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Do mobile phones, economic growth, bank competition and stability matter for financial inclusion in Africa?

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Abstract: The lower levels of financial inclusion and severe financial inclusion gaps in Africa motivates the investigation of whether mobile phones, economic growth, bank competition and stability matter for financial inclusion. Data from 49 countries for the periods 2004–2016 were collected and analysed using a five-variable panel structural vector autoregressive model. There was evidence to show that financial inclusion responds positively and significantly to shocks in bank competition, economic growth, mobile phones and bank stability. However, the results reveal that all the variables respond to one standard deviation shock in financial inclusion, suggesting that while the variables matter for financial inclusion, they also require financial inclusion for their effective operation. Hence, the conclusion is that financial inclusion plays a central in the effective running of economies.

Subjects: Quantitative Finance; Statistics for Business, Finance & Economics; Banking & Finance Law; Entrepreneurial Finance

Keywords: financial inclusion; bank competition; bank stability; economic growth; panel structural vector autoregressive model
JEL classification: G2; F65; G21; L5

1. Introduction

The purpose of this study is to analyse the financial inclusion of the African economies in the context of mobile phones, economic growth, bank competition and stability. Among the developing and emerging economies, financial inclusion is lowest in Africa (Mehrotra & Yetman, 2015). The

ABOUT THE AUTHOR

Tough Chinoda is an emerging researcher in the area of financial inclusion. He is also a PhD student from University of KwaZulu Natal in the School of Accounting, Economics and Finance. Farai Kwenda is the promoter to the corresponding author who specialise in Finance. Our research area is on financial inclusion in the African region. We are exploring a bigger picture of financial inclusion in the region. Tough Chinoda has an academic experience of more than 5 years in the area of finance whilst that of Farai Kwenda spans for more than 10 years in the same area.

PUBLIC INTEREST STATEMENT

This article investigates whether mobile phones, economic growth, bank competition and stability matters for financial inclusion in Africa. Data from 49 countries for the periods 2004–2016 were collected and analysed using a five-variable panel structural vector autoregressive model. There was evidence to show that financial inclusion responds positively and significantly to shocks in bank competition, economic growth, mobile phones and bank stability. However, the results reveal that all the variables respond to one standard deviation shock in financial inclusion, suggesting that while the variables matter for financial inclusion, they also require financial inclusion for their effective operation. Hence, the conclusion is that financial inclusion plays a central in the effective running of economies.

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region is also characterised by a wide heterogeneity in account ownership across countries. Whilst 82%, 75% and 70% of the adult population in countries like Mauritius, Kenya and South Africa are, respectively, banked, only 7% have a formal bank account in Burundi, Guinea and Niger (Demirgüç-Kunt, Klapper, Singer, & Van Oudheusden, 2015). On the other hand, the African region has for more than a decade recorded an unparalleled high economic growth rate, globally ranked one of the highest, despite the global economy's gloomy state (IMF, 2013). Thus, the region has attracted lots of interest from researchers, investors, and other stakeholders as they endeavour to either better understand the growth dynamics or take advantage of this growth trajectory within the region. Although financial inclusion is a global challenge, the situation in Africa poses a unique economic challenge, not only because the region ranks among the lowest in terms of financial inclusion compared to other regions, but also because of the heterogeneity that exists within the region and the seeming anomaly between financial inclusion and the level of economic growth. This poses massive challenges to policy-makers of improving financial inclusion that could support the anticipated development in the African region. Theoretical predictions have claimed bank competition and stability as the other channels in which financial inclusion is boosted (Cull, Demirgüç-Kunt, & Lyman, 2012;Fungáčová & Weill, 2015). In addition, mobile phones have also become a vital tool with the potential to promote financial inclusion (Kanobe, Alexander, & Bwalya, 2017). Thus, it requires empirical investigations of ways to improve financial inclusion in the region.

To the best of my knowledge, this is the first research to investigate the implications of mobile phones, economic growth, bank competition and stability on financial inclusion; second, the effect of financial inclusion on economic growth and bank stability. This study found evidence to support a direct and significant relationship between the economic growth, mobile phones, bank competition and stability and financial inclusion. Until now, no study has investigated these issues as suggested by the evidences available and are fundamental extension of literature.

The rest of this article ensues as follows: Section 2 covers theoretical and empirical literature review. Section 3 explains the methodology of the study including data source and description of variables employed. The results are presented in Section 4, and Section 5 provides the summary and conclusion.

2. Literature review

There is no consensus over the definition of financial inclusion as differences emanate from the context wherein the term is used, the state of economic development and geographical location of the area. Sarma (2008) defines financial inclusion as a process of ensuring easy access to, availability, and usage of formal financial systems to all members of an economy. In contrast, Amidžić, Massara and Mialou (2014) and Camara, Pena, and Tuesta (2014) define financial inclusion as the process of maximising access and usage while minimising involuntary financial exclusions. Therefore, they focus more on access, usage, and barriers, which capture both the demand and supply-side of financial access. World Bank concurred with Sarma (2008) and defined an inclusive financial system as one that ensures easy access to or use of affordable financial services and products (transactions, credit, savings, payments, and insurance) that meets the necessities of businesses and individuals, conveyed in a responsible and viable manner[1] (World Bank, 2017). Although different definitions of financial inclusion have been put forward, they all seem to concur that financial inclusion ensures easy access to and usage of formal financial services. We followed the definition by Sarma (2008) and the World Bank (2017) which includes numerous dimensions such as availability, accessibility, and usage, which can be discussed separately. The definition is also measurable and can be easily incorporated into theoretical and empirical work.

2.1. Financial inclusion and economic growth

Financial inclusion has been recently identified as an important driver of economic growth (Claessens, 2006; Claessens & Perotti, 2007). Akinboade and Kinfack (2014) have pointed out that improvements in the financial service sector result in an efficient resources allocation which leads to economic growth. According to Andrianaivo and Kpodar (2012) and Hariharan and

Marktanner (2012), financial inclusion has the capacity to enhance efficiency of intermediation, increase the savings portfolio of the financial sector and enhancement of entrepreneurial activities which eventually lead to economic growth. In addition, Khan (2011), expounded that financial access increases employment opportunities for rural households as more people get involved in economic activities, also the disposable income for the rural household would rise, resulting in more savings and deposits which will lead to economic growth through the multiplier effect. Numerous empirical studies have investigated the interplay between financial inclusion and economic growth (Andrianaivo & Kpodar, 2012; Michael & Sharon, 2014; Gretta, 2017; Hariharan & Marktanner, 2012; Iqbal & Sami, 2017; Lenka & Sharma, 2017; Mwaitete & George, 2018; Nkwede, 2015; Oruo, 2013; Onaolapo, 2015; Okoyo et al., 2017; Sharma, 2016; Saidi & Emara, 2017; Wang'oo, 2013). Some have concluded that financial inclusion catalyses economic growth; the supply-leading hypothesis (see Sharma, 2016; Lenka & Sharma, 2017; Okoye et al., 2017; Iqbal & Sami, 2017; Uchenna & Anyanwaokoro, 2017). Others have concluded that economic growth drives financial inclusion; the demand-following hypothesis (see Babajide, Adegboye, & Omankhanlen, 2015; Evans, 2015). Others have observed a reciprocal causality between the two variables (Gour'ene and Mendy, 2017; Kim, Yu, & Hassan, 2018). Others argue that there is simply independence or unimportant influence between financial inclusion and the growth of economies (Gour'ene and Mendy, 2017).

2.2. Competition and financial inclusion

Theoretical predictions on the effect of bank competition on financial inclusion have been ambiguous. On one side, the conventional market power hypothesis claims that bank competition increases the availability of credit as finance costs are reduced (Berger & Hannan, 1998). Barth, Lin, Lin, and Song (2009) proposed a channel where competition may be indirectly beneficial for financial inclusion. Corruption in lending emasculates the efficient allocation of scarce capital. In a simple bargaining model, they show that the higher the bank concentration the more the bank-lending corruption.

On the other side, the information hypothesis suggests that in the presence of agency costs and information asymmetries, competition can reduce financial access by making it more unattractive for banks to internalise the returns from investing in lending, especially, with opaque clients. The information hypothesis contends that market power may ease the information wedge between borrowers and lenders through monitoring and screening activities. Beck, Demirgüc-Kunt and Maksimovic (2003), World Bank (2014) and Fangacova et al. (2015) contend that low competition increases the difficulty in attaining finance. Moreover, Corvoisier and Gropp (2002) also argued that borrowers in markets with low competition face higher loans costs. The high cost of borrowing impacts negatively on small businesses that needs to grow which goes a long way to affect the growth of the economy and employment.

2.3. Bank stability and financial inclusion

Bank stability is another channel in which financial inclusion affects economic growth. Studies on the various possible linkages between bank stability and financial inclusion are new and largely realised by those institutions, policymakers, international bodies, regulators responsible for safeguarding financial inclusion and/or stability. Until recently, the majority of the documents consisting of case studies from countries or regions gathered in speeches or working documents, which do not demonstrate nor explore empirically the proposed links. They also failed to apply a concrete conceptual framework.

Cull et al. (2012) pointed out four distinctive ways in which financial inclusion relates to bank stability. First, they argue that since financial inclusion attracts small savers, such savings boost stability at the household and individual level and they potentially enhance financial stability given their large numbers. Second, the authors argued that financial inclusion could also contribute to enhanced financial stability as an inclusive financial system results in healthier small business sector and households. Third, since, evidence at country level suggests financial inclusion can result in greater financial intermediation, this may strengthen sound investment cycle and

domestic savings and consequently leads to greater stability. Fourth, Cull et al. (2012) argued that greater clientele diversification which is related to financial inclusion is expected to lead to a more resilient and more stable economy.

2.4. Mobile phones and financial inclusion

Notably, mobile phones have become a vital tool in promoting financial inclusion to the unbanked in developing countries (Kanobe et al., 2017). Due to their distinctive features such as being personalised small devices, mobility, and always-on availability, mobile phones have diffused rapidly in most developing countries to overcome socio-economic and geographical barriers. Distance, costs and bureaucracy are the major barriers to financial inclusion (World Bank, 2014). Mobile phones reduce banks costs since they can switch from large fixed infrastructure costs in rural and poorer areas to a per-transaction variable cost structure. It is particularly cost efficient for customers, as it reduces travelling costs to and from distant branches. Besides costs reduction, mobile phones also allow customers to network with their bank, initiate transactions and check balances more directly from wherever they are since the device offers convenience, a level of control and immediacy to customers that cannot be provided by other channels. The interaction between banks and their clients through mobile phones creates an opportunity for information capturing which is one of the barriers to financial inclusion. There also exists a possibility of reverse causality from financial inclusion to mobile phone diffusion. There is an opportunity for people to either save or borrow and buy mobile phones as they get financially included. Mihasonirina and Kangni (2011), Andrianaivo and Kpodar (2012), Maria and Frida (2014), Sekantsi and Motelle (2016), Ouma, Odongo, and Were (2017), Seng (2017), and Lenka and Barik (2018) used various methodologies to examine the interplay between mobile phones and economic growth for African countries, Cambodia and South Asian Association for Regional Cooperation (SAARC) countries and found a stable positive relationship between internet-enabled mobile phones and financial inclusion in the long run and that mobile phones Granger causes financial inclusion in the long run. Specifically, we contributed to extant literature in the transmission effect between financial inclusion and mobile phones, economic growth, bank competition and stability.

3. Data and methodology

3.1. Methodology

To effectively analyse the impact on financial inclusion of mobile phones, economic growth, bank competition and stability and how financial inclusion also affects these variables, this study chose to perform a short-term analysis using the panel structural vector autoregressive (P-SVAR) model. The choice of method is justified by its flexibility to permit the recovery of interesting pattern with little or no theoretical background (see De Graeve & Karas, 2010), especially in researches as in the case of this study. Moreover, the ability of panel vector autoregression (PVAR) to combine past, present and future scenarios in a study (Canova & Ciccarelli, 2009) stresses its power over other methods such as ordinary least squares (OLS) and generalised method of moments (GMM), including its ability to accommodate more variables without the loss of degree of freedom (Raghavan & Silvapulle, 2008). In addition, it is useful in separating shocks as to whether it is temporary or permanent (Ramaswamy & Sløk, 1998), while also providing the flexibility of dynamic slope heterogeneity and cross section (Canova & Ciccarelli, 2009). In fact, it combines the merits of vector autoregression (VAR), PVAR and SVAR as it overcomes their individual limitations.

This study follows the P-SVAR approach of Gisanabagabo and Ngalawa (2017) and Akande and Kwenda (2017) to analyse the transmission effect between the variables under study. Hence, the P-SVAR can be written in a reduced form as:

$$X_{it} = Y_i + Z \cdot (B) \cdot X_{it} + it \tag{1}$$

where X_{it} is (n $\times k$) vector variable given as:

$$X_{it} = (ZSCORE,\ FII,\ MOBILE,\ BOONE,\ GDPPCGR) \tag{2}$$

Equation 2 is a vector of endogenous variables for African countries used in the study where; ZSCORE is the stability measure, FII is the financial inclusion index, MOBILE is the mobile phones subscription per 100 adults, BOONE is the competition measure and GDPPCGR is the economic growth measure. From Equation 1, Y_i is the intercept terms of the country, Z(B) is the lag operator matrix of the polynomial that captures the interplay between endogenous variables and their lags, and $\mu_{it}=\theta^{-1}\kappa\varepsilon_{it}$ and/or $\theta it = \kappa\varepsilon_{it}$, is the random disturbance vector. This was employed to estimate the interaction between mobile phones, economic growth, bank competition and stability and financial inclusion in the African region.

To allow the recovery of information in the structural model, we imposed restrictions in the matrices θ and κ in the system for which we follow the identification scheme of (Akande & Kwenda, 2017; Gisanabagabo & Ngalawa, 2017) where structural restrictions are applied to the contemporaneous parameter matrix. This process allows the contemporaneous variables reactions to the individual innovations centred on their ordering (see Akande & Kwenda, 2017; Gisanabagabo & Ngalawa, 2017). Based on the identification scheme of Amisano, Cesura, Giannini, and Seghelini (1997), we imposed 35 or $2n^2 - n(n+1)/2$ restrictions on the A and B matrices combined (where n is the number of variables) for the five-variable P-SVAR. Twenty maximum restrictions are imposed on the diagonal matrix B so that the A matrix absorbed the remaining 15 restrictions for the system to be exactly identified.

The impulse response functions (IRFs) and forecast error variance decomposition (FEVDs) will be conducted to measure the sensitivity, magnitude, direction and timing of the variables on an unanticipated innovation in financial inclusion.

3.2. Data sources and variable description

The P-SVAR used in this study comprises five variables, namely, financial inclusion, proxied by the financial inclusion index (FII) computed through the principal component analysis, financial stability (Z-Score), bank competition (BOONE), mobile phones penetration (MOBILE), and the rate of economic growth (GDPPCGR). Data on financial inclusion, mobile phones subscriptions, bank competition, financial stability and economic growth were obtained from the World Bank's Global Development Indicators Database (GFDD), which provides data for 189 countries across the globe. The WDI Database is much broader and contains significant details on the variables under study. In addition, it facilitates better comparison across countries. However, this database's major limitation is that several countries have missing data, especially on financial inclusion indicators. Therefore, data availability largely determines the selection of countries. We used annual data from a panel of 49 countries from the African region sourced over the period 2004–2016.

3.3. Model specification and diagnostic tests

3.3.1. Stationarity tests

It is imperative to consider the temporal properties of data prior to conducting VAR model specification, so as to determine whether the VAR model should be specified using variables in first differencing, in levels or else using vector error correction model (VECM).[2] We performed panel unit root tests using the Maddala and Wu-Fisher Chi-square using Augmented Dickey Fuller and Phillips and Perron tests (Maddala & Wu, 1999), and Im, Pesaran and Shin test (Im, Pesaran, & Shin, 2003). The preliminary results indicate that most of the variables are integrated of order 1 or 1(1) and are cointegrated. A VECM is preferred if the exact/correct cointegration relationship is known, but if one is not sure; then, the VECM estimates will be inconsistent. Alternatively, a VAR specified in levels in a similar circumstance produces inefficient but consistent estimates (Sims, 1980); a better result than VECM that produces inconsistent estimates. The main objective of our study is not to determine the long-run relationship between the variables but to ascertain causality and produce unbiased IRFs and VDs, thus the P-SVAR model is used. We also borrowed from Sims,

Stock, and Watson (1990) and Amisano and Giannini (2012) who neither paid attention to data non-stationarity as an impending problem of the VAR methodology.

4. Estimation results

4.1. Descriptive statistics

Table 1 presents a descriptive statistics of the data used in this study over 13 periods (2004–2016). The summary statistics provide an intuition into the nature of data employed. The study found that the average financial inclusion in Africa range between 0.01 and 0.88 supporting the view that Africa is characterised by severe financial inclusion disparities and adamant financial exclusion (Ndlovu, 2017). The average measure of stability over the period hovers around 13%, which signifies a stable banking system. The banking system in Africa is also faced with a monopolistic competitive market, with a minimum average indicator of −3.2 and a maximum of 1.13 based on the Boone indicator. It can be concluded that banks in Africa are less competitive over the period. There is an increased opportunity for bringing on board a large number of unbanked populations in Africa as witnessed by mean mobile phones subscriptions. The mean economic growth for African countries is 2.58% and on average the values range from −62% to 30% indicating a high disparity in economic performance.

4.2. Stationarity tests

Before conducting a VAR analysis it is essential that we understand temporal properties of the data. We performed panel unit root tests using the Maddala and Wu-Fisher Chi-square using Augmented Dickey Fuller and Phillips and Perron tests (Maddala & Wu, 1999), and Im, Pesaran and Shin test (Im et al., 2003). The preliminary results from Tables 2 and 3 respectively indicate that most of the variables are stationary in their first difference or integrated of order 1 or 1(1), except financial inclusion and stability which was stationary at levels or 1(0). GDP growth is non-stationary though unusual could be as a result of unusual booms or crises which makes it impossible to forecast. The Johansen cointegration tests (Johansen, 1988) were performed on those variables involving purely 1(1) variables. We, however, did not report the results of the cointegration test since the main focus of the study is to explore causality and produce unbiased FEVDs and IFRs and not to find the long run relationship between the variables.

The following diagnostic and specification tests (unit root tests, lag length selection, serial correlation tests, normality tests and heteroskedasticity tests) were also conducted. Given the importance of lag length selection for VAR models estimations as highlighted by Canova and Ciccarelli (2009), the researcher carried out an optimum lag length selection criteria procedure and found five lags to be

Table 1. Descriptive statistics

	BOONE	FII	GDPPCGR	MOBILE	Z-SCORE
Mean	−0.083131	0.168,477	2.578,027	58.30,474	12.54,634
Median	−0.050000	0.109,276	2.448,667	50.63,907	10.63,000
Std. dev.	0.265,531	0.169,514	4.841,117	42.45,680	8.703,130
Maximum	1.130,000	0.880,000	30.35,658	176.6859	63.87,000
Minimum	−3.200,000	0.006435	−62.22,509	0.208,422	1.400,000
Kurtosis	75.39,909	6.949,192	85.96,982	2.567,370	10.36,713
Skewness	−7.075556	1.955,465	−5.417,190	0.641,617	2.361,636
Jarque-Bera	89,337.56	507.1352	114,939.2	30.10,579	1257.253
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	−32.75,359	66.37,979	1015.743	22,972.07	4943.257
Sum sq. dev.	27.70,908	11.29,285	9210.509	708,413.8	29,767.58
Observations	594[3]	594	594	594	594

Source: Author's computation based on The World Development Indicators Database (2018).

Table 2. IPS, ADF and PP unit root test @ I (0) level

	IPS		ADF		PP	
	Statistics	***p*-Value**	**Statistics**	***p*-Value**	**Statistics**	***p*-Value**
GDPPCGR	−0.82,270	0.2053	49.2592	0.5030	71.3228	0.0255
MOBILE	1.36,505	0.9139	40.2330	0.8367	45.6002	0.6504
FII	−4.91,861	0.0000	74.9299	0.0045	107.756	0.0000
BOONE	−0.77,402	0.2195	59.7416	0.0840	119.639	0.0000
Z-SCORE	−1.50,592	0.0660	61.6248	0.1254	75.6720	0.0110

Table 3. IPS, ADF and PP unit root test @ I (1) level

	IPS		ADF		PP	
	Statistics	***p*-Value**	**Statistics**	***p*-Value**	**Statistics**	***p*-Value**
Δ GDPPCGR	−1.99,073	0.0233***	68.0191	0.0458***	89.8449	0.0005***
Δ MOBILE	−3.06285	0.0011***	86.1722	0.0011***	85.8807	0.0012***
Δ FII	−7.34,936	0.0000***	125.812	0.0000***	281.428	0.0000***
Δ BOONE	−4.57,784	0.0000***	100.588	0.0000***	315.677	0.0000***
Δ Z-SCORE	−4.08750	0.0000***	99.1543	0.0000***	217.248	0.0000***

Source: Author's calculations.
Note: (*), (**), and (***) specify the rejection of the unit root test hypothesis at the 10%, 5% and 1% levels, respectively. Δ denotes first differences.

the optimal lag length based on the five most commonly used information criteria. According to Stock and Watson (2007), using the optimum selection helps to achieve the best results as too few lags omit information that could result in a misspecified equation with the problem of autocorrelation while too many lags also pose the danger of wastage of degrees of freedom including increasing errors in the forecasts. The choice of the five lags by this study underscores the need for an accurate and more robust dynamics without necessarily overly shortening the estimation sample, which would compromise the degrees of confidence. According to Kutu and Ngalawa (2016), issues of serial correlation in the residuals are resolved with the right lag length selection. For robustness, the researcher also conducted diagnostic tests in the form of LM test for autocorrelation, normality tests (skewness, kurtosis and Jarque-Bera), heteroskedasticity tests and VAR stability tests whose outcome validates the model specifications (see diagrams in the appendix).

4.3. P-SVAR results

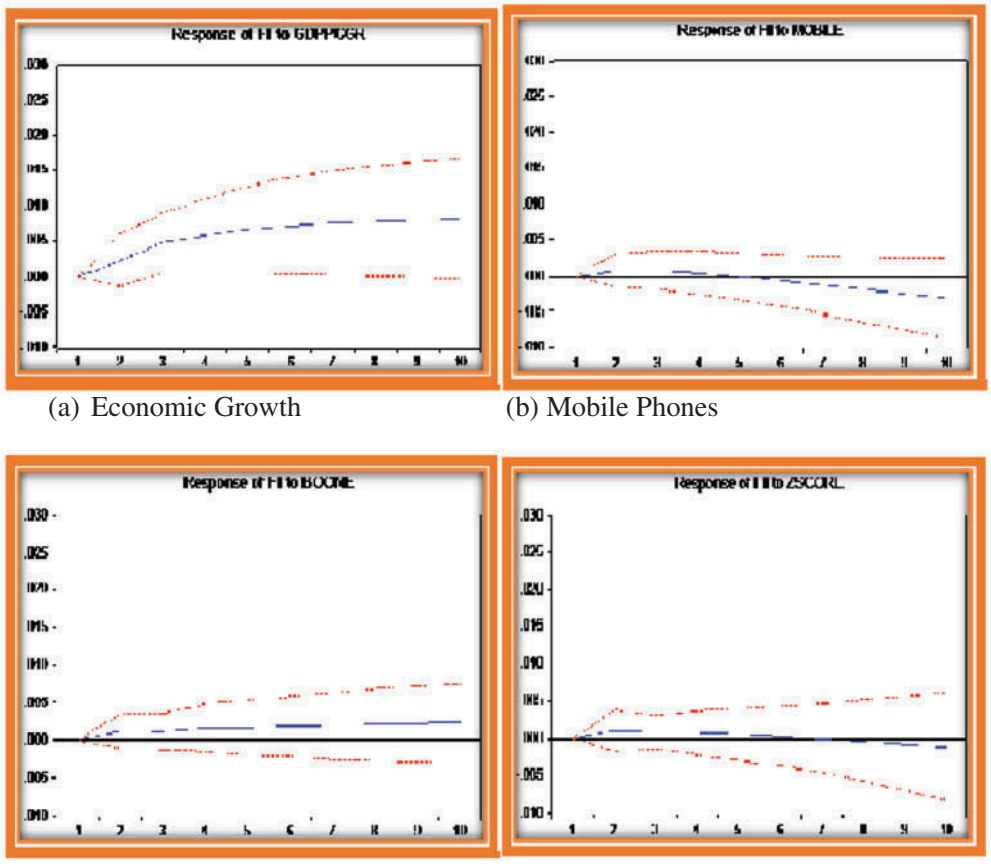
This study follows the P-SVAR approach of Gisanabagabo and Ngalawa (2017) and Akande and Kwenda (2017) to analyse the transmission effect between the variables under study. Having satisfied the requirements for implementing VAR, the results of the variance decomposition and impulse response function are discussed and interpreted below.

4.3.1. Impulse response analysis

We analyse the response of financial inclusion to one standard deviation shock in mobile phones, economic growth, bank competition and stability, as well as the response of these variables to one standard deviation shock in financial inclusion in the African region. Impulse response function provides information on the future states of the African economies as it relates to the changes in any of the variables. Financial inclusion response to economic growth is significant and positive with an increasing trend over the periods. In Figure 1(a), financial inclusion increased significantly from period 1 to period 10. The implication of this is that the level of economic growth determines the relative financial inclusion within an economy and that economic growth has a direct short and long-term positive relationship with financial inclusion in the African region in line with the demand

Figure 1. Impulse responses of financial inclusion.

(a) Economic Growth, (b) Mobile Phones, (c) Bank Competition, (d) Bank Stability.



following hypothesis. Figure 1(b) depicts the impulse response graph for mobile phones and financial inclusion. A standard deviation shock in mobile phones causes a steady decrease in financial inclusion between periods 1 andperiod 10. In other words, financial inclusion does not react significantly in the short run, even though it is positive over the first two periods and at some points became negative. This could be as a result of the low mobile phones penetration in countries with a large number of financially excluded population which hinders the use of mobile money to advance financial inclusion. For example, Democratic Republic of Congo, Madagascar, Malawi and Mozambique have the lowest financial inclusion and mobile phones levels, implying that expanding financial services through the use of mobile money would be impeded by lower mobile phone penetration, and this is the scenario in Africa. This might also be due to lower coverage of mobile networks in rural areas suggesting that using mobile phones for expanding financial inclusion to people in the rural areas requires development of mobile telephone infrastructure. As for bank competition, Figure 1(c) shows a positive and significant relationship between bank competition and financial inclusion. As indicated in the graph, a standard deviation bank competition shock triggers quite an interesting pattern of reactions over the next 10 period. In line with a priori bank competition has direct bearing on financial inclusion. Bank competition is positive and strongly significant in explaining its relationship with financial inclusion in the African region from period 1 to 10. This reiterates the fact that financial inclusion is directly affected by bank competition with short and long-term considerable influence. In the other results, financial inclusion responded significantly and positively to a one standard deviation shock in bank stability as shown in Figure 1(d). Although the response is insignificantly different from zero between period 1 and period 4, financial inclusion does rise in response to a shock in financial stability of one standard deviation from period 5 to period 10. This suggests that a decrease in financial stability may significantly reduce financial inclusion for the next 10 years. These findings are

consistent with the results of Khan (2011) who observed that financial stability can enhance financial inclusion through enhanced trust in the financial system.

Figure 2 shows a number of responses of the variables being considered to a standard deviation financial inclusion shock. As shown in Figure 2(a), financial inclusion is positive but insignificant in terms of explaining economic growth in the short term. Despite being positive, economic growth does not react significantly over the study period and at some points is close to zero.

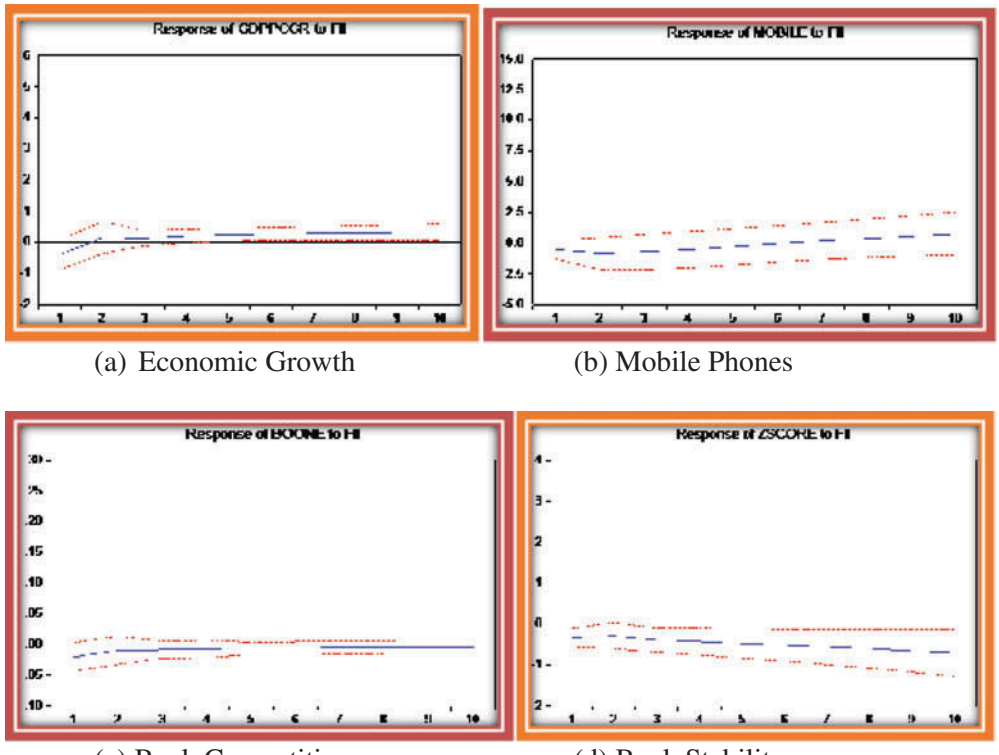
In the case of mobile phones, it was found in Figure 2(b) that mobile phones significantly increase with financial inclusion. It shows that mobile phones penetration responds significantly and positively to a standard deviation financial inclusion shock for most parts of the periods. Financial inclusion as shown in Figure 2(c) is positive and insignificantly related to bank competition as measured by the Boone indicator. It was found that the response of bank competition to a standard deviation shock in financial inclusion to be initially positive up to period 10. The response of bank stability to financial inclusion is represented in Figure 2(d). The study found a negative relationship between financial inclusion and stability between periods 1 to 10.

4.3.2. Variance decomposition

With the variance decomposition, the extent to which mobile phones, economic growth, bank competition and stability variables explain the variation in financial inclusion can be determined (see Ziegel, 1995). The extract is presented in Table 4, which reveals the shocks in economic growth, bank competition and stability to have the most direct impacts on the changes in financial inclusion. Notably, mobile phones least affect financial inclusion and with their effect transmitted through the other variables. Innovation in bank competition has an average of 0.43% impact on the changes in financial inclusion over the periods. Specifically, 0.00%, 0.16%, 0.23%, 0.37%, 0.45%,0.54%, 060%, 0.64%, 0.67% and 0.68% by the end of periods 1 to 10, respectively. The impact of shocks in bank stability significantly increased from 0.00% in period 1 to 0.24% in period

Figure 2. Impulse responses to financial inclusion.

(a) Economic Growth, (b) Mobile Phones, (c) Bank Competition, (d) Bank Stability.



(a) Economic Growth (b) Mobile Phones

(c) Bank Competition (d) Bank Stability

Table 4. Variance decomposition of FII

Period	S.E.	FII	BOONE	LGZSCORE	GDPPCGR	M-PHONES
1	0.023019	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.028761	98.76,600	0.163,197	0.001723	0.644,489	0.015606
3	0.034497	97.23,354	0.232,754	0.017630	2.147,228	0.015656
4	0.039414	95.89,223	0.367,584	0.059773	3.326,657	0.017611
5	0.044015	94.66,531	0.451,639	0.136,022	4.381,542	0.063811
6	0.048362	93.55,044	0.538,614	0.246,327	5.212,894	0.179,558
7	0.052540	92.52,222	0.595,517	0.389,218	5.875,309	0.371,681
8	0.056601	91.54,660	0.641,668	0.565,283	6.386,021	0.635,513
9	0.060580	90.61,155	0.669,818	0.771,672	6.777,079	0.960,958
10	0.064504	89.70,343	0.687,855	1.007463	7.067359	1.335,557

Source: Author's Computation using Stata.

6 to 0.39%, 0.57%, 0.77% and 1% thereafter to the end of period 10. Again, the impact of shocks in economic growth produces the highest changes in financial inclusion with 0.64% in period 1 and increased significantly to 2.15%, 3.33%, 4.38%, 5.21%, 5.88%, 6.39%, 6.78% and 7.07% by the end of period 10 in that order. In like manner, shocks of mobile phones to changes in financial inclusion are almost negligible with an average of 0.02% between period 1 and 5 and became pronounced from the end of period 6 at 0.18%, 0.37%, 0.64%, 0.96% and 1.34% by the end of the sixth to the tenth period, respectively. Variance decomposition of financial inclusion is shown in Table 4.

4.3.3. Inference discussion of findings

Expectedly, financial inclusion in Figure 1(a) responds significantly positively to the measure of economic growth, suggesting a direct relationship between economic growth and financial inclusion. The result suggests an increase in financial inclusion in the future with a standard deviation of economic growth innovation. Economic growth increases the demand for financial services following demand from other economic agents including investors. As the economy grows, private businesses and individuals are likely to make investments which enhances their demand for financial services (Babajide et al., 2015). Improved firms performance may cause firms to demand more capital for expansion, denoting that financial inclusion positively responds to economic growth. Businesses and individuals borrow more from banks to exploiting opportunities that will be available. It also provides an affirmation to the findings of Evans (2015) of an increase in financial inclusion with economic growth, as such could conclude that economic growth is good for financial inclusion in Africa in line with the demand following hypothesis. But economic growth in Africa does not respond significantly to shocks in financial inclusion as shown in Figure 2(a) ruling out the possibility of reverse causality in the short term. Although various studies have argued for and against the financial inclusion and economic growth relationship (Wang'oo, 2013; Iqbal & Sami, 2017; Saidi & Emara, 2017; Mwaitete & George, 2018, among others), the argument by Evans and Osi (2016), Evans and Alenoghena (2017), Okoye et al. (2017) that financial inclusion only provides an enabling environment for economic growth may explain well why this relationship is insignificant in the short term. This result appears counterintuitive given numerous empirical evidence that financial inclusion is key to economic growth. The insignificant positive impact of financial inclusion on economic growth means that the low levels of financial inclusion in Africa have not affected economic growth in the region between 2004 and 2016 in the short and long run. This outcome is expected since the region is characterised by other intervening barriers which lead to higher levels of financial exclusion which is projected around 90% thereby not contributing to economic growth as expected. Tackling these barriers could significantly increase economic growth. However, this finding contradicts the results of several researchers (Iqbal & Sami, 2017; Mwaitete & George, 2018; Saidi & Emara, 2017) who find a significant positive relationship between the two variables. On the other hand, Okoye et al. (2017); and Simpasa et al. (2017) posit that

financial inclusion has a significant negative impact on economic growth thereby disputing the result of this study. They cited a high level of financial exclusion as the major cause of the result. Some studies even found no evidence for the direct effect of financial inclusion on economic growth (Gourene' & Mendy, 2017), concluding that financial inclusion plays only a minor role in enhancing economic growth. The result, however, significantly differs when bank competition measured by the Boone index was considered as shown in Figure 1(c). While financial inclusion responds significantly positively to bank competition, bank competition does respond positively and insignificantly to one standard deviation shock in financial inclusion as seen in Figure 2(c). Hence, it is consistent with the market power hypothesis which states that bank competition increase access to finance.

Figures 1(d) and 2(d) are the responses of financial inclusion to bank stability and bank stability to financial inclusion. While financial inclusion significantly and positively responded to bank stability, bank stability significantly and negatively responds to financial inclusion showing that financial inclusion can derail stability if expanded to uncreditworthy clients and to unfamiliar areas which leads to an increase in credit risk due to a large number of borrowers who are difficult to monitor thus leading to erosion of credit standards and bad reputation risk consistent with Khan (2011). For example, the US financial crisis which led to the loan and savings debacle of the 1980s, the collapse of Continental Illinois Bank in 1984, the Eurozone financial crisis and the 2007 sub-prime global financial crisis had their roots in liberal credit extension which ended up disrupting the financial sector. Policy initiatives should revolve around improving financial inclusion without compromising stability. Figures 1(c) and 2v) are the responses of financial inclusion to mobile phones penetration and mobile phones penetration to financial inclusion. In the case of mobile phones, an inverse relationship with financial inclusion was found and also mobile phones significantly increased with financial inclusion. It shows that mobile phones penetration responds significantly and positively to a standard deviation financial inclusion shock for most parts of the periods and not vice versa supporting the unidirectional causality from financial inclusion to mobile phones. This is inconsistent with Lenka and Barik (2018) who argued that mobile phones Granger cause financial inclusion in a unidirectional manner. Our results show that mobile phones respond to financial inclusion, and economic growth responds to mobile phones. In other words, financial inclusion causes mobile phones penetration which causes economic growth, suggesting a possible intermediation of mobile phones on the financial inclusion–growth relationship. The policy implication for financial inclusion is that pro-growth policies, bank competition and mobile phones must be closely paid attention to, without compromising bank stability. Mobile phones have the potential to become the game changer indirectly as they boost economic growth; therefore, policies to boost financial inclusion in Africa must consider incentives that can speed up the diffusion of internet-based mobile devices so as to bring on board the unbanked. Maintaining and driving a justifiable banking competition in Africa is a welcome development and is most ultimate. However, the challenge rests on boosting competition to accomplish the desired goal of making certain the dynamic efficiency of the financial sector that would prompt stability and subsequently, economic growth which has a positive effect on financial inclusion.

4.4. Robustness check

We used pooled OLS, fixed effect, random effect and GMM models to further help validate the results of the P-SVAR model. Columns 1–4 of Table 5 shows the results. We mainly focused on the GMM results which are consistent with P-SVAR results in most cases. For instance, financial inclusion is shown to relate positively to economic growth also in line with the static models and also consistent with the Granger causality test, implying that increase in economic growth will enhance financial inclusion. Similarly, bank competition (BOONE) under the GMM model is positive and significant in line with the P-SVAR models thereby enhancing the robustness of the overall results.

Table 5. Dynamic and static and panel regressions

	Model 1	Model 2	Model 3	Model 4
	Pooled OLS	FE regression	RE regression	GMM regression
Variables	**Financial inclusion**	**Financial inclusion**	**Financial inclusion**	**Financial inclusion**
L.Financial Inclusion				0.549*** (0.000)
GDPPCGR	0.00267** (0.085)	0.00124*** (0.000)	0.00116*** (0.001)	0.00241*** (0.000)
ZSCORES	0.00371*** (0.000)	−0.00220*** (0.000)	−0.00189*** (0.002)	0.0042*** (0.000)
BOONE	0.00605 (0.824)	0.01607*** (0.018)	0.01589*** (0.024)	0.1475*** (0.000)
MOBILE PHONES	0.00191*** (0.000)	0.00005*** (0.000)	0.00032*** (0.000)	0.297*** (0.001)
Constant	0.00319*** (0.844)	0.1799*** (0.000)	0.18,173*** (0.000)	0.488*** (0.000)
Observations	594	594	594	592
R^2	0.3067	0.1341		
F/Wald Stats	43.02	304.47	52.09	10,732.83
Probability	0.000	0.000	0.000	0.000

Source: Authors' computation, 2019.

Notes: Standard error; ** p <0.05, *** p <0.01; adjusted R^2 probability—0.361; Hansen J statistics—0.514.

5. Summary and conclusion

We analysed financial inclusion in the African region in the light of mobile phones, economic growth, bank competition and stability. Based on the theory of the perceived transmissions among these variables, the study fitted a five-variable P-SVAR to gauge the response of financial inclusion to and from mobile phones, economic growth, and bank competition and stability proxy variables. The essence is finding a way to boost financial inclusion within the African region that will drive the much-anticipated development of the region. The findings reveal a direct relationship among economic growth, bank competition and stability and financial inclusion and an indirect relationship between financial inclusion and economic growth via mobile phones. Financial inclusion did not lead to economic growth and bank stability but is however positively related to mobile phones penetration. We, therefore, conclude that bank mobile phones, economic growth, bank competition and stability matter for financial inclusion, as financial inclusion matters for mobile phones penetration and bank stability. Hence, to boost financial inclusion in the region, bank competition and stability must be adequately enhanced through competition monitoring and moderation along with a continuous review of regulatory frameworks that enhances availability, accessibility and usage of quality formal financial products. One major limitation of our study is that it did not consider the quality of financial products due to unavailability of data.

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Notes

1. Definition obtained from http://www,worldbank.org/en/topic/financialinclusion/overview.
2. A VAR model using levels of variables is run if the variables are stationary at levels, if the variables are non-stationary and cointegrated then a VECM

should be used (Johansen, 1988). However, specifying a VAR model using first differences of variables is recommended for non-stationary and non-cointegrated variables. This, however, applies if one is interested in obtaining correct estimate parameters for interpretation.

3. Countries like Benin, Burkina Faso, DRC, Cote DIvore, Gambia, Sierra Leone, Sao Tome and Senegal had some missing data on financial inclusion, thus resulting in 594 observations as compared to the 637 observations expected.

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Appendix 1. VAR residual correlation LM Tests sample: 2004Q1 2016Q4

Null hypothesis: No serial correlation at lag h

Lag	LRE*Stat	d.f	Prob.	Rao F-Stats	d.f	Prob.
1	5.690,026	25	1.0000	0.226,384	(25, 1610.0)	1.0000
2	5.835,284	25	1.0000	0.232,173	(25, 1610.0)	1.0000
3	7.244,694	25	0.9998	0.288,376	(25, 1610.0)	0.9998
4	200.7533	25	0.0000	8.487,759	(25, 1610.0)	0.0000
5	4.811,412	25	1.0000	0.191,375	(25, 1610.0)	1.0000

VAR Residual Correlation LM Tests

Null hypothesis: No serial correlation at lag 1 to h						
Lag	**LRE*Stat**	**d.f**	**Prob.**	**Rao F-Stats**	**d.f**	**Prob.**
1	5.690,026	25	1.0000	0.226,384	(25, 1610.0)	1.0000
2	12.82,481	50	1.0000	0.254,209	(50, 1955.3)	1.0000
3	22.13,908	75	1.0000	0.291,533	(75, 2030.3)	1.0000
4	212.6716	100	0.0000	2.186,115	(100,2043.9)	0.0000
5	213.5568	125	0.0000	1.745,699	(125,2037.4)	0.0000

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix 2. Roots of characteristic polynomial

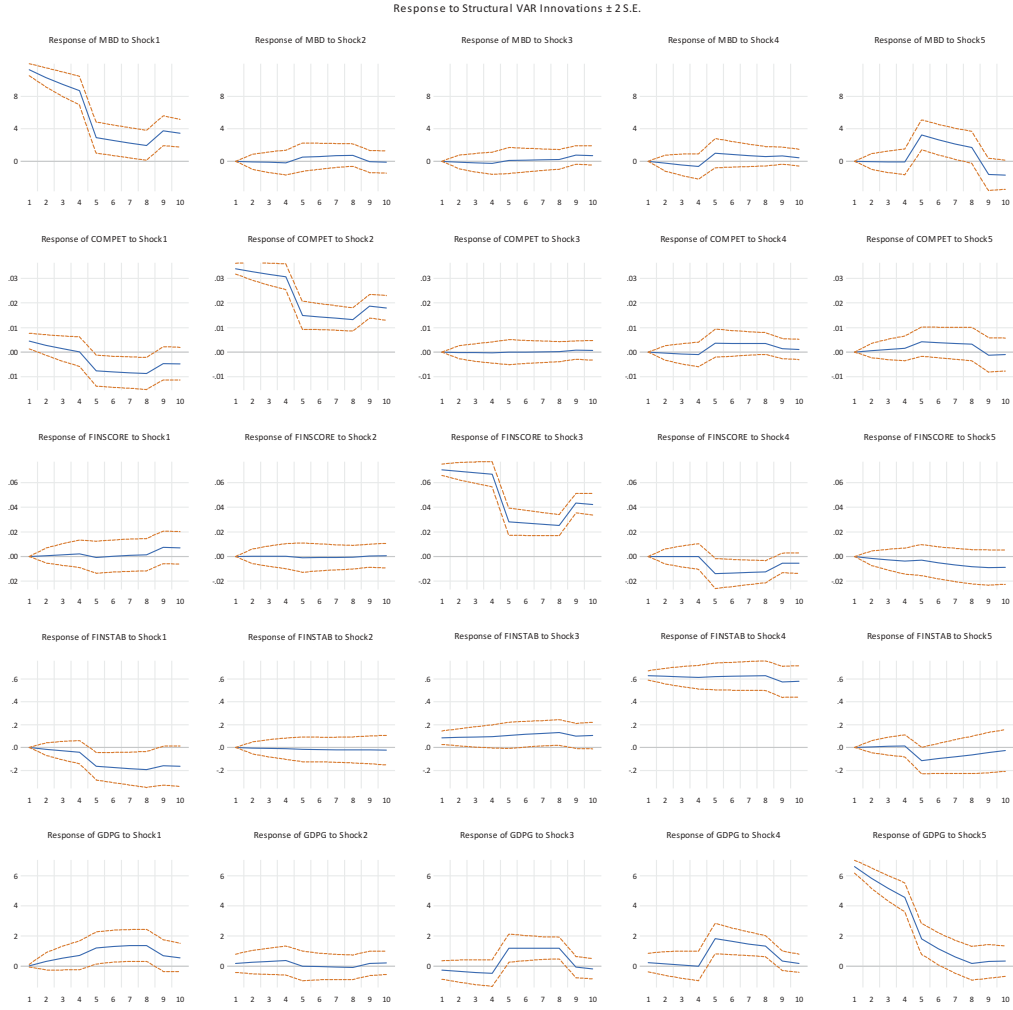
Endogenous variables; MOBILE, BOONE, Z-SCORE, FII, GDPPCGR

Root	Modulus
−0.808,185 + 0.587181i	0.998,971
−0.808,185−0.587181i	0.998,971
0.308,699 + 0.950078i	0.998,971
0.308,699−0.950078i	0.998,971
0.998,971	0.998,971
0.302,933 + 0.932332i	0.980,312
0.302,933−0.932332i	0.980,312
0.980,312	0.980,312
−0.793,089−0.576213i	0.980,312
−0.793,089 + 0.576213i	0.980,312
0.951,162	0.951,162
−0.769,506−0.559079i	0.951,162
−0.769,506 + 0.559079i	0.951,162
0.293,925 + 0.904609i	0.951,162
0.293,925−0.904609i	0.951,162
−0.755,741−0.549078i	0.934,147
−0.755,741 + 0.549078i	0.934,147
0.934,147	0.934,147
0.288,667 + 0.888427i	0.934,147
0.288,667−0.888427i	0.934,147
−0.727,543−0.528591i	0.899,292
−0.727,543 + 0.528591i	0.899,292
0.899,292	0.899,292
0.277,897 + 0.855278i	0.899,292
0.277,897−0.855278i	0.899,292

No root lies outside the unit circle.

VAR satisfies the stability condition.

Appendix 3. Response to SVAR innovation



Appendix 4. Lag length selection

Lag	LogL	Likelihood ratio test	Final prediction error	Schwarz information criteria	Akaike information criteria	Hannan and Quinn criteria
0	−4486.877	N/A	739.7706	20.84,281	20.79,573	20.81,432
1	−2371.346	4172.297	0.046327	11.39,987*	11.11,734	11.22,888
2	−2326.107	18.00670	0.049836	11.70,828	11.19,031	11.39,480
3	−2349.272	24.71,854	0.052729	12.00004	11.24,663	11.54,408
4	−2329.901	36.85,987	0.054133	12.26,154	11.27,269	11.66,308
5	−2100.885	430.4652*	0.021058*	11.55,247	10.32,817*	10.81,152*
6	−2096.853	7.485,262	0.023216	11.88,498	10.42,525	11.00154
7	−2091.734	9.385,084	0.025472	12.21,246	10.51,729	11.18,654
8	−2084.956	12.26,850	0.027740	12.53,227	10.60,165	11.36,385

Source: Author's calculations.

* Specifies lag order selected by the criterion.

Appendix 5. VAR residual serial correlation LM tests null hypothesis: no serial correlation at lag order *h*

Lags	LM statistic	Probability
1	5.690,026	1.0000
2	5.835,284	1.0000
3	7.244,694	0.9998
4	200.7533	0.0000
5	4.811,412	1.0000
Logs from Chi^2 with 25 d.f		

Appendix 6. VAR normality tests (SVAR)

	Kurtosis				Skewness				Jarque-Bera		
Component	**Statistic**	**Chi-sq.**	**df**	**Prob***	**Statistic**	**Chi-sq.**	**df**	**Prob***	**Statistic**	**df**	**Prob**
1	86.4659	135,847.	1	0.000	4.54,725	1612.84	1	0.000	137,461	2	0.000
2	35.3403	20,394.8	1	0.000	1.32,966	137.903	1	0.000	20,532.8	2	0.000
3	17.5342	4119.22	1	0.000	−0.6832	36.4075	1	0.000	4155.63	2	0.000
4	20.1912	5762.98	1	0.000	0.58,602	26.7871	1	0.000	5789.77	2	0.000
5	13.8102	2278.77	1	0.000	−1.8747	274.145	1	0.000	2552.92	2	0.000
Joint		168,404	5	0.000		2088.08	5	0.000	170,492	10	0.000

*-Approximate *p*-values do not account for coefficient estimation.

Source: Author's calculations.

Appendix 7. Heteroskedasticity tests

JOINT TEST				
	No cross term		Includes cross term	
Chi-square	Degrees of freedom	Probability	Degrees of freedom	Probability
1274.642	750	0.0000	4005.838	0.0000

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