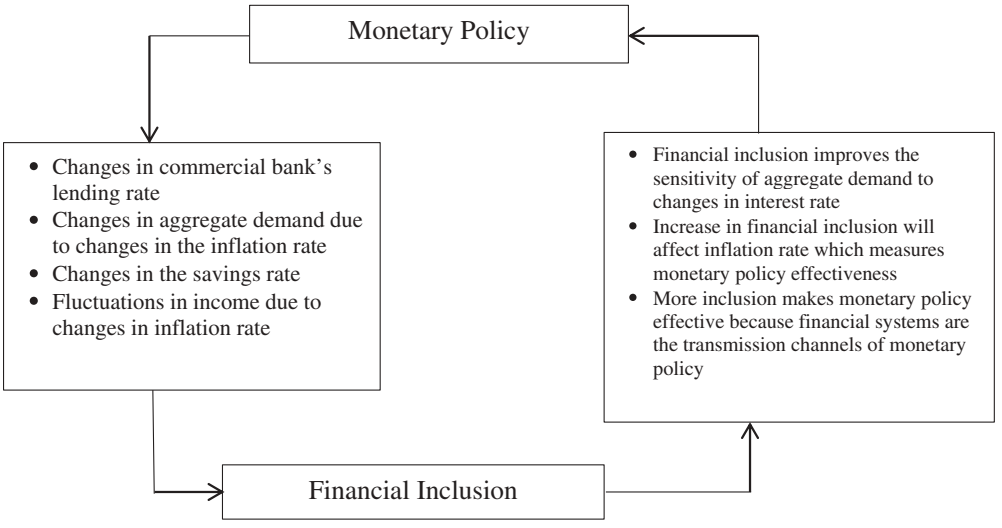

Figure 1. Conceptual framework.

aggregate demand to changes in interest rate and this enhances the effectiveness of monetary policy. On the other hand, monetary policy indicators such as changes in commercial banks' lending rate, changes in aggregate demand due to changes in the inflation rate, changes in the saving rate, and fluctuations in income due to changes in inflation rate will promote financial inclusion.

Methodology and data source

This study employed the PVAR technique to investigate the causal and dynamic link between monetary policy and financial inclusion by specifying the endogenous behavior between monetary policy and financial inclusion. The advantages of the PVAR approach originate from the conventional VAR framework that considers all the variables in the system as endogenous. However, the PVAR estimation technique is more advantageous because it permits all the variable unobserved individual heterogeneity by considering fixed effects which ensures that the estimates are consistent.

The use of PVAR is necessitated by the fact that PVARs allows the flexibility of inclusion of weak and truly exogenous variables. The use of PVARs addressed the problem of endogeneity, which is one of the most serious problems of econometric modeling of panel data analysis. The general PVAR model is stated as follows:

$$Y_{it} = \beta_{oit} + \sum_{k=1}^{p} \alpha_{it} Y_{it-k} + u_{it} \tag{1}$$

Where Y_{it} represents a vector of K endogenous variables for each country.

$i = 1, \ldots$ N over $t = 1 \ldots T$ time periods, the y_{it} is stated as

$$Y_{it} = \begin{bmatrix} MPR_{it} \\ FINC_{it} \\ GDPGR_{it} \\ INFLRA_{it} \\ REER_{it} \end{bmatrix} \tag{2}$$

These variables are defined in Table 1. β_{oit} captures all the deterministic components, and that includes the constant, time dummies, etc.

Y_{it-k} are the lagged figures of the endogenous variables and U_{it} is a $K \times I$ vector of random errors which is given by:

$$U_{it} = \left[U_{1t}, U_{2t,} \ldots\ldots U_{Nt}\right] \sim iid\ (0, \delta) \tag{3}$$

$\propto_{it}$ and $\beta_{oi(t)}$ are permitted to be cross-sectionally dependent. In the event that the exogenous variables are present, Equation (1) becomes:

$$Y_{it} = \beta_{oi(t)} + \sum_{k=1}^{p} \alpha_{it} Y_{it-k} + D_i(l)R_t + U_{it} \tag{4}$$

where *Dij* are $K \times M$ matrices for each lag $j = 1, \ldots.. p$, and R_t is an $M \times 1$ vector of exogenous variables common to all countries *i*. Similarly, following Love and Ziccino (2006), one can also specify the panel VAR in a reduced form as follows:

$$Y_{it} = + \sum_{k=1}^{p} \alpha_{it} Y_{it-k} + \tau_2 R_{it} + f_i + d_t + e_{it} \tag{5}$$

Alternatively, the baseline PVAR model following Love and Ziccino (2006) can also be written as:

$$Z_{it} = \tau_1 Z_{it-1} + \tau_2 R_{it} + f_i + d_t + e_{it} \tag{6}$$

where Z_{it} is a five-variable vector $[MPR,\ FINC\ INFLRA, GDPGR,\ REER]$

R_{it} captures exogenous variables if there are any;

where f_i captures fixed-effects-unobservable time-invariant effects specific to each country;

d_t captures time dummies that are country specific which represent each country-specific macro shock;

e_{it} the random error term assumed to be iid.

The empirical model

Following Equation (5) and (6), the researchers empirically model monetary policy and financial inclusion. The equations modeling these two variables are specified below. The researchers specified monetary policy as a function of its own lags, the lags of financial inclusion index, and the lags of the controlled variables while controlling for time and country specific fixed effects as follows:

$$\mathrm{MPR_{it}} = \sum_{j=1}^{p} \emptyset_{1j}\mathrm{MPR_{it-j}} + \sum_{j=1}^{p} \emptyset_{2j}\mathrm{FINC_{it-j}} + \sum_{j=1}^{p} \emptyset_{3j} GDPGR_{it-j} + \sum_{j=1}^{p} \emptyset_{4j}\mathrm{INFLRA_{it-j}} + \sum_{j=1}^{p} \emptyset_{5j}\mathrm{REER_{it-j}} + \mathrm{f_i} + \mathrm{d_i} + \mathrm{e_{it}} \quad (7)$$

i is the country subscript while t is the time subscript, MPR_{it} is the monetary policy rate for country i at time t, $FINC_{it-j}$ is lag of financial inclusion index, $GDPGR_{it-j}$ is the lag of the GDP growth rate; $REER_{it-j}$ is the lag of the real effective exchange rate, $INFRA_{\mathrm{it-j}}$ is the lag of the inflation rate; f_i captures the country $i-$ specific intercept representing country-specific fixed effect: d_i captures time dummies, and e_{it} is the noise error term.

Similarly, financial inclusion index can also be specified as follows:

$$\mathrm{FINC_{it}} = \sum_{j=1}^{p} \emptyset_{1j}\mathrm{FINC_{it-j}} + \sum_{j=1}^{p} \emptyset_{2j}\mathrm{MPR_{it-j}} + \sum_{j=1}^{p} \emptyset_{3j} GDPGR_{it-j} + \sum_{j=1}^{p} \emptyset_{4j}\mathrm{INFLRA_{it-j}} + \sum_{j=1}^{p} \emptyset_{5j}\mathrm{REER_{it-j}} + \mathrm{f_i} + \mathrm{d_i} + \mathrm{e_{it}} \quad (8)$$

The controlled variables are also modeled as follows:

$$\mathrm{GDPGR_{it}} = \sum_{j=1}^{p} \emptyset_{1j}\mathrm{GDPGR_{it-j}} + \sum_{j=1}^{p} \emptyset_{2j}\mathrm{MPR_{it-j}} + \sum_{j=1}^{p} \emptyset_{3j} FINC_{it-j} + \sum_{j=1}^{p} \emptyset_{4j}\mathrm{INFLRA_{it-j}} + \sum_{j=1}^{p} \emptyset_{5j}\mathrm{REER_{it-j}} + \mathrm{f_i} + \mathrm{d_i} + \mathrm{e_{it}} \quad (9)$$

$$\mathrm{INFLRA_{it}} = \sum_{j=1}^{p} \emptyset_{1j}\mathrm{INFLRA_{it-j}} + \sum_{j=1}^{p} \emptyset_{2j}\mathrm{MPR_{it-j}} + \sum_{j=1}^{p} \emptyset_{3j} FINC_{it-j} + \sum_{j=1}^{p} \emptyset_{4j}\mathrm{GDPGR_{it-j}} + \sum_{j=1}^{p} \emptyset_{5j}\mathrm{REER_{it-j}} + \mathrm{f_i} + \mathrm{d_i} + \mathrm{e_{it}} \quad (10)$$

$$\mathrm{REER_{it}} = \sum_{j=1}^{p} \emptyset_{1j}\mathrm{REER_{it-j}} + \sum_{j=1}^{p} \emptyset_{2j}\mathrm{MPR_{it-j}} + \sum_{j=1}^{p} \emptyset_{3j} FINC_{it-j} + \sum_{j=1}^{p} \emptyset_{4j}\mathrm{GDPGR_{it-j}} + \sum_{j=1}^{p} \emptyset_{5j}\mathrm{INFLRA_{it-j}} + \mathrm{f_i} + \mathrm{d_i} + \mathrm{e_{it}} \quad (11)$$

where all the variables are defined under Table 1.

The modified Bayesian information criterion (MBIC), modified Akaike information criterion (MAIC) and modified quasi-information criterion (MQIC) are used to choose the optimal autoregressive lag order. This study employed a four panel unit root test: the Levine–Lin Chu (LLC) test, Im Pesaran and Shin (IPS) test, augmented Dickey Fuller (ADF) test and Philips Perron (PP) test to test for stationarity of the variables. These tests outperform other panel unit root tests such as Westerlund's group-mean test, the Larsson et al. test (LLL) and Breitung test (Hlouskova & Wagner, 2006).

Finally, in order to analyze the generalized impulse-response functions (IRF), estimating the confidence intervals for the impulse-response functions is a necessary condition, since the impulse-response functions are generated from the computed VAR parameters and their standard errors. Moreover, the researchers also present the forecast-error variance decompositions to show how important shocks in the variables are in modeling the variations of another variable in the PVAR model by giving the percentage of the variation in one variable that is explained by another variable shocks over time. Unlike impulse response functions that provide the future direction of the

Table 1. Data and variables selection.

Variable	Notation	Description	Data source
Monetary policy rate	MPR	Central bank monetary policy rate	IFS
Financial inclusion index	FINC	Index of six variables of financial inclusion	
Financial inclusion	ATMSPHTA	ATMS per hundred thousand adults	IFS
Financial inclusion	BRPHTA	Bank branches per hundred thousand adults	IFS
Financial inclusion	CBB	Commercial bank branches per hundred thousand adults	IFS
Financial inclusion	BAPTA	Bank accounts per thousand adults	IFS
Financial inclusion	BFCB	Borrowers from commercial banks per thousand adults	IFS
Financial inclusion	DCBPTA	Depositors with commercial banks per thousand adults	IFS
Inflation rate	INFLRA	Log of consumer price index (CPI)	WDI
Real effective exchange rate	REER	Real effective exchange rate	WDI
Economic growth	GDPGR	GDP growth (annual %)	WDI

variables when there is a shock, forecast error variance decompositions determine the overall effect magnitude.

Data source and description of variables

Data on the monetary policy rate (MPR) and all the financial inclusion variables were taken from the international financial statistics (IFS) and other variables were obtained from the World Bank development indicators (WDI). The sample consists of 48 sub-Saharan countries spanning the period 1990 to 2014. Even though the study focused on sub-Saharan Africa, the researchers performed PVARs for the full sample as well to see if the African story is different.

Principal component analysis (PCA)

The study used the panel principal component analysis (PCA) estimation technique to construct a financial inclusion index made up of six chosen measures of financial inclusion. According to this estimation techniques, the j^{th} factor index can be specified as:

$$FINC_j = W_{J1}X_1 + W_{J2}X_2 + W_{J3}X_3 + \ldots + W_{JP}X_P \tag{12}$$

where $FINC_j$ *is* the financial inclusion index; Wj is the weight of the coefficient of the factor score; X is the original figure of the respective components; while P is the number of variables in the equation. The financial inclusion composite index has been constructed by two dimensions of financial inclusion where each dimension consists of three factors. The first dimension is the supply-side factors, which include: ATMs per hundred thousand adults (ATMSPHTA); bank branches per one hundred thousand adults (BRPHTA); and commercial bank branches per hundred thousand adults (CBB). The second dimension factors are the demand-side factors which include bank accounts per thousand adults (BAPTA), borrowers from commercial banks per thousand adults (BFCB), and depositors with commercial banks per thousand adults (DCBPTA). The financial inclusion index (FINDEX) is made up of six factors. The index is specified as follows:

$$FINC = f\ (ATMSPHTA,\ BRPHTA,\ CBB,\ BAPTA,\ BFCB,\ DCBPTA) \tag{13}$$

Discussion of empirical results

Descriptive statistics

The descriptive statistics of the sub-Saharan Africa sample and the full sample are presented in Table 2. However, because the mean is subject to distortions from outliers, the discussion is based on the median of the distribution. The median monetary policy rate (MPR) in sub-Saharan Africa is 6%, while the full (world) sample median monetary policy rate is 5.50%. The sub-Saharan African monetary policy rate is higher relative to the world average. This explains why interest rates in sub-Saharan Africa are generally higher than those for the rest of the world. ATMs per hundred thousand adults, which is a measure of financial inclusion, has a median value of 3.20 per hundred thousand adults in Sub-Saharan Africa, while the full sample median is 30.33 ATMs per hundred thousand adults. This indicates that the degree of financial inclusion in sub-Saharan Africa is still very low relative to the rest of the world. The rest of the measures of financial inclusion, which include bank accounts per thousand adults (BAPTA), borrowers from commercial banks per thousand adults (BFCB), bank branches per hundred thousand adults (BRPHTA), commercial bank branches per hundred thousand adults (CBB), and depositors with commercial banks per thousand adults (DCBPTA), have median values of 87.13, 2.84, 2.97, 17.42, and 106.48 respectively in the sub-Saharan sample, while their world median values are 337.76, 13.03, 12.57, 97.18, and 339.50 respectively. From the median values of the other measures of financial inclusion above, the sub-Saharan Africa values are lower comparative to the world or full sample values. This explains why the extent of financial inclusion in sub-Saharan Africa is lower compared to the world sample. The median GDP growth rate in sub-Saharan Africa is 4.20%, while that of the world is 3.80%. The median consumer price index, which is an indicator of inflation, is 71.22 in sub-Saharan Africa and 77.52 in the world sample. The median real affective exchange per the dollar in sub-Saharan Africa is 100.35, and that of the full sample (world) is 99.

Selection and estimation of lag order

The procedure for selecting the appropriate model is reported in Table 3. Based on the selection criteria of the three models by Donald and Biao (2001) and the overall co-efficient of determination, the first-order PVAR model is selected. This is because it has the least MBIC, MAIC, and MQIC values. Based on the results of the model selection in Table 3, a first-order PVAR was used.

Results of panel unit root test

In panel data analysis, it is essential that the variables are stationary. A stationarity test is necessary because the variables order of integration will help in the selection of the appropriate model for the estimation of the parameters and help prevent spurious regression. This study employed four panel unit root tests: the Im Pesaran Shin (IPS) test; Levine–Lin Chu (LLC) test; augmented Dickey Fuller (ADF) test; and Philips Perron (PP) test.

Table 2. Descriptive statistics.

	MPR	ATMSPHTA	BAPTA	BRPHTA	CBB	BFCB	DCBPTA	GDPGR	CPI	REER
Sub-Sahara Africa sample										
Mean	11.86	7.95	156.79	4.16	5.66	40.98	216.66	4.30	69.52	115.79
Median	6.00	3.20	87.13	2.84	2.97	17.42	106.48	4.20	71.22	100.35
Maximum	70.00	66.20	834.28	24.19	54.17	257.67	1777.71	149.97	298.51	827.17
Minimum	2.00	0.00	0.00	0.13	0.12	0.00	0.00	−51.03	0.00	47.93
Std dev.	11.79	12.56	170.18	4.37	8.47	55.50	293.87	8.86	36.92	58.57
Skewness	2.09	2.39	1.60	2.38	3.29	1.89	2.88	5.06	0.50	5.89
Kurtosis	7.60	8.33	4.95	9.38	14.51	5.86	12.89	90.17	4.68	60.25
Jarque-Bera	377.49	763.63	195.87	1158.35	3604.23	262.31	2074.39	365,785.40	164.17	60,204.57
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	235.00	357.00	335.00	439.00	492.00	281.00	380.00	1140.00	1030.00	423.00
Full (world) Sample										
Mean	8.95	41.48	512.87	20.17	19.37	171.54	520.12	3.72	73.62	100.62
Median	5.50	30.33	337.76	13.03	12.57	97.18	339.50	3.80	77.52	99.47
Maximum	200.00	290.66	3368.39	285.00	289.83	1156.05	3371.49	149.97	348.17	827.17
Minimum	0.00	0.00	0.00	0.13	0.12	0.00	0.00	−64.05	0.00	32.16
Std dev.	13.45	44.28	559.67	27.38	26.41	208.89	545.97	6.65	32.21	30.21
Skewness	7.72	1.86	1.90	5.37	5.68	1.97	1.78	3.01	0.02	8.82
Kurtosis	90.84	7.59	7.81	45.39	50.65	7.13	7.38	84.28	5.18	172.57
Jarque-Bera	372,845.80	2423.50	1277.59	144,111.00	195,843.00	1217.62	1145.91	1,321,073.00	806.52	2,799,888.00
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1125.00	1668.00	816.00	1809.00	1959.00	897.00	862.00	4773.00	4079.00	2312.00

Source. Authors' estimate from research data.

Table 3. Lag order selection and estimation.

Lag	CD	J	J p-value	MBIC	MAIC	MQIC
1	1	76.39136	433,566	−354.8131	−73.60864	−185.9728
2	1	43.69921	0.722815	−243.7704	−56.30079	−131.2102
3	.9999991	19.68907	0.7629393	−124.0458	−30.31093	−67.76564

Note. MBIC = modified Bayesian criteria; MAIC = modified Akaike information criteria;MQIC = modified Hannan–Quinn information criteria.

Table 4. Panel unit root test.

	MPR	FINC	GDPGR	INFLRA	REER
Sub-Sahara Africa sample					
Level					
LLC	−4.27***	6.76	−19.55***	−17.36***	3.65
IPS	−2.12***	11.94	−20.09***	−18.64***	33.74
ADF	79.58***	5.89	478.44***	434.70***	41.6
PP	104.30***	6.86	492.15***	453.47***	46.34
First difference					
LLC		−9.21***			3.10***
IPC		−4.69***			7.62***
ADF		131.64***			593.74***
PP		144.50***			601.09***
Full sample					
Level					
LLC	−347.36***	7.73	−33.17***	−271.14***	5.07
IPS	−80.76***	11.6	−34.67***	−63.05***	10.32
ADF	302.65***	153.63	1662.67***	1757.92***	146.98
PP	349.24***	222.67	1660.74***	1826.43***	168.15
First difference					
LLC		−1433.6***			−1.51.68***
IPC		−85.57***			−50.54***
ADF		588.69***			1949.35***
PP		607.68***			1996.17***

Source. Authors' estimate from research data;
Note. $P<0.01^{***}$ $P<0.05^{**}$ $P<0.10^{*}$

The results of the panel unit root test for the sub-Saharan Africa sample and the full sample are reported in Table 4. The results from Table 4 indicate that all the variables are integrated of order zero I(0) except the financial inclusion index (FINC) and the real effective exchange rate (REER) variables that are integrated of order one I(1). This implies that not all the variables used in the study follow a unit root process. The researchers used the first difference of the variables that are integrated of order one I(1) in the analysis.

Regression results

There is strong confirmation of a reverse causality between monetary policy and financial inclusion in Africa. This evidence is shown in Table 5. There is strong evidence of a negative effect of the lag financial inclusion on monetary policy rate in sub-Saharan Africa as indicated by the statistical significance, as well as the negative co-efficient of the lag of financial inclusion in model (1) as shown in Table 5. The explanation we offer for this finding is that when more people have access to formal financial services, it increases the number of depositors with commercial banks, and this increases the supply of loanable funds, and hence interest rates and the monetary policy rate will reduce. This finding of a negative relationship

Table 5. Sub-Saharan African sample panel VAR results.

	MPR	FINC	GDPGR	INFLRA	REER
MPR(−1)	0.023603	0.02129***	−0.013743	0.000546	−0.444725**
	(0.15746)	(0.00646)	(0.08358)	(0.00042)	(0.17938)
	[0.14990]	[3.29536]	[−0.16442]	[1.31335]	[−2.47919]
FINC(−1)	−3.61276*	1.19755***	0.819741	−0.003619	−7.97499***
	(2.10976)	(0.08658)	(1.11993)	(0.00557)	(2.40356)
	[−1.71240]	[13.8323]	[0.73196]	[−0.64915]	[−3.31800]
GDPGR(−1)	0.016636	−0.08482***	0.072169	0.000247	0.256234
	(0.35095)	(0.01440)	(0.18630)	(0.00093)	(0.39982)
	[0.04740]	[−5.88985]	[0.38739]	[0.26679]	[0.64087]
INFLRA(−1)	−2.345014	14.9573***	−34.4839*	1.09650***	−102.032***
	(33.2947)	(1.36629)	(17.6738)	(0.08798)	(37.9311)
	[−0.07043]	[10.9474]	[−1.95113]	[12.4635]	[−2.68995]
REER(−1)	−0.898121**	−0.04670***	0.257205	−0.002270**	0.325585
	(0.36037)	(0.01479)	(0.19129)	(0.00095)	(0.41055)
	[−2.49223]	[−3.15793]	[1.34455]	[−2.38372]	[0.79304]
C	117.2955	−25.7529***	50.54684	0.062321	305.974***
	(79.1699)	(3.24883)	(42.0258)	(0.20920)	(90.1945)
	[1.48157]	[−7.92684]	[1.20276]	[0.29791]	[3.39238]
R-squared	0.782957	0.997287	0.605006	0.977327	0.940483
Adj. R-squared	0.511654	0.993895	0.111264	0.948985	0.866086
F-statistic	2.885910	294.0352	1.225347	34.48387	12.64150

Notes. Standard errors in () and t-statistics in []***, **, * represents significance at 1%, 5% and 10% respectively.

between monetary policy rate and lag financial inclusion is consistent with other studies (Lenka & Bairwa, 2016; Mbutor & Uba, 2013). We found similar evidence of a negative relationship between monetary policy rate and the lag of financial inclusion when we used the full sample. In the full sample, the lag of financial inclusion has a negative effect on monetary policy rate in model 1 in Table 6.

On the other hand, the lag of monetary policy rate positively impacts financial inclusion in model 2 in Table 5. This finding of a positive relationship between the lag monetary policy and financial inclusion suggests that when the central bank

Table 6. Full sample panel VAR results.

	MPR	FINC	GDPGR	INFLRA	REER
MPR(−1)	0.62477***	−0.020788	−0.05014*	0.32435***	4.63737*
	(0.02849)	(0.04264)	(0.02625)	(0.06565)	(2.53636)
	[21.9326]	[−0.48747]	[−1.91053]	[4.94096]	[1.82836]
FINC(−1)	−0.00472*	1.01667***	−0.007542**	−0.009226	−0.127608
	(0.00275)	(0.00412)	(0.00253)	(0.00634)	(0.24481)
	[−1.71906]	[247.003]	[−2.97701]	[−1.45616]	[−0.52125]
GDPGR(−1)	0.082952**	0.123499**	0.52410***	0.203945**	−1.268414
	(0.03690)	(0.05524)	(0.03400)	(0.08504)	(3.28557)
	[2.24799]	[2.23564]	[15.4152]	[2.39834]	[−0.38606]
INFLRA(−1)	0.019916	0.05547*	0.06393***	0.24265***	−0.822442
	(0.01974)	(0.02954)	(0.01818)	(0.04548)	(1.75725)
	[1.00915]	[1.87764]	[3.51601]	[5.33537]	[−0.46803]
REER(−1)	0.00011***	2.27E-05	2.27E-05	0.00016*	1.03520***
	(3.7E-05)	(5.6E-05)	(3.4E-05)	(8.6E-05)	(0.00331)
	[3.12181]	[0.40712]	[0.66049]	[1.90154]	[312.327]
C	1.443340**	0.487696	1.92825***	0.421411	−3.338042
	(0.48494)	(0.72596)	(0.44681)	(1.11753)	(43.1782)
	[2.97634]	[0.67179]	[4.31560]	[0.37709]	[−0.07731]
R-squared	0.678438	0.993626	0.519238	0.361553	0.995740
Adj. R-squared	0.667975	0.993418	0.503595	0.340779	0.995601
F-statistic	64.84185	4790.836	33.19301	17.40427	7183.539

Notes. Standard errors in () and t-statistics in []***, **, * represents significance at 1%, 5% and 10% respectively.

monetary policy rate increases, the number of depositors with commercial banks increases, since interest rates will also increase and hence more people will be financially included. In other words, increases in the monetary policy rate results in temporary fluctuations in people incomes due to increases in inflations rate, and hence people will resort to the use of financial institutions by borrowing to smoothen their consumption according to the permanent income hypothesis. Our finding of a positive relationship between the lag monetary policy and financial inclusion is not consistent with other studies that found a negative relationship (Evans, 2016). In the full sample, we did not find a significant relationship between the lag monetary policy rate and financial inclusion in model 2 in Table 6.

The study also controlled for macroeconomic factors such as GDP growth rate, inflation rate, and the real effective exchange rate. We found out that GDP growth rate and inflation rate do not influence monetary policy rate in sub-Saharan Africa, but rather it is the real effective exchange rate (REER) that has a significant impact on monetary policy rate in sub-Saharan Africa. This is evident by the negative co-efficient of the REER in model 1 in Table 5. It implies that increases in the REER reduces monetary policy rate in sub-Saharan Africa. Our finding of a negative relationship between monetary policy and the real effective exchange is consistent with other studies that found a negative relationship (Lenka & Bairwa, 2016). In the case of the full sample results, the lag of GDP growth rate and the REER are significant drivers of monetary policy rate according to the results in model 1 in Table 6.

In the sub-Saharan African sample, macroeconomic factors are significant drivers of financial inclusion index (FINC). The lag of GDP growth rate GDPGR, the lag of inflation rate INFLRA and the lag of the real effective exchange rate are drivers of financial inclusion index FINDEX in sub-Saharan Africa, according to the results in model 2 in Table 5. GDP growth rate has a negative co-efficient, implying that economic growth in sub-Saharan Africa does not translate into FINC. The INFLRA has a positive effect on financial inclusion. The explanation we offer for this finding is that increases in the inflation rate reduces people's real income, and to maintain the same living standard people will resort to the use of financial institutions to borrow to make up for the difference in their real income.

In the case of the full sample, the only macroeconomic variables that are significant drivers of financial inclusion is the lag of GDPGR and the INFLRA, and they both carry the expected signs. This is evident by the positive coefficient of the lag of GDPGR and INFLRA in model 2 in Table 6. The explanation we offer for this finding is that increases in GDP growth rate and Inflation rate enhance financial inclusion in the world. However, the lag of real effective exchange rate is not a significant driver of financial inclusion, according the full sample results in Table 6.

We also examined how the monetary policy rate (MPR) and financial inclusion index (FINC) could also be influenced by these macroeconomic variables (GDP growth rate, inflation rate and the real effective exchange rate). According to the sub-Saharan Africa sample results presented in Table 5, the lag of the MPR and the FINC are not significant drivers of GDP growth rate and inflation rate, but they are drivers of the real effective exchange rate in model 3 in Table 5. In the case of the full sample results, the lag of the MPR significantly impacts the GDPGR, INFLRA, and REER according to the results in Table 6.

However, the lag of financial inclusion only impacts GDP the GDPGR in model 3 in Table 6, though it does not influence the INFLRA and the REER. This finding also confirms the widely held view that macroeconomic variables affect financial inclusion and people's behavior.

Variance decomposition

Our results seem to be confirmed by the forecast-error variance decomposition (FEVD) based on a Cholesky decomposition of the residual covariance matrix of the underlying PVAR model of the sub-Saharan African countries (see Tables 7 and 8) and the PVAR model of the full sample (see Tables 9 and 10). The results contained in Table 7 show that the contribution of financial inclusion (second column) and GDP growth rate (third column) explains the 48.72% and 29.19% of the variation of monetary policy in the long run; that is, after 10 years. After 10 years, more than 0.11% and 0.009% of the variation in monetary policy is explained by inflation rate and the real effective exchange rate shocks respectively, while in the full sample, the results contained in Table 9 show that the contribution of financial inclusion (second column) and GDP growth rate (third column) explains 0.42% and 0.24% of the variation of monetary policy in the long run; that is, after 10 years. After 10 years, more than 0.003% and 7.57% of the variation in monetary policy are explained by inflation rate and the real effective exchange rate shocks respectively. Table 8 represents the variance decomposition of financial inclusion index of the sub-Saharan African sample. It shows that monetary policy and GDP growth rate shocks contribute significantly to the variation of financial inclusion in the long run. After 10 years, monetary policy and GDP growth

Table 7. Variance decomposition of monetary policy rate of sub-Saharan Africa sample.

Period	SE	MPR	FINC	GDPGR	INFLRA	REER
1	4.281080	100.0000	0.000000	0.000000	0.000000	0.000000
2	5.514375	89.58446	2.870952	7.491100	0.027685	0.025804
3	6.438761	72.61725	11.19307	16.11312	0.051211	0.025344
4	7.419481	55.23871	21.59479	23.09076	0.055972	0.019770
5	8.505756	42.21249	30.57751	27.14819	0.046707	0.015100
6	9.632797	34.01644	37.03584	28.89880	0.036478	0.012437
7	10.72542	29.14010	41.41955	29.39421	0.035002	0.011145
8	11.73786	26.07831	44.48325	29.38107	0.046898	0.010469
9	12.65923	23.85623	46.80393	29.25651	0.073392	0.009946
10	13.50656	21.95179	48.72930	29.19593	0.113605	0.009366

Table 8. Variance decomposition of financial inclusion of sub-Saharan Africa sample.

Period	SE	MPR	FINC	GDPGR	INFLRA	REER
1	0.848924	1.771153	98.22885	0.000000	0.000000	0.000000
2	1.315779	4.791631	80.59127	14.60695	0.007533	0.002608
3	1.698374	6.701208	72.84819	20.41573	0.030787	0.004090
4	2.015370	7.721874	69.36027	22.84247	0.070532	0.004862
5	2.286837	8.008087	67.70999	24.15149	0.125365	0.005070
6	2.530160	7.741097	66.95346	25.10842	0.192156	0.004868
7	2.761521	7.115976	66.62993	25.98350	0.266172	0.004417
8	2.996294	6.309216	66.47620	26.86917	0.341551	0.003859
9	3.248891	5.453993	66.34271	27.78776	0.412234	0.003298
10	3.532526	4.632205	66.16166	28.73024	0.473102	0.002790

Table 9. Variance decomposition of monetary policy rate of full sample.

Period	SE	MPR	FINC	GDPGR	INFLRA	REER
1	1.905375	100.0000	0.000000	0.000000	0.000000	0.000000
2	2.483832	99.24542	0.016109	0.015275	8.57E-05	0.723110
3	2.824780	97.99892	0.050888	0.012007	0.000187	1.937994
4	3.049407	96.60292	0.099032	0.026881	0.000241	3.270925
5	3.205427	95.27080	0.155837	0.062404	0.000247	4.510709
6	3.316763	94.10633	0.218026	0.108836	0.000232	5.566580
7	3.397288	93.14092	0.283536	0.157224	0.000231	6.418084
8	3.455888	92.36706	0.351117	0.202166	0.000272	7.079381
9	3.498626	91.76007	0.420015	0.241201	0.000371	7.578339
10	3.529803	91.29034	0.489766	0.273691	0.000535	7.945668

Table 10. Variance decomposition of financial inclusion of full sample.

Period	S.E.	MPR	FINC	GDPGR	INFLRA	REER
1	4.370157	0.002182	99.99782	0.000000	0.000000	0.000000
2	6.198869	0.026930	99.47850	0.148162	0.002491	0.343913
3	7.620461	0.056658	98.76834	0.190116	0.008431	0.976459
4	8.837050	0.084250	97.99793	0.178281	0.018106	1.721433
5	9.925629	0.109347	97.23605	0.152806	0.031739	2.470054
6	10.92440	0.131532	96.52374	0.128461	0.049454	3.166809
7	11.85538	0.150073	95.88119	0.109136	0.071297	3.788305
8	12.73268	0.164287	95.31505	0.095037	0.097254	4.328372
9	13.56606	0.173779	94.82426	0.085359	0.127275	4.789329
10	14.36274	0.178518	94.40380	0.079170	0.161278	5.177238

rate shocks explain about 4.63% and 28.73% respectively of the variation of financial inclusion, while in Table 10, which represents the variance decomposition of financial inclusion of the full sample, after 10 years monetary policy and GDP growth rate shocks explain about 0.179% and 0.079% respectively of the variation of financial inclusion

Impulse response functions

Figure 2 displays the impulse response functions of all the endogenous variables of the PVAR model of the African sample. The accumulated impulse responses are presented over time. The response of monetary policy rate to financial inclusion and GDP growth rate shocks is positive and statistically significant. This seems to be consistent with our findings.

The accumulated response of financial inclusion to monetary policy rate shocks shows it is positive and is statistically significant. This means that expansionary monetary policy can induce financial inclusion. Figure 3 displays the impulse response functions for all the endogenous variables of the PVAR model of the full sample. The accumulated impulse responses are presented over time. The response of monetary policy rate to financial inclusion shocks in the full sample is negative but not statistically significant. This implies that an increase in financial inclusion reduces the monetary policy rate.

The accumulated response of financial inclusion to monetary policy rate shocks in the full sample shows it is not statistically significant.

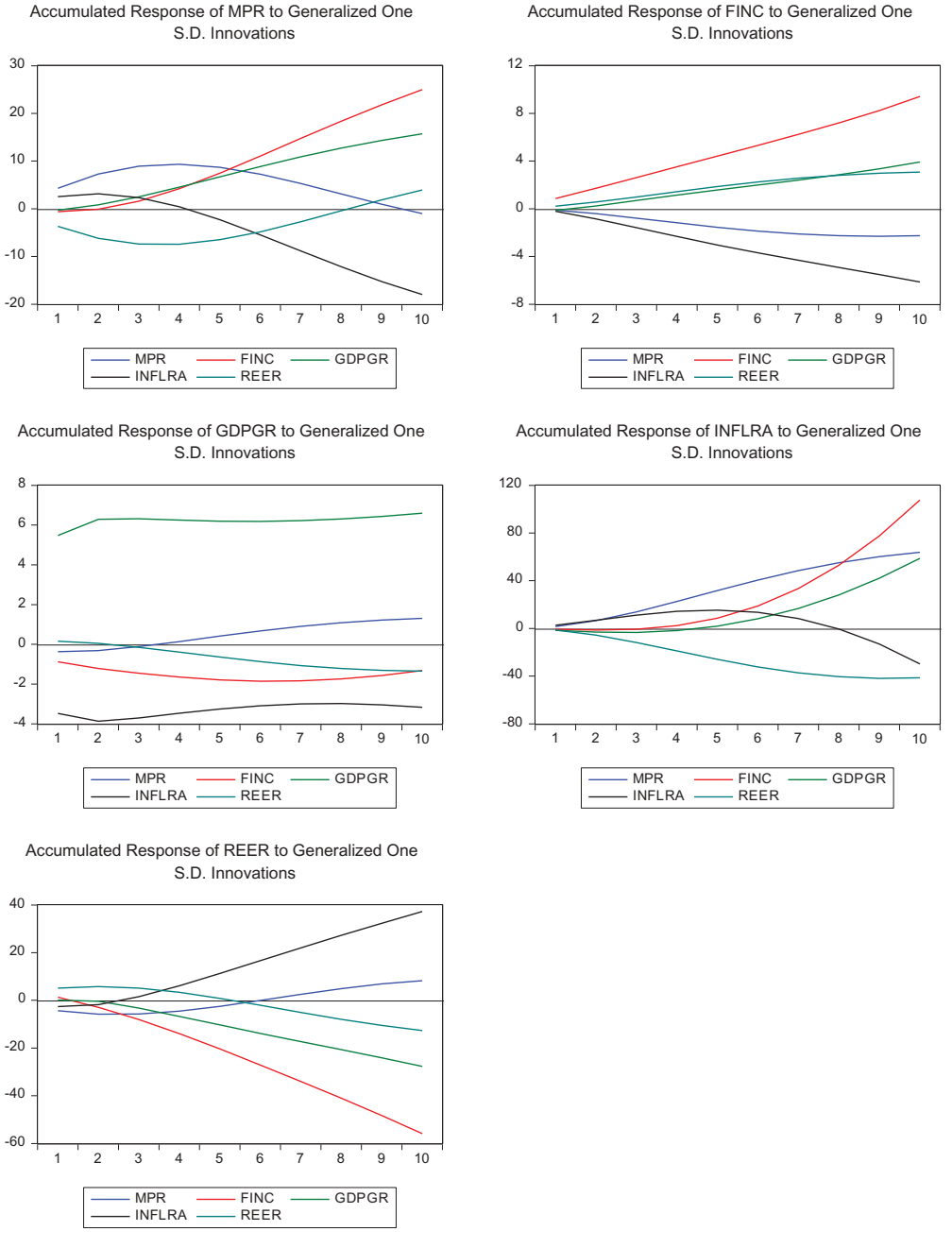

Figure 2. Impulse response functions of the sub-Saharan African sample.
Source: Authors Compilation

Conclusions

This study has investigated the dynamic link between monetary policy and financial inclusion in sub-Saharan Africa. We have examined the empirical relations between

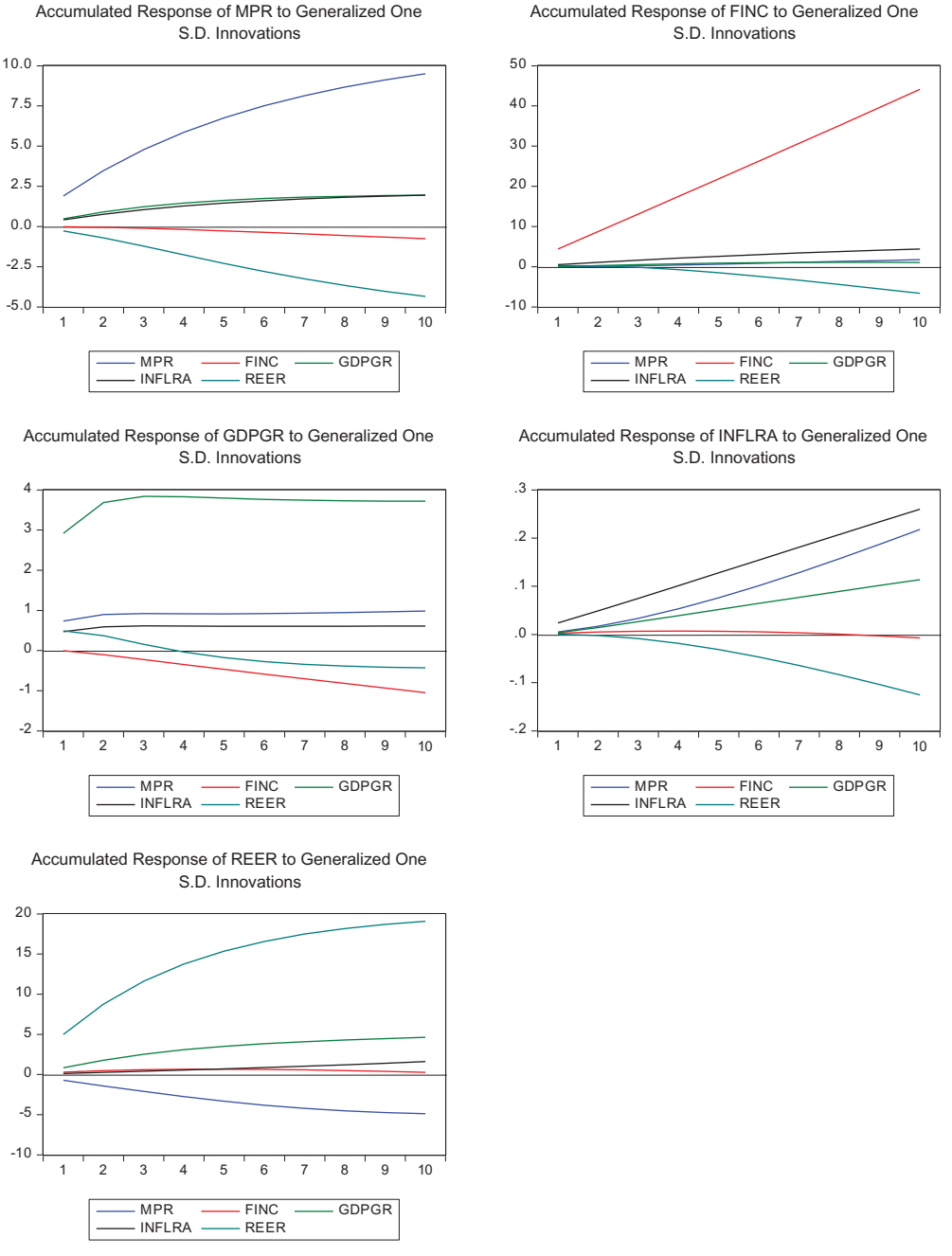

Figure 3. Impulse response functions of the full sample.

monetary policy and financial inclusion using a PVAR approach. We found a very complex web of relationships among monetary policy, financial inclusion, GDP growth rate, inflation rate, and the real effective exchange rate.

Monetary policy and financial inclusion play key roles in sub-Saharan Africa and have greater implications for macroeconomic stability. We found that monetary policy

has a significant impact on financial inclusion and this has a strong implication for policymaking. It implies that monetary authorities in sub-Saharan Africa should not see a change in monetary policy rate as the only tool aimed at macroeconomic stability; they should also consider financial inclusion. This is because we found that financial inclusion could also enhance macroeconomic stability. From our findings we observed that financial inclusion significantly impacts macroeconomic variables such as the GDP growth rate, the inflation rate, and the real effective exchange rate. This suggests that it is not only monetary policy that could affect these variables to ensure economic stability, but financial inclusion can also perform the same function as monetary policy, and therefore the two are substitutes. This finding suggests that sub-Saharan African governments should not only pursue monetary policy as a policy objective, since monetary policy can also be an outcome variable of financial inclusion. Hence, efforts should be geared toward advancing financial inclusion as well.

Our findings are consistent with studies that examine the relationship between monetary policy and financial inclusion in SAARC countries and Nigeria (Lenka & Bairwa, 2016; Evans, 2016; Mbutor & Uba, 2013).

Our study additionally found that monetary policy also depends on financial inclusion in Africa. It suggests, therefore, that since the effectiveness of monetary policy depends on financial inclusion, the efforts of governments in Africa should not only be on the behavior of macroeconomic variables to influence their monetary policy rate but also on financial inclusion.

Our article extends the discussions on monetary policy and financial inclusion by using a PVAR approach to establish the relationship between monetary policy and financial inclusion which addresses the endogeneity problem of these variables. We contribute to the advancement of theory by establishing that there is a reverse causality between monetary policy and financial inclusion.

Disclosure statement

No potential conflict of interest was reported by the authors.

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