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P-SVAR Analysis of Stability in Sub-Saharan Africa Commercial Banks

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Abstract

This study analyses the implication of regulation and competition for stability in the Sub-Saharan Africa (SSA) banking sector. We employ a Panel Structural Vector Autoregressive Model (P-SVAR) to investigate regulatory and competition shocks affecting stability in SSA banking sectors, using transformed quarterly data for the period 2006 to 2015 in order to recover some interesting patterns of behaviour in the structural model. A seven-variable P-SVAR with short-term restrictions is constructed from the variables of our analysis. The study provides evidence to show that variations in capital regulation among other regulatory variables employed, have the largest impact on the stability of the commercial banking sectors of SSA. While no short-term relation was found between capital and competition, the results suggest that while stability responds instantaneously to competition, most of the impacts of competition on stability are transmitted via efficiency. The implication is that crafting the right regulatory policies as suggested by our models will ensure optimal banking stability while harnessing the strong advantage that competition has for efficiency, rather than decimating efforts at fine-tuning market structure and/or degree of competition.

JEL Codes: G21, B26, C58
Keywords: Competition, Regulation, Stability, Panel Structural Vector Autoregressive Model, Commercial Banks.

1. Introduction

The financial intermediation role of the banking system in any economy cannot be over-emphasised. Issues of bank stability are critical for the wellbeing of a national economy – especially as failure in a single bank may trigger systemic fragility relating to the so-called Too-Big-to-Fail (TBF). Vives (2016b) states that the failure of the banking system can potentially bring an economy to a halt. The economies in SSA as in other regional economies of the world are not immune to the catastrophic effects of fragility in their banking systems. Fu, Lin, and Molyneux (2014) found evidence to conclude that the recent financial crisis was orchestrated by excessive competition and deregulation. For example, counting the cost of banking system instability globally between 1980 and 2002 there were about 168 systemic and non-systemic banking crises (Caprio & Klingebiel, 2002). According to Mlachila et al. (2013), from 1980 to 2010 about 35 SSA countries suffered banking system instability. These are not without their attendant costs, as governments expend billions of dollars in bailout funds. Such funds would have been better spent on governance and infrastructural developments to stimulate the economy in a region like SSA which is struggling to fight poverty.

The proponents of the competition-fragility view have argued that a major cause of failure in the banking system is competition. However, given the arguments of the competition-stability view, SSA clamours for in- creased competition in their banking systems to stimulate the dynamic efficiency of their economies in order to enhance economic growth and hence fight poverty. Meanwhile, there are a burning, ongoing debates be- tween these two opposing views in the economic and finance literature. Moyo, Nandwa, Council, Oduor, and Simpasa (2014), Kouki and Al-Nasser (2014), and Akande and Kwenda (2017), is the only literature known to us which has considered the views in panel studies focusing on the African region. While Moyo et al. (2014) found evidence consistent with competition-stability view, the other authors found evidence of fragility. Given these opposing conclusions in the region, there is the possibility of aligning to the views of Vives (2016b) that there is a trade-off relationship between competition and stability. Vives believes in the growing consensus that competition is not necessarily the cause of fragility in the banking system, but that its presence can aggravate the instability of the system, and admits that managing the trade-off is crucial to harnessing the gains of com- petition without having to incur the travails of fragility.

Banks have been historically regulated to enhance competition and to ensure the stability of the system (Bhattacharya, Boot, & Thakor, 1998; Casu, Girardone, & Molyneux, 2015; Llewellyn, 1999). However, regulation has not necessarily alleviated the problems as confusion created by the opposing arguments is argued to be problematic to policy decisions. The question is - how then is this relationship better managed? Thus, the aim of this study is to analyse commercial bank stability in SSA in the light of regulation and stability, using the Panel Structural Vector Autoregressive (P-SVAR) model. The essence is to use the past regulations and competition in the system to gauge the current status of banking stability, and thus to forecast into the near future. This will give insight into policy issues in the management of stability in banking. This study therefore aligns with a long history in the literature dealing with banking stability, and, most importantly, the concerns about through which channel of transmission does competition and regulation impact on the stability of the system. Our contribution involves the application of the unique P-SVAR to recover some interesting patterns of behaviour in bank stability measured in the structural model. We found evidence to support the relationships between these three phenomena among the commercial banks of SSA. Our results reveal capital regulation as being most important in dealing with issues of stability in banks and in how best to respond to this in the next 24 quarters in SSA. This is expected to provide insight into policy on the management of stability in the banking system. To the best of our knowledge, this is the first study of this kind in the literature.

In the rest of the paper we provide: brief literature review in section 2; section 3 explains methods adopted including data sources and the description of variables employed; section 4 presents the results; and the summary and conclusion are included in section 5

2. Literature Review

Theoretical reviews in this area basically considers factors that borders on stability in the banking system. The most considered in the theoretical literature are: the effects of capital requirements (Hakenes & Schnabel, 2011; Kim & Santomero, 1988), competition (see Freixas & Ma, 2014; Matutes & Vives, 1996, among others), moral hazards (Niinimäki, 2004), financial liberalisation (Chang & Velasco, 2001), liquidity management arising from selection problems (Dell'Ariccia & Marquez, 2006) among others. Studies that linked competition and stability aligned along two strands of the literature – those having evidence to conclude that competition positively in- fluences the stability of banks, and those that consider otherwise. Competition-stability view studies find their roots in the industrial organisation market structure theory, linking the structure of the market to efficiency, which, in turn is argued to drive bank stability. The efficiency and stability literature concludes that efficiency enhances loan administrations reducing the probability of loan defaults and hence increasing the stability of the system (Berger & Mester, 1997; Petersen & Rajan, 1995; Williams, 2004) . Specifically, Bolt and Tieman (2004) did a theoretical dynamic modelling of demand for loan to examine the interaction of competition, bank risk taking and regulation, and concluded that increased competition in the banking industry leads to riskier banking behaviour. They argue that it is more beneficial for banks to hold more equity than prescribed by regulators as the more intense the competition, the greater the risk taking by commercial banks, the higher the failure rates, and hence the charter value falls. Vives (2016b), in a review of theoretical and empirical literature concludes that competition is not the reason for fragility in the banking system. While he admits that the existence of a heightened competitive banking environment could only aggravate the situation, instability in banks and systemic failure in general is a subject of certain bank fundamentals. In other words, banks may fail without this necessarily having been caused by competition. The banking literature on efficiency and stability argues that the bank evaluation and monitoring procedure is better with more efficient banks, reducing the possibilities of NPLs occurrence, and hence stability.

There is a fair amount of empirical literature on the effects of regulation as well as the impact of other factors on stability with and without banking competition. Capital regulation influences stability in various ways. Stringent capital requirements can constitute a barrier to newcomers and thus restrict competition and increase stability. Agoraki, Delis, and Pasiouras (2011) argue that high fixed costs of running banks are associated with high overall banking capital requirements, which will only be affordable to fewer banks. According to Bolt and Tieman (2004), more stringent capital adequacy requirements raise the bar of new loan acceptance criteria which has the potential to reduce the incidence of non-performing loans, and hence increase bank stability. Agoraki et al. (2011) did a GMM analysis on some sets of Central and Eastern European (CEE) banking sectors for the period 1998-2005 with the view to examine whether bank regulation affects stability directly, and, if not, whether it is transmitted via banks market power. They found that for CEE countries, capital requirements reduce risks generally, but that the effect is less effective with market power and the effects may end up eroded and perhaps reversed at a very high market power. In other words, their studies provide evidence in a long-term analysis of the role of capital in determining the stability of banks. Their study also found evidence to support the role of activity restriction and supervision as they found that a combination of high activity restriction and market power reduced credit risk and the likelihood of default with supervisory power having a direct impact on bank risk. Although they agree with the findings of Agoraki et al. (2011) on capital having an impact on the competition and stability relationship, Berger, Klapper, and Turk-Ariss (2009) differ on market power eroding and/or reversing the impact of capital. In a GMM analysis of Zscore, non-performing loans, the equity capital ratio and Lerner index of

8235 banks from 23 countries over 7 years from 1999 to 2005, found that market power increases loan portfolio risk but their results provide evidence to show that such risk may be offset in part by a higher equity capital ratio. The findings favour increased equity capital ratio as a cushion to the risk that market power may pose for banks loan portfolio. According to Tabak, Fazio, and Cajueiro (2012), bank capitalisation is an essential force in explaining the non-linear relationship they found between competition and risk-taking behaviour of banks. In a GMM regression of stability on competition to investigate the role of capital and size in the risk and competition relationship in 10 Latin America's 376 banks between 2003 and 2008, they emphasis that a higher capital ratio has merits for banks to operate in collusive markets but argue that the capitalisation only enhances the stability of larger banks that operate under high and aver- age competition. Maghyereh and Awartani (2016) also affirm the importance of the role of regulation on the competition stability relationship. Applying a dynamic panel-data analysis using GMM on the influence of the financial stability of 70 banks in Gulf cooperation countries between 2001 and 2011, they found that increased competition results in rising fragility with the influence determined by the strength of regulation across the council. They state, in particular, that the impact on bank soundness strongly depends on the size of capital, the strength of supervisory power, the strictness of the regulations imposed on bank activities, and the level of transparency and market discipline.

In related studies, Beck, De Jonghe, and Schepens (2013), in a simple multiple regression of stability (Zscore) on competition (Lerner index) for over 17000 banks in 79 countries from 1994 to 2009, advocate the understanding of a banking system regulatory environment in explaining their competition and stability relationship. The impact of increased competition will be much felt in bank risk-taking behaviour in banking markets with stricter activities restriction. They list other factors as the level of development of the capital market, the nature of deposit insurance held, and the effectiveness of the systems of sharing credit information – as having roles to play. Fernández, González, and Suárez (2013) did not agree any less. Their study of the effects of market concentration, regulation and institution in shaping the real effects of the banking crisis in 68 systemic banking crises in 54 countries over the period 1980-2000, shows a negative impact of lax restriction on non-traditional banking activities. With an instrumental variable and OLS estimations of activity restriction, HHI and con- centration ratios, they found evidence that combining traditional and non-traditional banking activities has a negative effect on economic growth during normal periods but mitigates the negative effects of banking crises on economic growth. That this changing influence between crisis and non-crisis periods is reinforced by market concentration, explicit deposit insurance, and better accounting standards, mitigates the negative real effects of systemic banking crises and interacts positively with bank concentration to minimise the reduction of economic growth during the periods of crisis. Investigating the impact of regulation and supervision on bank risk-taking, Bouheni (2014) also employed dynamic panel analysis base on GMM in European banking sectors for the period 2005-2011. She found that stability reacts differently depending on the extent of regulation in a particular location. Specifically, she found evidence to show that stability improves in the French, German and United Kingdom banking systems due to restrictions on banking activities during the study period but also found that supervisors power and capital adequacy encouraged risk taking. She also found that risk incentives were encouraged by more supervisor power, but only in the largest banks in Italy, Greece and Spain, while regulation and supervision strengthening weaken bank stability, with risk taking reduced by capital requirements in these countries. Overall, she argues that tightening the regulatory and supervisory framework and also compliance with the Basel principles enhances financial stability in Europe and that the different results reflect the level of monitoring of regulation and supervision.

Beck, Demirgüç-Kunt, and Levine (2006) examined the impact of national bank concentration, bank regulations, and national institutions on the likelihood of a country suffering a systemic banking crisis, using the logit probability model that is robust to heteroskedasticity in 69 countries, for the period 1980-1997. Their analysis suggests that stability and/or less crisis thrive better with a concentrated banking system. However, their data reveal that greater banking fragility is associated with regulatory policies and institutions that distort competition. In the second part of the foregoing study, Beck (2007) repeated the same approach and probed the reasons for the conflict in theories and empirical studies on these relationships, and found that while their result on concentration and fragility subsist, there is no reverse causality concentration and stability, and a concentrated banking system is well diversified. Nonetheless, Beck found evidence to prove that the presence of concentration in the banking sector does not translate to the absence of competition in the system, as he found less crisis in competitive regulatory and institutional environments. Furthermore, Beck (2008) reviewed the literature on the position of theories and empirical studies in competition and stability relations, and concluded that the failure of bank regulation and supervision is often the reason why liberalisation and uncontrolled competition results in instability in the banking system. He recommends that the strong advantage that competition has for efficiency and inclusive financial systems could only be harnessed if policies on regulation and supervision dwell on engendering the right banking environment instead of dissipating efforts at fine-tuning market structure and/or the degree of competition.

Few studies have also considered these issues in Asian countries. Fu et al. (2014) used the instrumental variable technique with a GMM estimator to investigate the influence of bank competition, concentration, regulation and national institutions on individual bank fragility in 14 Asia Pacific economies for the period 2003-2010. They found that tougher restrictions may benefit bank stability, while stronger deposit insurance schemes are associated with greater bank instability. Jeon and Lim (2013) examined the influence of competition and concentration on Korean financial industry stability during 1999-2011 using OLS, and found that competition and stability relations depend on financial institution features while emphasising the role of corporate governance.

In an individual country study OECD (2011), reviewed competition in retail banking and financial stability, and concluded that the design of financial regulations is just as important as market structure for the stability of the banking sector. Marques-Ibanez, Altunbas, and van Leuvensteijn (2014), in a probit regression of roles played by securitisation and capital in competition and risk relationship during the 2007-2009 crisis, found that higher level of capital did not mediate impact of competition on realised risk as competition increases banks resorting more heavily to securitisation find incentives to take more risk. Exploring whether increased banking sector competition via financial liberalisation enhances bank stability, Moyo et al. (2014) used the duration bank stress prediction model on 16 SSA country banking sectors from 1995 to 2010, and found evidence that CAMEL-type bank specific factors are good predictors of which banks are more likely to experience banking distress. They also found that increased competition via liberalisation increases lead time to distress post reform periods, and that banking system stability in a liberalised and competitive system is contingent on pursuing sound macroeconomic policies and enhanced institutional effectiveness.

Despite the deluge of literature which has considered the issues impacting on the stability of the banking system, empirical works dealing with how stability can be measured are rare, given the conflicting conclusions. Vives (2016b) opine that the management of the trade-off between competition and stability is key, as the presence of increased competition aggravates potential fragility. Our study therefore contributes to filling the gap in stability management in the literature by employing P-SVAR that can relate past banking events in terms of regulation, competition and efficiency to generate the future pattern of regulation in the near-term. The study specifically investigates how stability responds to regulation via capital, liquid assets and asset quality, as well as competition including it implication for efficiency in the banking system in the short-term, with a view to managing it.

3. Methodology

The objective of this paper is to analyse the relationship between competition, regulation and stability among SSA commercial banks - using a P-SVAR approach. The identical yet distinctive features of the economies in SSA provide an incentive for this study to pool cross-sectional data and to deploy a panel data estimation. In particular, SSA countries adopted similar banking regulations to liberalise their various banking systems, in order to make them more competitive. In addition, SSA countries are faced with a common enemy, poverty, leading to under-development in their systems and economies.

Most of the previous studies that have considered the relationship between regulation, competition and stability have employed dynamic panel data analysis like the GMM, and, at best, used the Granger causality test. Although VAR pioneered by Sims (1980) is most popular among monetary economists in terms of studying the short-run impulse response function relationship among variables, (see Beetsma & Giuliodori, 2011; Boubtane, Coulibaly, & Rault, 2013; Canova & Ciccarelli, 2014, among others), it has been criticised for not catering for the needs of researchers interested in shocks other than monetary policy shocks (Bernanke, 1986; Elbourne, 2008). Hence the birth of SVAR which caters for this deficiency and also accounts for economic information that lays bare the rationale for the restrictions that even help identify other shocks. For instance, Omolade (2014) used this to measure oil resources and oil price shocks in the individual economies of five net oil-producing nations in Africa. We also recently have seen it application in banking and finance-related studies – Graeve and Karas (2010) applied VAR to the study of bank run, likewise (Love & Zicchino, 2006). However, both VAR and SVAR only deal with time-series data, which limit their application to one economy and precludes the gains of panel data analysis in carrying out such an investigation. Further efforts to capture effects of transmissions and interdependences across countries and economic units created the Panel VAR (PVAR) (Canova & Ciccarelli, 2014), plagued with the problem of dimensionality. Hence, the P-SVAR applied in this study was introduced by Kutu and Ngalawa (2016), which makes this study to benefit from the gains of SVAR in terms of being able to accommodate studies interested in shocks outside monetary policies but is still able to pool the panel data of 37 SSA commercial banks. Moreover, it overcome the problem of PVAR while ensuring that the dynamic behaviour of the variables in the model is captured, and obtains a more efficient estimation of the parameters which are in congruent with this study. In addition, the power of structural VARs lies in the fact that they allow the recovery of interesting patterns in the VAR using a minimum amount of theory. This is particularly useful in fields with little or no theoretical consensus (Graeve & Karas, 2010), as is the case with this study. Furthermore, with VAR, this study does not lose focus on the differences in the countries under review, as it affords the flexibility of dynamic cross section and slope heterogeneity (Canova & Ciccarelli, 2014).

3.1 Model Specification

This study follows the P-SVAR approach of Kutu and Ngalawa (2016) to analyse the banking variables that impact on the stability of commercial banks in SSA.

Assuming that the SSA commercial banking sector can be represented in the following structural model:

$$QY_{it} = \beta_{io} + \omega_1 Y_{it-1} + \omega_2 Y_{it-2} + \cdots + \omega_\rho Y_{it-\rho} + K\varsigma_{it} \qquad (1.1)$$

Where Q is an invertible $(k\ x\ k)$ explaining the simultaneous relationship among the bank variables; Yit is a $(k\ x\ 1)$ vector of banks endogenous variables such that $Y_t = Y_{1t},\ Y_{2t} \cdots Y_{nt}$; β_{io} is a vector of constant denoting country specific intercept terms; $\omega_1,\ \omega_2,\ \cdots \omega_\rho$ are (kxk) matrix of lagged endogenous variables respectively; K represents a (kxK) matrix with a zero diagonal elements that allow for direct effects of some shocks on more than one endogenous variable in the system; and it is a vector of uncorrelated error terms (structural shocks or white noise innovation). Since the P–SVAR *equation (1.1)* above could not be estimated directly because of the feedback that is innate to the VAR process (Enders, 2008), the reduced form representing Y as the lagged form of Y is estimated by multiplying through by the inverse of Q to produce:

$$Y_{it} = Q^{-1}\beta_{io} + Q^{-1}\omega_1 Y_{it-1} + Q^{-1}\omega_2 Y_{it-2} + \cdots + Q^{-1}\omega_\rho Y_{it-\rho} + Q^{-1}K\varsigma_{it} \qquad (1.2)$$

Further simplifying the foregoing equation, we represent; $Q^{-1}\beta_{io} = J_i$, $Q^{-1}\omega_1 = L_i$ for $i = 1 \cdots \rho$, $Q^{-1}K\varsigma_{it} = \mu_{it}$. Therefore, equation (1.3) becomes:

$$Y_{it} = J_i + L_i Y_{it-1} + L_2 Y_{it-2} + \cdots + L_\rho Y_{it-\rho} + \mu_{it} \qquad (1.3)$$

Equation 1.3 differs from *equation 1.1* in that the latter is a primitive system allowing all variables to have contemporaneous impact on one another, while the former is the standard/reduced form of P–SVAR where all the right-hand side variables are predetermined at time t with no variable having an immediate impact on another in the system. Furthermore, according to Enders (2008), the error term (μit) is composite shocks in Yit. Hence, the reduced form of the P–SVAR from *equation (1.3)* above, can be rewritten as:

$$Y_{it} = J_i + L(B)Y_{it} + \mu_{it} \qquad (1.4)$$

Where Yit is (nxk) vector variable given as:

$$Yit = (ECR, LQTY, AQLTY, LERNERI, IRS, EFF, ZSCORE) \qquad (1.5)$$

Equation (1.5) is the vector of SSA commercial banks endogenous variables used in the study, where ZSCORE is stability measure, IRS is interest rate spread and LERNERI is competition index. Others are ECR, representing regulatory capital; LQTY is liquidity; AQLTY is asset quality; and EFF is efficiency score estimated with SFA as an efficiency measure. From *equation (1.4)*, Ji is the vector of constants denoting country intercept terms, $L(B)$ is the matrix of polynomial in the lag operator that captures the relationship between the banks endogenous variables and their lags, and $\mu it = Q^{-1}KEit$ and/or $Qit = KEit$, is a vector of random disturbance. This will be employed to estimate the interaction between the regulation, competition and stability of SSA commercial banks.

To recover the information in the structural model, we impose restriction in the matrix *Q* and *K* in the system, as contained in *equation 3.6* below. The identification scheme follows Kutu and Ngalawa (2016), whereby structural restrictions are applied to the contemporaneous parameter matrix.

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \omega_{21} & 1 & 0 & \omega_{24} & 0 & 0 & 0 \\ 0 & \omega_{32} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & \omega_{52} & \omega_{53} & \omega_{54} & 1 & \omega_{56} & 0 \\ \omega_{61} & 0 & 0 & 0 & 0 & 1 & 0 \\ \omega_{71} & \omega_{72} & \omega_{73} & \omega_{74} & \omega_{75} & \omega_{76} & 1 \end{pmatrix} \begin{pmatrix} \varsigma_{it}^{a} \\ \varsigma_{it}^{b} \\ \varsigma_{it}^{c} \\ \varsigma_{it}^{d} \\ \varsigma_{it}^{e} \\ \varsigma_{it}^{f} \\ \varsigma_{it}^{g} \end{pmatrix} = \begin{pmatrix} \eta_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \eta_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \eta_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \eta_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \eta_5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \eta_6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \eta_7 \end{pmatrix} \begin{pmatrix} \mu_{it}^{a} \\ \mu_{it}^{b} \\ \mu_{it}^{c} \\ \mu_{it}^{d} \\ \mu_{it}^{e} \\ \mu_{it}^{f} \\ \mu_{it}^{g} \end{pmatrix} \quad (1.6)$$

The notations *a, b, c, d, e, f and g* in the matrix above are used to represent each variable *ECR, LQTY, AQLTY, LERNERI, IRS, EFF and ZSCORE* respectively. Variables ordering meant that bank features react to simultaneous innovations in regulations. The first matrix in *equation 1.6* is the Q matrix, relating to the non-recursive restrictions in the system. The diagonal matrix, also known as the *K* matrix describes the first matrix on the left-hand side of the same system. ς_{it}^{a}, ς_{it}^{b}, ς_{it}^{c}, ς_{it}^{d}, ς_{it}^{e}, ς_{it}^{f}, ς_{it}^{g} are terms denoting the residuals in the standard form disturbances to the variables and further explain unexpected movements of each variable, based on the information in the system, while μ_{it}^{a}, μ_{it}^{b}, μ_{it}^{c}, μ_{it}^{d}, μ_{it}^{e}, μ_{it}^{f} and μ_{it}^{g} are the structural shocks associated with the respective equations.

We relied on Amisano and Giannini (1997) for the identification of the scheme, whereby the *P–SVAR*requires $2n^2 - n(n+1)/2$ or 70 restrictions on the *Q* and *K* matrices combined (where *n* is the number of variables). We imposed 48 maximum restrictions on the diagonal matrix *K* so that the *Q* matrix absorbed the remaining 28 restrictions for the system to be exactly identified. Given that our non-recursive *P–SVAR* imposes 28 zero restrictions on Q, the system is over-identified and 21 free parameters in the *Q* matrix with the 7 in the *K* matrix were estimated – see *equation1.6*.

The *P–SVAR* used in this study contains seven variables. ECR, LQTY and AQLTY are regulation surrogates, LERNERI measures competition, IRS measures banks pricing of their core intermediation activities which are influenced by competition and regulation, EFF measures surrogate efficiency that is a direct effect of competition in the system, while ZSCORE is a stability measures. The ordering of the variables and their position in the identification scheme is informed by the way the variables influence one another – which is largely informed by theories and empirical models. One unique strength of *SVAR* is that it also provides flexibility in cases without underlying theories (see Davoodi, Dixit, & Pinter, 2013)[1]. The regulation surrogates are deemed to determine the level of competition and

[1] Part of the justification for its application in this study

stability of the banking system. We also expect some sort of transmission from competition to stability via efficiency, given the competition-stability view. The non-zero coefficients in the matrices, ωmn indicates that variable *m* affects variable *n* immediately. In other words, row 1 for instance measures the effects of capital regulation on the system captured by ECR. The second and third rows represents liquid assets ratio and asset quality. Based on the Basel accords, these – besides capital regulations – are the most important targets of regulations in banking. While the main transmissions are expected from these three variables as the main targets are competition and stability variables, $\omega 21$, $\omega 24$ and $\omega 32$ indicates that the regulations variables respond to shocks within themselves and that of the system as well. Liquidity responds instantaneously to capital and to competition measured by the Lerner index, while asset quality responds to liquid assets.

In the fourth and fifth equations are competition variables, Lerner index and IRS, we included an efficiency measure variable, efficiency score, in *equation 6* based on possible transmission in models from competition to efficiency then to stability. $\omega 52$, $\omega 53$, $\omega 54$, $\omega 56$ and $\omega 61$ signify that IRS does respond to liquidity, asset quality, Lerner index and efficiency with efficiency responding instantaneously to capital. Finally, is stability measure, ZSCORE, sitting at equation 7 responding immediately to all the variables in the system, capital, liquidity, asset quality, competition and/or market power and efficiency measure, given $\omega 71$, $\omega 72$, $\omega 73$, $\omega 74$, $\omega 75$ and $\omega 76$ allowing simultaneous relations between stability, competition and regulations.

3.2 Variable Description and Data Source

Data were collected from 2006 to 2015 for an unbalanced panel of commercial banks[2] ranging from 196 in 2006 to 440 in 2015. The variation in the number of banks predominantly accounts for entry and exit and data availability in Bankscope. As the data coverage is short for the purpose of implementing P-SAVR analysis, we transformed it to higher frequencies of a quarterly basis following Borys, Horváth, and Franta (2009), Ngalawa and Viegi (2011) and Kutu and Ngalawa (2016).

Given the nature of the study area in terms of availability of data for banking studies, our choice of bank regulatory parameters was instructed by some of the components of *CAMEL*[3] for which data are readily accessible. Regulatory capital (ECR) measured by the ratio of equity capital constitutes the main capital measurement used in banking regulation research (Agoraki et al., 2011; Casu et al., 2015). The higher the capital adequacy ratio a bank has, the more it has an ability to compete favourably and the higher its cushion to promote stability. As argued by Matutes and Vives (2000) and Repullo (2004), capital requirements may be inadequate as regulation for the banking sector, and hence they advocated, among other things, the inclusion of deposit rates' control. This conforms with the industrial organisation theory of banking that emphasises the equilibrium mechanism of the banking sectors market structure, based on the deposits rates, loans rates and the liquidity reserves a bank is allowed to maintain. Liquidity ratio thus is a formidable regulatory instrument used to curtail the activities of banks. This study uses the ratio of bank liquid assets to depreciation and short-term funds to measure liquidity reserves. This provides an insight into the level of liquid assets a bank has at its disposal to discharge its routine obligations – including funding loan assets (see Moyo et al.,

[2] Excluded South Africa banking sectors for the sophistication of the system and other SSA countries ravaged by war.

[3] Capital adequacy, Asset quality, Management capability, Earnings, Liquidity, and Sensitivity to market risk (see Akins, 2014)

2014). Interest rate spread, used interchangeably as the net interest margin is the difference between interest received on bank assets such as loans and those paid on its liabilities such as deposits. It is often used in the banking literature as an indication of competitiveness of the sector, as high interest rate spread denotes a highly concentrated banking sector (Demirguc-Kunt, Laeven, & Levine, 2003; Laeven & Majnoni, 2005).

Asset quality (AQ), measured as loan loss reserves to net loan assets, is one of the targets of regulatory requirements (Moyo et al., 2014). The quality of the assets a bank possesses determines it stability and also impacts on it competitive abilities. A bank's asset quality is also a major determinant of the performance of its loan portfolio – in terms of whether it is performing or non-performing. A high incidence of non-performing loans (NPL), in turn impacts on stability. These ratios are expected to be positively related to the likelihood of bank survival.

Another competition measure used is the Lerner index[4] . While data for IRS were sourced directly from Bankscope, we follow Kouki and Al-Nasser (2014) to estimate Lerner index. Which is given as:

$$LI_{ikt} = \frac{P_{ikt} - MC_{ikt}}{P_{ikt}} \tag{1.7}$$

Where $Pikt$ is the estimate of average price of bank production for bank *i* in country *k* at time *t* which is proxy by the ratio of bank total revenue to total assets and $MCit$ is the marginal cost of bank production, which is the first derivative of transcendental logarithmic cost function (translog cost function). The translog cost function is a second-order Taylor series expansion of banks cost[5] in natural logarithm, whose short form we modelled as:

$$ln(C) = \beta_0 + \beta_1 ln(QTY_{it}) + \frac{1}{2}\beta_2 ln(QTY_{it}^2) + \sum_{k=1}^{3}\theta_k ln(W_{kit}) + \sum_{k=1}^{3}\int_k ln(QTY_{it})ln(W_{kit}) + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3}\varnothing_{kj} ln(W_{kit})ln(W_{jit}) + \mu_{it} \tag{1.8}$$

Where $QTYit$ is bank output measured as the natural log of total assets of bank *i* in time *t* (Guevara & Maudos, 2011), $Wkit$ is the vector of the three input prices and μit is the error term. The first derivative of *equation (1.8)* with respect to output give the marginal cost as:

$$MC_{it} = \frac{\delta C_{it}}{\delta QTY_{it}} = \frac{1}{QTY_{it}}\left(\beta_1 + \beta_2 ln(QTY_{it}) + \sum_{k=1}^{3}\int_k ln(W_{kit})\right) \tag{1.9}$$

Substituting this for marginal cost in *equation (1.7)*, bank level competition is estimated using;

[4] Alternatives to Lerner index is Panzar-Rosse H-Statistics (Panzar & Rosse, 1987), Boone in the indicator (Boone, 2008), persistent of profit (Mueller, 1977), among others. Lerner index is chosen for this study because of its ability to compute bank level competition and the fact that it is based on strong industrial organisation theories consistent with this study. Besides Liu, Molyneux, and Wilson (2013) adjudged it one of two best measures of competition in banking.

[5] According to (Ajisafe & Akinlo, 2013; Sealey & Lindley, 1977) the total cost of banks consists of one output, *QTY*, and three inputs, $W1$, $W2$,and $W3$, representing price of labour (ratio of personnel expense to total assets), price of physical capital (non-interest expense to fixed assets) and price of fund (interest expense to total deposits) respectively.

$$LI = \frac{P_{it} - \frac{1}{QTY_{it}}\left(\beta_1 + \beta_2 ln(QTY_{it}) + \sum_{k=1}^{3} \int_k ln(W_{kit})\right)}{P_{it}} \quad (1.10)$$

Data collected for the competition index estimation includes total assets, total revenue, personal costs, interest expenses, non-interest expenses, total deposits and fixed assets. These are contained in the bank profile data collected from Bankscope.

We measured stability following Roy (1952), to employ Zscore,

given as

$$Z = \frac{\overline{ROA_{ikt}} - \overline{ECR_{ikt}}}{\sigma ROA_{ikt}} \quad (1.11)$$

Where $ROAikt$ is average return on assets, $ECRikt$ is the average equity capital ratio, and $\sigma ROAikt$ denotes the standard deviation of *ROA*, and *ikt* is bank *i* in country *k* at time *t*. This is used to estimate the stability of the SSA commercial banks by simply computing the Z-score for individual banks and taking the weighted average by bank size (usually assets) (see Cihak, Demirgu¨¸c-Kunt, Mart´ınez Per´ıa, & Mohseni-Cheraghlou, 2012; Kouki & Al-Nasser, 2014; Laeven & Levine, 2009; Lepetit & Strobel, 2013). The Z-score value depends positively on the bank's profitability and capital ratio and negatively on the vulnerability of a bank's profit. A high score indicates more stable bank or rather less likelihood that a bank will become bankrupt – and thus indicating lower risk. Data on *ROA* and *ECR* are sourced from the Bankscope.

Furthermore, we generated the banking sectors' efficiency scores using Stochastic frontier analysis, following

Coelli, Rao, O'Donnell, and Battese (2005) and Coelli and Rao (1998). It is an output-orientated bank production efficiency variant that models bank efficiency beyond the deterministic factors common to all banks. We assumed that bank production could be modelled based on an output-input equation with random components, as follows:

$$PBT_i = TE_i . f(X_i : b), \quad (3.12)$$

So that $P\,BTi$ denotes profit before tax of bank *i*, $i = 1, \cdot \cdot \cdot, N$. TEi is the technical efficiency, Xi is a vector of *J* input used by bank *i*, $f(Xi, b)$ is the frontier, and *b* is a vector of technology parameter to be estimated. With this we can measure maximum visible output from all the banks in the system – from which it is possible to compare the performance of each relative to the frontier.

Because *Equation (1.12)* is deterministic, we introduce random shocks to consider the stochastic component that describes random shocks affecting the production process so that the stochastic frontier becomes:

$$PBT_i = e^{vi} . TE_i . f(X_i : b) \quad (1.13)$$

The e^{vi} in the equation is the shock resulting from random white noise in the economy, to account for shocks peculiar to each bank that could be expressed by a common distribution. TE_i is further described as a stochastic variable with a specific distribution function:

$$TE_i = e^{-ui}, \tag{1.14}$$

Where $ui \geq 0$, since it is required that $TEi \leq 1$, and hence the following equation is obtained

$$PBT_i = e^{vi-ui}.f(X_i : b). \tag{1.15}$$

Assuming bank profitability is expressed as a specific log linear production function, the frontier becomes:

$$In(PBT_{it}) = \alpha + \sum_{h=1}^{H} b_h ln(X_{it,h}) + v_{it} - u_{it} \tag{1.16}$$

Where v_i is the noise component, considered as two-sided normally distributed variable, and ui is the non- negative technical inefficiency component. Because v_i and u_i constitute a compound error term with a specific distribution to be determined, SFA is therefore often referred to as composed error model.

The above stochastic frontier will therefore be used to generate the efficiency scores used in the P-SVAR system given the unrestricted model below which determines the highest possible profitability, based solely on the book value of assets employed:

$$PBT_{it}(ABV) = \alpha + b_1 ABV_{it} + b_2 (ABV_{it})^2 + e_{it} \tag{1.17}$$

Where $PBTit$ equals pre-tax income, $ABVit$ is assets book value, $e_{it} = \oint_{it} - \lambda_{it}$, the composite error, $\oint \sim iidN(0, \delta^2_{\oint})$, is the stochastic noise which is a two-sided error term, $\lambda \sim$ $iidN$ (0, δ_λ), the systematic all (technical inefficiency) is a one-sided error and $\lambda..0$. The quadratic equation is used to allow for a nonlinear relation between the pre-tax income and the book value of the asset. This is to allow technical efficiency to vary through time and in a different manner for each bank (Kumbhakar & Lovell, 2003). The efficiency is then estimated using frontier 4.1 by Coelli (1996). Data input into the frontier model are annual data on PBTARATIO (comprising pretax income (Chiou & Porter, 2015) and total assets (Barro & Barro, 1990)).

3.2.1 Data Summary

We present the mean of the data for this study in Table 1 for the periods under consideration. The table shows that commercial banks in SSA are well capitalised above the 8% minimum total capital ratio required by most financial regulations and the Basel Accord. On average, the capital base was up to 18.10% in 2014 and a minimum average of 13.97% in 2011. Overall the banking system in terms of the capital base can be considered to be robust. Closely allied to capital is stability measure. We estimated the stability of SSA commercial banks using the Z-score. The higher the level of Z-score the better a banking system is in terms of stability. The average stability measure over the period hovers around 3%, which by every standard signifies a stable banking system reflecting the level of capitalisation. The banking system is also faced with a monopolistic competitive market, with a maximum average index in 2013 of 0.3521 and a minimum in 2006 of 0.2557 based on the Lerner index. The Lerner index is a measure of market power and the lower the index the more competitive the banking sectors will be. The reverse is the case where the index is high – denoting high market power. During the periods covered by this study the SSA commercial banking system can thus be concluded as being competitive. Another variable that has been used over time to measure concentration/market power in banking studies is interest rate spread. It is also a variable that reflects the potency of deposits and interest rate regimes in a banking system. The mechanism is that a monopoly bank can charge high lending rates while offering lower rates to their depositors. The case is different with a competitive market where pooling effects may make a bank offer competitive rates for deposits and lower lending rates to attract customers. Apparently, the interest rate spread (see Table 1 above) is relatively high overtime compared to other region of the world and does not reflect the competitive nature of the banking system as reported by the Lerner index. Efficiency generated with SFA seems quite high and close 1 (the frontier). SFA allows the efficiency to be exogenously modelled to generate the frontier, from which the efficiency of each bank in the system is compared in order to produce the efficiency score. The distance between the frontier and the individual bank score reflects the level of inefficiency. Liquidity gives bank depositors the ability to honour their contracts. It is often one of the elements of the asset side of a bank balance sheet which can trigger runs, and it is not surprising that it is now part of the cardinal points in pillar I of the new Basel Accord (Basel III). Banks that can manage their liquid assets to strike a balance between profiting and honouring the short-term obligations as they fall due, are able to avoid insolvency problems. Thus, suggest the liquid assets of SSA commercial banks ranged between 37% in 2011 and 47% in 2006. The level of liquidity a bank must hold will generally depends on the volume of obligation, but, according to Basel III, the bank must have sufficient liquid assets available for one-month of survival in a stress scenario case. Asset quality over time ranged from 1.4% in 2006 to 2.6% in 2015. The bank asset quality ratio is at the heart of the stability of the system as it measures the loan loss rate in the banking system. A higher ratio of loan loss suggests danger in relation to the stability of the banks and the system as a whole.

Table 1: Summary Statistics

				Mean				
year	N	Capital	Liquidity	Asset Quality	Lerner Index	IRS	Efficiency Score	Zscore
2006	190	0.1611557	0.470746	0.0139041	0.2556606	0.0701743	0.9632438	3.54343
2007	215	0.1441192	0.4439588	0.0153758	0.2693673	0.0702588	0.9611767	3.204579
2008	250	0.1568832	0.3978305	0.0160256	0.2884124	0.0752672	0.962111	3.380152
2009	275	0.150284	0.4420819	0.021476	0.293903	0.0758463	0.958097	3.29502
2010	296	0.1563837	0.4201964	0.0241048	0.2959335	0.0743105	0.9552949	3.273991
2011	320	0.139725	0.3727514	0.0221538	0.2821636	0.0725276	0.9558327	2.988873
2012	357	0.1542496	0.3743644	0.0210687	0.3237032	0.0736195	0.9566049	3.235099
2013	392	0.170136	0.4193003	0.0221185	0.3520863	0.0722735	0.9559925	3.403835
2014	430	0.1810446	0.3973395	0.0226412	0.3318136	0.0916671	0.9549598	3.624344
2015	440	0.1704147	0.3809	0.0260906	0.3243521	0.0804629	0.954971	3.484

Authors' computation, 2017

3.3 Panel Unit Root

Unit root deals with the stationarity of the data series used in the analysis (see Table 2 below). According to Dendramis, Spungin, and Tzavalis (2014) one necessary precondition to implementing any VAR estimation is that all data series must be integrated in the same order, but not cointegrated. Hence, this study follows Vonn´ak

(2005), Ibrahim and Amin (2005), Uhlig (2005), Peersman and Smets (2005), F`eve and Guay (2010), Elbourne (2008), Kutu and Ngalawa (2016), among others, that used VAR at levels. They argued that the estimation of VAR or SVAR when all series are at levels, will prevent efficiency loss or loss of vital information about the data sets usually associated with differenced SVARs and VARs. A further justification is in Afandi (2005), who argued that this procedure also has the advantage of producing consistent parameter estimates – irrespective of whether the time series are integrated or not, and making it produce a more robust result than a cointegrated SVAR or VAR model. Moreover, Berkelmans (2005) considers that the inclusion of lagged lengths in the SVARs or VARs variables enables the residual to be stationary even with I(1).

Table 2: IPS, LLC and ADF Unit Root Test @Levels

	IPS		LLC		ADF	
	statistics	p-value	statistics	p-value	statistics	p-value
ECR	-5.44164	0.0000	-33.1423	0.0000	791.553	0.0000
LQTY	-9.69417	0.0000	-26.8801	0.0000	947.605	0.0000
AQLTY	-9.40409	0.0000	-79.2647	0.0000	832.255	0.0000
LERNERI	-8.72906	0.0000	-90.1484	0.0000	791.448	0.0000
IRS	-4.35749	0.0000	-23.4108	0.0000	745.239	0.0000
EFF	-3.3514	0.0004	-16.7139	0.0000	736.259	0.0000
ZSCORE	-4.08961	0.0000	-17.896	0.0000	759.189	0.0000

4. Empirical Results

We expect a causal relationship among competition, regulation and stability. Specifically, we expect an individual transmission from regulation to competition and from regulation to stability. Since models have established a relationship between competition and stability, we assume this should result in a tripartite causality/relationship running from regulation to competition to stability. According to Casu et al. (2015) and Llewellyn (1999), the main reason for bank regulation is to foster competition and stability in the banking system. Competition on the one hand is there to engender the efficiency of the system which leads to stability, while on the other hand stability is needed to sustain confidence and reduce bank run. For this pioneering study, we adopted several measures to proxy regulation, competition and stability.

4.1 Lag Selection

Lag selection is an important component of VAR estimation (see Canova, 2007). This is because, too many lags could increase the error in the forecasts and waste degree of freedoms, while too few lags could leave out relevant information – leaving the equations potentially misspecified with the likelihood of causing autocorrelation in the residuals (see Stock & Watson, 2007). Besides experience, knowledge and theory that underscore the determination of the number of lags required, there are information criterion procedures that help to come up

with the optimal number of lags to allow for adjustments in the model and the attainment of well-behaved residuals. Five commonly used information criteria are: Sequential Modified LR test, Final Prediction Error (FPE), Schwarz's Bayesian information criterion (SBIC), Akaike's information criterion (AIC), and the Hannan and Quinn information criterion (HQIC). Given a transformed quarterly data series, we test for the optimal lag lengths using these different lag selection criteria. The result as shown in Table 3 show that the standard FPE, AIC, SBIC and HQIC suggest optimal 5-lag lengths, while the Sequential Modified LR test suggests an optimal 8-lag length for the P-SVAR. Most criteria opt for a 5 maximum lag length, given that all the criteria are efficient, and of the five criteria four suggest a 5-lag length compared to one suggesting an 8 maximum lag length. So, we follow the majority and choose the more general model suggested by the FPE, AIC, SBIC and HQIC. The choice of the 5 lags by this study offers accurate and more robust dynamics, without necessarily shortening the estimation sample too much which would compromise the degrees of confidence. This lag length also allows for no serial correlation in the residuals (see Kutu & Ngalawa, 2016).

Table 3: Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	37007.05	NA	4.39e-13	-8.588685	-8.582948	-8.586729
1	96299.30	118474.4	4.68e-19	-22.34060	-22.29470	-22.32495
2	96386.83	174.7456	4.64e-19	-22.34954	-22.26349	-22.32020
3	96486.74	199.3086	4.58e-19	-22.36136	-22.23515	-22.31832
4	96602.49	230.7264	4.51e-19	-22.37685	-22.21048	-22.32012
5	98766.75	4310.433	2.76e-19*	-22.86786*	-22.66133*	-22.79743*
6	98801.25	68.65684	2.77e-19	-22.86450	-22.61781	-22.78037
7	98839.49	76.03393	2.78e-19	-22.86200	-22.57515	-22.76418
8	98882.60	85.65135*	2.78e-19	-22.86063	-22.53362	-22.74912

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

4.2 Other Econometric Issues

For robustness, we present various diagnostic tests relevant for this study – the serial correlation test in Table 4, normality tests in Table 5, and tests of heteroskedasticity in Table 6. As indicated in Table 4 below there is an absence of serial correlation at lag 5 (Table 3). This also serves to validate the optimal lag selection procedure carried out, as a misspecified model base on wrong lag length would result in problems.

Table 4: VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	45.21092	0.6275
2	30.90877	0.9797
3	29.86301	0.9859
4	2768.030	0.0000
5	59.70867	0.1405

Probs from chi-square with 49 df.

of serial correlation. In addition, it suggests the absence of cross-sectional dependencies across time. Even though P-SVAR accounts for cross-sectional interdependence across panels/economics units, it was originally developed to recognise and account for transmissions and the effects of one unit on another as global interdependence became apparent with globalisation Canova and Ciccarelli (2014). We do not envisage any break in the model series, because although banking policies are homogeneous almost across regions, they are undertaken at different points in time. Besides, the period considered for this study is not seriously affected by the only known global financial crisis, as only 2006 data came from before the crisis. Moreover, the IPS unit root test carried out, (see Table 2), is argued to account for issues of structural breaks, if present (Glynn, Perera, & Verma, 2007). Based on the foregoing we proceed with the model analysis in the two subsections that follows.

Table 5: Diagnostics; VAR Normality Test Estimated from Structural Var

	Skewness				Kurtosis				Jarque-Bera		
Component	Statistics	Chi-sq	df	Prob.	Statistics	Chi-sq	df	Prob.	Statistics	df	Prob.
1	0.948222	1479.059	1	0.0000	172.9737	11881445	1	0.0000	11882925	2	0.0000
2	16.41088	443026.6	1	0.0000	1439.607	8.49E+08	1	0.0000	8.49E+08	2	0.0000
3	3.485937	19989.64	1	0.0000	226.2924	20504714	1	0.0000	20524703	2	0.0000
4	-51.56618	4374172	1	0.0000	3830.342	6.02E+09	1	0.0000	6.03E+09	2	0.0000
5	2.153931	7631.843	1	0.0000	69.09553	1796595	1	0.0000	1804227	2	0.0000
6	-2.291313	8636.443	1	0.0000	143.9973	8175744	1	0.0000	8184380	2	0.0000
7	4.989659	40955.06	1	0.0000	393.6743	62767615	1	0.0000	62808570	2	0.0000

Table 6: Diagnostics; Heteroskedasticity Tests

Joint test:					
No Cross Term			Includes Cross Term		
Chi-sq	Df	Prob.	Chi-sq	df	Prob.
35870.81	1960	o.0000	118843.4	10388	0.ooo

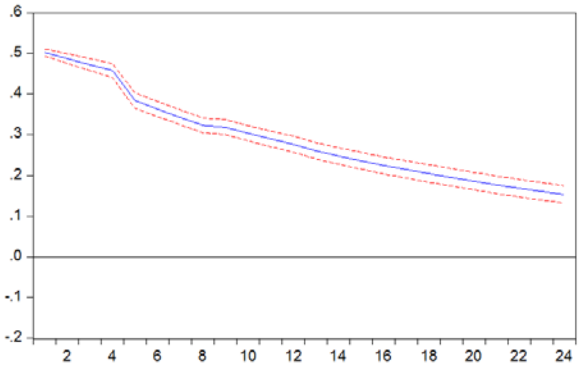
4.3 Impulse Response Analysis

The impulse response function analysis was first introduced in VAR modelling by Sims (1980). It helps to highlight the state of an economic system in the future, if there is a change in any of the components. Put differently, the impulse response provides an answer to the question of how the future of a system is affected with a change in one of its variable. It thus shows how much time to the future the variables react to each other. This is given the assumption that innovation returns to zero in subsequent periods and that all other innovations are equal to zero (see Amisano & Giannini, 1997; Stock & Watson, 2001; Ziegel & Enders, 1995). It permits the tracing out of the time-path response of current and future values of each variable to a one unit increase in the current value of one of the VAR innovations, and provides a quantitative measure of the reaction of each variable to shocks in the different equations of the system (Bernanke & Mihov, 1997). Having found VAR to be stable (see Appendix A), we analysed the SSA banking system impulse response of stability to innovations in regulations: capital, liquidity and asset quality, competition, looking at the Lerner index measure of competition and interest rate spread, and efficiency.

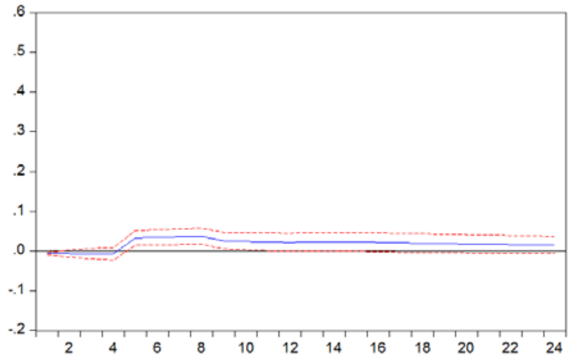
Figure 1 below shows the impulse responses of commercial banks stability to shocks in capital, liquidity and asset quality regulations and competition, interest rate spread and efficiency over the next 24 periods, – *i.e.* the next six years approximately. As indicated in Figure 1*(a)*, in line with a priori capital regulation has direct bearing on the stability of banks. Capital is positive and strongly significant in explaining its relationship with bank stability in the SSA banking sector. This is consistent with the results of Moyo et al. (2014) and Agoraki et al. (2011). Moyo et al. (2014) found a positive and strong relationship between capital and stability pre- and post- reforms in SSA countries. However, this result does not fully support the findings of Fu et al. (2014) who found a positive but insignificant relationship between the two phenomenona. In terms of a transmission mechanism, we found a somewhat declining response of stability to an innovation in capital regulation. The capital and stability relationship confirms our expectation of an alternative hypothesis that capital regulation can have a direct impact on stability, and is consistent with the literature on stability which posits that the essence of regulation in banks is engendering the stability of the sector (see Llewellyn, 1999, among others). From the result in Figure 1*(a)*, stability will decline over the period with any decrease in the subsisting capital base of the commercial banks in SSA. Every time capital decreases it has consequences for the stability of the banking system. There is a sharp decrease in stability if capital falls from the first period to the ninth, and continues to fall steadily over the periods to the next 24th period. This is why Bolt and Tieman (2004) may have advocated more stringent minimum capital requirements. This again reiterates the importance of capital regulation in terms of ensuring the stability of the banking sector. In Figure 1*(b)* we test the reaction of commercial bank stability to bank liquidity regulation. Liquidity is significant and positively related to bank stability, affirming the results of Moyo et al. (2014). Stability does rise in response to one standard deviation shock in liquidity from the fourth quarter, but flatly fluctuates over the rest of the period. This suggests that a decrease in bank liquid assets may not significantly reduces bank stability for the next 24 quarters. This may be plausible because statistics revealed that most of the banking sectors in SSA are highly liquid. However this must be approached with a great deal of caution, given the implications of illiquidity with respect to bank runs. Similarly, in Figure 1(c) we observe that stability responds to shocks in asset quality almost as with liquidity. We found that one standard deviation asset quality shock is at first insignificant, becomes significant

and positive at some point in period four, and then is flattened until period eight where it declines gradually but is positive until the end of the period. Our result negates the positive but insignificant relationship found by Moyo et al. (2014) between asset quality and the stability of banks. Asset quality is directly linked to the bank loan portfolio which has implications for liquidity and the profitability of the banking system, and is one of the biggest problematic components of banking – with great implication for stability. This further clearly shows that the stability of the banking system can be directly influenced by the nature, extent and manner in which the regulation is made and managed.

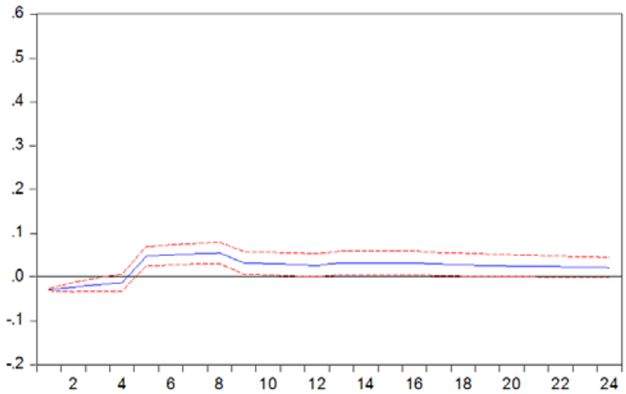
Figure 1: Impulse Responses to of Stability



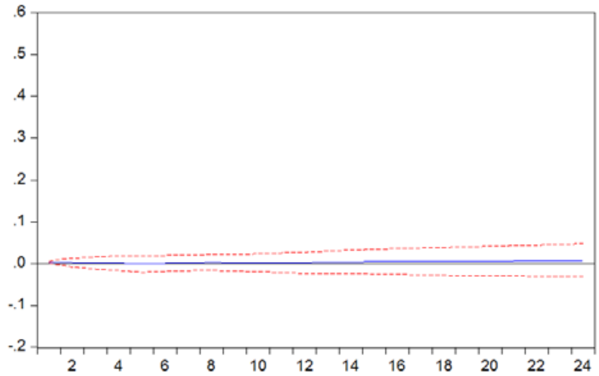
(a)Capital Regulation



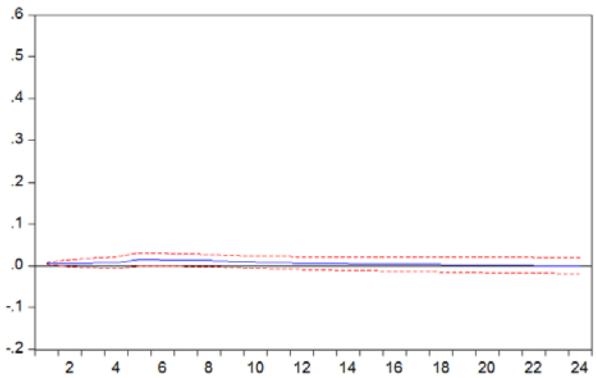
(b) Liquidity



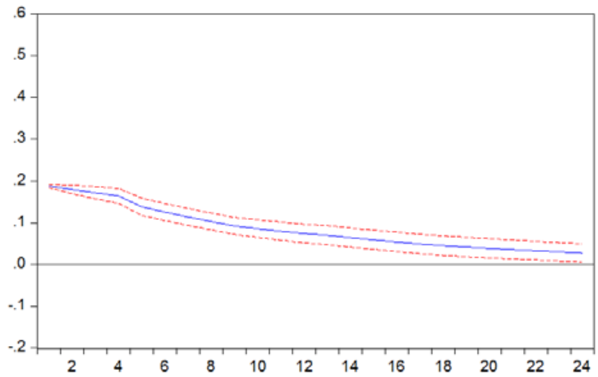
(c) Asset Quality



(d) Competition



(e) Interest Rate Spread



(f) Efficiency

The reaction of stability to competition is shown in Figure 1*(d)*. Competition is positive but insignificant in terms of explaining stability in the short term. In other words, stability does not react significantly, even though it is positive over the study period and at some points is not seemingly different from zero. Although various studies have argued against and for the competition and stability relationship (Amidu, 2013; Beck et al., 2013; Fu et al., 2014; Maghyereh & Awartani, 2016, among others), the argument by Vives (2016a) that competition only provides an enabling environment for the stability or otherwise of the banking system may well explain why this relationship is not significant in the short term. This Indicates that stability does not generate an immediate response from stability. Figure 1*(e)* shows the response of stability to a one standard deviation interest rate innovation. The stability respond is positive but insignificant, and rises above zero for most of the periods from the start to the 18th quarter. This is partly consistent with the result of Fu et al. (2014), who found a positive significance relationship between the variables at 10%. A cumulative long-run relationship may well be consistent with concentration and/or market power and stability. Finally, Figure 1*(f)* establishes the existence of a short-term relationship between bank efficiency and bank stability. Stability responds positively and significantly to a one standard deviation efficiency innovation. The response declines steadily over time, but is positive and significant over the periods. Efficiency has been argued to influence the stability of banks in the competition, efficiency and stability literature. We found agreement with Berger and Mester (1997), Petersen and Rajan (1995) and Williams (2004), who argued that efficient banks were more stable because of better loan administration, among other things. This therefore provides evidence to underscore the importance of efficiency in banks in relation to stability – especially in the short-term which will major implications for policy development in this area.

4.4 Variance Decomposition

Variance decomposition indicates the extent to which the forecast error variance of each variable can be explained by shocks exogenous to the remaining variables. According to Ziegel and Enders (1995), variance decomposition accounts for the information about the proportion of the movements in a sequence that are due to the shock in the variable itself and other shocks identified. This separates the variation in endogenous variables into the component shocks of the VAR. Table 7 below shows the variance decomposition of stability – explaining whether innovations in the variables in the system are the reasons for the variations in stability.We found from the table that shocks in capital substantially account for the variation in the stability of banks, followed

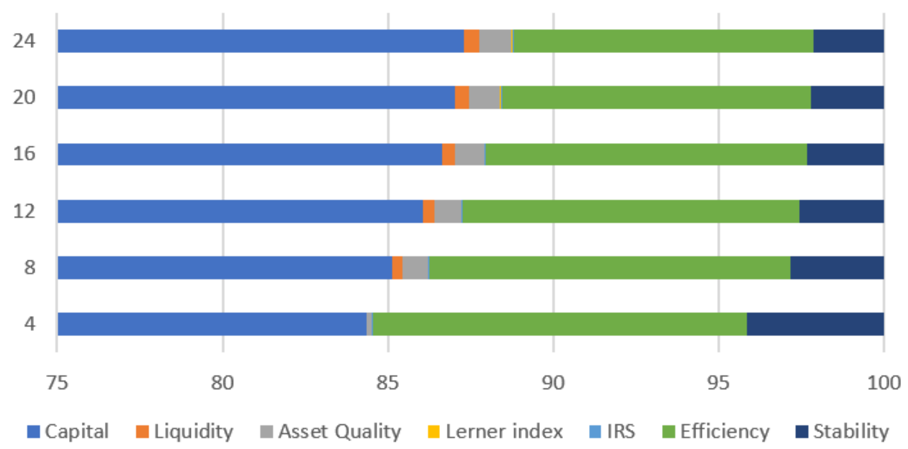
Table 7: Variance Decomposition of Stability

Period	S.E.	Capital	Liquidity	Asset Quality	Lerner Index	Interest RS	Efficiency	Stability
4	1.046061	84.34058	0.018223	0.163104	0.002261	0.014259	11.32617	4.135404
8	1.293435	85.14309	0.303692	0.746914	0.002325	0.055910	10.89870	2.849366
12	1.437686	86.06973	0.352647	0.775919	0.002776	0.057704	10.16140	2.579824
16	1.525033	86.62596	0.401873	0.868822	0.006062	0.054816	9.696503	2.345965

20	1.581024	87.02667	0.432162	0.928954	0.010347	0.052107	9.329244	2.220520
24	1.617507	87.31053	0.451480	0.970396	0.017677	0.049881	9.066356	2.133677

by efficiency, asset quality and liquidity. It also becomes apparent that even though shocks in competition have no significant influence on stability, the impact seems indirect and transmitted through other variables such as efficiency providing credence to the supposed transmission from competition to stability via efficiency in the literature (see Schaeck & Cihák, 2014). Capital accounts for an average of over 80% of the variation in stability over the periods, with 84.34%, 85.14%, 86.07%, 86.63%, 87.03% and 87.31% from the end of the fourth to the 24th quarters, in that order. Interestingly, the influence is progressive throughout the periods. The impact of shocks in efficiency on stability though tangible, declines across time with 11.33%, 10.90%, 10.16%, 9.70%, 9.33% and 9.07% respectively at the ends of the periods. Next in influence is shocks in asset quality which accounts for 0.163%, 0.750%, 0.776%, 0.869%, 0.929% and 0.970% from the end of period 4, 8, 12, 16, 20 and 24 respectively. Then comes liquidity shocks that contribute about an average of 0.40% to changes in stability. Both competition measures contribute most insignificantly to changes in stability, with the Lerner index contributing the least at 0.002%, 0.002%, 0.003%, 0.0060%, 0.010% and 0.018% at the end of the fourth to the 24th periods. Figure 2 below also provides a clearer picture of the results – showing vividly the impact of capital graduating per quarter followed by efficiency, which although declining, remains a significant force in explaining the variations in stability. We also find from the figure the impact of asset quality which becomes visible after the end of period 8 and going forward, as well as liquidity - while the presence of the Lerner index is noticeably faint in the 20th period and beyond. Hence, competition indirectly affects changes in in- stability, and the effects may be transmitted through other variables in the system - especially through efficiency.

Figure 2: Stability Variance Decomposition Bar Chart



The cardinal objective of this study is to analyse the implication for stability of regulation and competition in the banking system. Studies suggest that regulation in banking is primarily to stabilise the system and to engender a competitive banking environment. Overall, the transmission mechanism provides insight for policy implication for a region that sought policies to simulate competition in its banking sectors, given the trade-off between competition and stability. Firstly, we found evidence to support the conclusion of Vives (2016b) that competition only provides an enabling environment to instability or otherwise in banks, and is not the major cause of instability. Our results show that capital regulation among other regulatory variables, is the singular shock that can decide variation in the stability of banks. We found that over 80% of these changes are attributable to changes in capital regulation. In other words, capital can decide directly and in the short-term whether the banking system will be stable, and hence Allen and Carletti (2013) called for the imposition of minimum capital regulation on banks. The minimum capital could be well revised on a time basis, based on the threat level. Suffice to say, capital regulation is the most important individual regulatory instrument for regulating the activities of the banking system and has been a major flashpoint for policy-makers, regulators and practitioners. One reason has been that a bank capital base provides the necessary cushion against eventualities and possible runs. Accordingly, this must be safeguarded at all points in time.

The impulse response analysis results in subsection 4.3 suggest that one standard deviation in capital innovation will amount to declining stability over the next 24 quarters in SSA commercial banks. This should be taking seriously by regulators to mitigate negative eventualities. Based on the summary statistics (see sub- section 3.2.1) the SSA commercial banks have been well capitalised over time and efforts must be made to maintain the status quo. Other regulatory variables consider that play a vital role in determining the stability of SSA commercial banks are liquidity and asset quality. Liquid assets determine how well banks can execute their day-to-day activities and also have been able to finance their commitments to the customers as they fall due which must also be balanced with the quest by banks to make profit. This is because theory suggests that banks face the moral hazard to over-allocate their liquid assets to trading at the expense of honouring their obligation to their customers, which in turn could result in instability (see Boot & Ratnovski, 2016). There is thus no doubt why stability responds significantly to shocks in liquidity and accounts for about an average of 1% in changes in stability, as suggested by the variance decomposition in stability. We therefore champion empirical evidence in this regard to provide support for the impact of liquidity on the stability of banks and that the liquid assets of banks can directly affect their stability. Further on regulatory variables is asset quality which determine the quality of earning assets that a bank has, including the collateral available against the asset side of the bank's balance sheet. This will usually affect stability where the quality is poor. Stability responds significantly and positively to innovations in asset quality, and this is substantiated in Table 7 with asset quality accounting for an average of about 1% in changes in stability. This all implies that changes in asset quality in the next 24 periods will have a considerable impact on the stability of commercial banks in SSA. Hence, policies relating to this must be enhanced to take advantage of and improve on this relationship.

For bank competition, the evidence shows that competition, especially as measured by the Lerner index, does not have a significant short-term influence on bank stability. This reinforces the empirical findings that competition may be a transmission channel through which these variables impact on each other. This suggests that competition effects on the system's stability may not be immediate, and thus may take longer to manifest hence serving as just a conduit. This is notwithstanding that the results show that stability responds significantly and positively at some points to interest rate spread. Efficiency in banking seems to be central to the effectiveness of regulation and competition on stability in banking system. Figure 1*(f)*reflects the influence of efficiency on stability and is buttressed by the variance decompositions in Table 7. Hence, one can conclude that efficiency is the 'blood' of the banking system that aids the transmission of every other vitality. To our knowledge, no short-run analysis has been done on this aspect.

To recap then, regulations, especially on capital, have direct effects on stability and a transmitting effect through to stability via efficiency. Efficiency also has direct effects on stability. The result also suggests that competition has an indirect influence on stability through efficiency but has no direct link to stability in the short-term. Policy should focus on strengthening regulation, especially on capital. Although there may not be an immediate threat to the banking system in SSA in terms of their capital base, ongoing management is key to ensuring the stability of the system. Regulators in the region must expedite efforts to fully comply with the Basel Accord provisions, as currently most of the countries have yet to start implementation of Basel II, let alone Basel III. The implementation will also largely cater for issues of liquidity and the quality of assets, as they are largely embedded in it.

5. Summary and Conclusion

The short-term implication of regulation and competition for stability was analysed in commercial banks in SSA using P-SVAR. The essence was to establish the possible transmission channels/mechanisms from these variables in relation to stability. We introduced efficiency as a measure by SFA into the system, to capture its role between competition and stability, while competition is estimated based on the Lerner index and Zscore for stability. Theories and the empirical literature have been conflicted in their conclusions on the relationship between competition and stability but there is a growing acceptance of the possibility of trade-off in the com- petition/stability relationship. There is also evidence that competition does not necessarily result in fragility in the banking system, as some fundamental features of banks play an important role for which competition may only aggravate the process. However, there seems to be no headway with regard to how the interplay of these outcomes could be managed and/or moderated, to get the best out of the relationship to promote the economic growth of the host economies.

In this study, we carried out for the first time a holistic transmission analysis of regulation, competition, efficiency and stability in the SSA commercial banking sectors. We found direct effects of regulation capital, liquidity and asset quality of bank efficiency and stability respectively in the short term. Our results do not suggest any short-term stability, since stability does not respond significantly in the short run to shocks in com- petition residuals. We therefore found evidence to conclude that there is a direct effect of capital on stability, as well as transmission from regulation through efficiency to stability. The result also suggests a transmission from competition through efficiency to stability since efficiency impacts directly on stability and competition impacts directly on efficiency. The impulse response function and the variance decomposition results also pro- vide insights into how these phenomena could be managed over the next 24 quarters, in order to optimise the outcome of their interactions. For instance, response of stability to capital regulation suggests that stability will decline over time, with one standard deviation in capital innovation. This must be taken seriously.

As regulation, especially capital and efficiency have become the cardinal variables for short-term moderation in bank stability in the banking system and especially in the SSA commercial banking system as revealed by this study's results practitioners and regulators alike mostly ensure regulatory capital is sustained at all times. Rather than fine-tuning competition as the supposed cause of instability in the banking sectors, attention should be directed to managing other fundamentals like moral hazards, information asymmetry and adverse selection, among others, in order to complement the impact of regulation and competition in terms of engendering efficiency and therefore stability. Our contribution lies in the study of the behaviour of stability in relation to regulation and competition in the SSA banking sector in order to assist policy-makers craft the right policy.

Appendices

A P-SVAR Stability Test

Table 8: VAR Stability Test

Roots of Characteristic Polynomial
Endogenous variables: ECR LQTY AQLTY LERNERI IRS EFF SCORE ZSCORE
Exogenous variables: C; Lag specification: 1 5; Date: 02/22/17 Time: 16:38

Root	Modulus
0.996483	0.996483
0.982237	0.982237
0.956690	0.956690
0.935582	0.935582
0.922969	0.922969
0.905222	0.905222
0.885821	0.885821
-0.565913 + 0.565038i	0.799703
-0.565913 - 0.565038i	0.799703
0.562555 + 0.567942i	0.799391
0.562555 - 0.567942i	0.799391
0.536567 - 0.544952i	0.764773
0.536567 + 0.544952i	0.764773
-0.544854 - 0.533533i	0.762577
-0.544854 + 0.533533i	0.762577
-0.529484 + 0.547130i	0.761383
-0.529484 - 0.547130i	0.761383
0.556670 - 0.510497i	0.755307
0.556670 + 0.510497i	0.755307
-0.489433 + 0.491865i	0.693885
-0.489433 - 0.491865i	0.693885
0.494690 - 0.482038i	0.690709
0.494690 + 0.482038i	0.690709
-0.421133 + 0.423945i	0.597564
-0.421133 - 0.423945i	0.597564
0.426110 - 0.412440i	0.593023
0.426110 + 0.412440i	0.593023
-0.357522 - 0.360735i	0.507889
-0.357522 + 0.360735i	0.507889
0.360001 - 0.348949i	0.501365
0.360001 + 0.348949i	0.501365
-0.315725	0.315725
0.003877 + 0.313552i	0.313576
0.003877 - 0.313552i	0.313576
0.307014	0.307014

No root lies outside the unit circle; VAR satisfies the stability condition.

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