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Financial regulation and financial inclusion in Sub-Saharan Africa: Does financial stability play a moderating role?

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ABSTRACT

This study examines the impact of financial regulation on financial inclusion in Sub-Saharan Africa, considering the moderating role of financial stability. By analysing the relationship between financial inclusion and the most prominent macro-prudential regulation (capital adequacy), we find that tightening prudential regulations could negatively impact access to finance, thereby conflicting with Sub-Saharan African economies' financial inclusion goals. More specifically, the capital adequacy requirement tremendously reduces banks' capacity to provide financial services and this could lead to credit rationing thereby reducing financial inclusion. The results also indicate that, the interaction of financial regulation with financial stability positively impacts financial inclusion. Thus, financial stability augments financial regulation to have an affirmative impact on financial inclusion. The practical implications of this paper are that, one of the ways central governments and policy makers in Sub-Saharan African countries can increase and get the most out of financial inclusion is to formulate policies targeted at reducing capital adequacy requirements of financial institutions and other constraints that limit the operations and efficiency of financial institutions. Such policies should also aim at creating an enabling environment to promote financial stability.

1. Introduction

Despite the role financial regulations play in preventing distortions to competition, maintaining market integrity, mitigating negative externalities and reducing information asymmetry, they may also present unpleasant repercussions by inadvertently hampering the efficient intermediation process of financial institutions and impede their ability to provide financial services (see Kodongo, 2018). For example, capital adequacy regulations may compel some banks that are not financially sound to close or merge with other banks and this may cause barriers to entry into the banking sector, thereby impeding competition and decreasing the availability of funds to commercial banks for lending and this will impede financial inclusion. Low credit volumes precipitated by financial regulatory constraints may compel lenders to pursue profit by providing credit to only successful credit applicants at high interest rates which serves as a further impediment to accessing credit and hence lead to low financial inclusion (Kodongo, 2018). It is for this reason that financial regulatory agencies should promulgate and implement regulatory policies that can help countries attain the main goal of ensuring soundness, safety and financial sector stability while at the same time boosting financial inclusion. There has been a number of regulatory requirements of financial institutions in Sub-Saharan Africa ranging from Basel I capital adequacy requirement to Basel III, just to mention a few. Whether the impressive compliance with regulation of financial institutions in Sub-

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Saharan Africa has resulted in greater financial inclusion is an open empirical question that requires answers. The researcher posits that growth in banking services through regulatory agencies is only profitable if it helps in achieving an economy's financial inclusion goals.

Most empirical research that examine financial regulation and financial inclusion nexus are theoretical papers (Getnet, 2014; Tambunlertchai, 2015; Ricardo, 2015; Lewis and Lindley, 2015; Nurbekyan and Hovanesian, 2018) with some of them taking the form of single country studies (see, Kodongo, 2018; Getnet, 2014; Tambunlertchai, 2015; Nurbekyan and Hovanesian, 2018; Yoshino and Morgan, 2017). The difficulty with single country studies is that they do not permit for a general application of the ideas they produce. Other studies have also focus on how financial inclusion impact on monetary policy, financial sector development, income inequality, poverty reduction and economic growth (Anarfo et al., 2019a; Anarfo et al., 2019b; Dabla-Norris et al., 2015; Johal, 2016; Sharma, 2016; Kim et al., 2018).

While policy makers continue to seek ideas from researchers to use financial regulation more efficiently and effectively to promote financial inclusion, research in this area is scarce (see Kodongo, 2018). Nonetheless, for emerging and developing economies' policymakers, gaining insight about the impact of financial regulation on financial inclusion is a prerequisite for putting their economies on the path to speedy growth. The literature has hitherto largely disregarded the empirical examination of the link between financial inclusion and financial regulation from a Sub-Saharan African perspective. More specifically, the impact of financial regulation on financial inclusion appears to have escaped the attention of researchers. As a result, there is a narrow understanding of the link between financial regulation and financial inclusion. This study attempts to bridge the gap by empirically examining the financial regulation-financial inclusion nexus from the Sub-Saharan African perspective. The study also introduces financial stability measured by the bank Z-score as a moderating variable to moderate the relationship between financial regulation and financial inclusion. Our decision to use bank Z-score as a measure of financial stability was influenced by the literature (Demirguc-Kunt et al., 2004; Agoraki et al., 2011; Roy, 1952). We believe that financial stability will help strengthen the relationship between financial regulation and financial inclusion. In addition to the financial regulation variable, we controlled for factors in the bank-environment that might affect banks' decisions regarding lending and access to credit such as bank lending-deposit spread, competition and non-performing loans because these variables, according to the literature, affect financial inclusion (Ricardo, 2015).

One of the main problems bedevilling the study of the financial inclusion-financial regulation link is the use of inappropriate measures for financial inclusion. Financial inclusion has usually been measured by one variable such as the number of bank branches per thousand adults, the number of depositors with commercial banks per thousand adults and the number of ATMs per hundred thousand adults (see Mbutor and Uba, 2013; Evans, 2016). Others use log of credit to small-scale agriculture as an indicator of financial inclusion (see Kodongo, 2018). We posit that the financial inclusion measures mentioned above do not sufficiently address certain important role of financial institutions such as credit availability and ease of making bank account opening. Conclusions arising from such studies that use weak financial inclusion measures can be fallacious and spurious and may not be relevant for policy formulation. Most empirical researchers usually solve the problem by using several of these single variable measures to carry out what they called robustness checks; it is not that they are not aware of the issues embedded in the use of a single variable measure. This solution, though not bad, is not sufficient, as the different measures themselves may be proxying different aspects or just one aspect of financial inclusion. It is now being recognised that financial inclusion has at least two main dimensions: demand side factors (usage) and supply side factors (access) (Chakrabarty, 2012; Shah and Dubhashi, 2015). Therefore, it is essential that proxies of financial inclusion reflect the multidimensional nature of financial inclusion. We address this gap in the extant literature by measuring financial inclusion by constructing a composite index for financial inclusion after deriving the weights (factor loadings) from a panel principal component analysis (PCA). Unlike previous measures, our composite proxy is able to encapsulate the two key facets of financial inclusion: access and usage. By using this multidimensional measure, we are able to examine the relationship between financial inclusion and financial regulation from a holistic point of view. We also measure financial regulation using the capital adequacy ratio measured by a bank's capital divided as a proportion of its risk-weighted assets (see Kodongo, 2018). This paper seeks to answer the following research questions: (1) Does financial regulation affect financial inclusion in Sub-Saharan Africa? (2) Does financial stability enhance the link between financial regulation and financial inclusion in Sub-Saharan Africa?

The study contributes to the economics and finance disciplines in many ways. First, the paper adds to the financial inclusion literature by presenting a detailed evidence on the link between financial regulation and financial inclusion, using a large data set on Sub-Saharan Africa, covering 48 countries for a period of two decades. Another key contribution of this paper is that it presents evidence of the moderating role of financial stability in the financial regulation-financial inclusion nexus which other researchers ignore. This study also contributes to the literature by generating a composite index to measure financial inclusion as opposed to the use of single variable measures. Our proxy of financial inclusion reflects the multidimensional feature of financial inclusion.

Lastly, from a theoretical point of view, this study provides grounds for theory development on the link between financial regulation and financial inclusion. Understanding the theoretical underpinnings of this relationship will help developing economies' policy makers to pursue policies that will enable them achieve the ultimate results from financial regulation and financial inclusion. Also, this research on financial inclusion and financial regulation is of much relevance because it will help researchers to better recognise the financial regulation and supervisory standards that will help financial systems to function well and enhance financial inclusion. With this understanding, policy makers and central governments will be in a good position to provide the needed financial sector regulatory reforms to achieve financial inclusion goals.

Briefly, this study presents the following results. Using one main indicator of prudential regulation such as the capital adequacy to investigate whether compliance to capital adequacy regulatory requirements by commercial banks has an impact on financial inclusion in Sub-Sahara Africa, we found that prudential regulation negatively impacts financial inclusion in Sub-Saharan Africa. More specifically, capital adequacy regulations have a negative and strong significant impact on financial inclusion. The interactive term of

financial regulation (capital adequacy) and financial stability, on the other hand, has an affirmative and significant impact on financial inclusion. This suggests that the interactive effect of financial regulation (capital adequacy) and financial stability appears to mitigate the negative effects of financial regulation on financial inclusion, suggesting that prudential financial regulatory measures are likely to have their intended impact of promoting financial inclusion in a stable financial environment. This means that financial stability (bank Z-score) augments financial regulation to have a positive impact on financial inclusion in sub-Saharan Africa.

The rest of this paper is structured as follows: Section 2 presents both theoretical and empirical literature review. Section 3 reports on the empirical models and methodology adopted. Section 4 presents the data analysis and discussion of results. Section 5 presents the summary, conclusions and policy implications of the paper.

2. Literature review

The financial crisis which occurred in 2007/9 has heightened the interest of several scholars globally on how important it is for improvement in the regulation of financial markets. This has led to the improvement and development of new regulations aimed at making financial institutions like the commercial banks which are deposit taking institutions safer by laying emphasis on having better asset quality (i.e., low nonperforming loans or high provisions for impaired loans), more capital (i.e., less leverage), more liquidity (i.e., less maturity intermediation) and better risk management to prevent build-up of negative externalities that might propel crises and contagion (Cecchetti et al., 2011). The Basel Committee – Basel III Accord – has included all these major debates on how to enhance the regulatory framework of financial institutions in its latest bank supervision recommendations and has placed more emphasis on equity capital, high liquidity standards and greater responsibility on supervisory agents to maintain integrity and discipline in the financial sector (see Sarra, 2012). Many African countries are progressively complying with the financial supervisory regulations based on Basel suggestions and recommendations. Recommendations made by the Basel committee are now backed by law and banks in Sub-Saharan Africa are, to a large extent, complying with them. Though this has strengthened the stability of the financial sector in Sub-Saharan Africa, it may be threatening the achievement of financial inclusion goals.

Carbo et al. (2007) undertook a study on financial inclusion in Europe. Their results suggest that the main reasons that could be partly accountable for financial exclusion in Europe were financial liberalization and intense competition in the banking sector. Thus, financial liberalization increased competition, economic growth and financial sector development (see Batuo et al., 2018). And this led to the development of several strategies by financial intermediaries to target the wealthy populace and to come up with loan application selection tools like credit scoring and draw up financial contracts which excluded non-profitable market segments. Empirical evidence by Demircug-Kunt et al. (2004) suggests that efficiency may be impeded in a regulated environment and cause few powerful banks to hinder competition. This is in consonance with findings from Sarma and Pais (2011) which indicate that financial regulation may have an adverse effect on financial inclusion. These authors, using data from 49 developing countries, discovered that non-performing assets as a proportion of total assets negatively affect financial inclusion. Their results also show that capital asset ratio has a negative impact on financial inclusion, suggesting that when banks are highly capitalized, they are cautious in their lending and this emphasizes the fact that high capitalization in the banking system encourages banks to be cautious in their lending which has the tendency of impeding financial inclusion. This finding concurs with more recent empirical studies which also conclude that increase in capital requirements impede bank lending given that equity is expensive and capital buffers are binding (see Aiyar et al., 2014).

However, in contrast, evidence from Ugwuanyi (2015) shows that bank capital increases results in bank risk-taking behaviour and this has the potential of resulting in greater financial inclusion in Nigeria. There has been increased interest in studies examining the relationship between regulations on financial integrity and financial inclusion. In principle, when individuals are financially excluded, it threatens financial integrity because these persons resort to the use of informal financial products and services which are mostly not operating within the regulatory framework. This compromises the efficacy of counter financial terrorism and anti-money laundering measures. Notwithstanding, there are still concerns that financial integrity regulations may hinder the achievement of financial inclusion goals by increasing costs of compliance, mounting regulatory barriers against new service providers and creating eligibility obstacles for new users (Bester et al., 2008; Isern and de Koker, 2009). The relationship between financial integrity and financial inclusion in many African countries remains inconclusive since access to formal financial services does not necessarily decrease preference for informal financial services (de Koker and Jentsch, 2013).

Stijn et al. (2016) posit that poor regulatory framework is one of the key setbacks to financial inclusion. Others cite lack of infrastructural development, low quality institutions and poor cooperation, economic and political instability, low level of financial literacy and higher poverty rates as the factors behind low financial inclusion (Nurbekyan and Hovanessian, 2018). Stijn et al. (2016) also argue that financial regulation can either be a hindrance or a catalyst to financial inclusion. There is a growing recognition of regulatory frameworks that promote access to financial services and account ownership. The regulatory framework is expected to be designed to facilitate expanding ownership of accounts through financial regulation such as bank capital regulation, introducing tiered documentation requirements, licensing bank agents, low-fee accounts and permitting the introduction of new technologies such as mobile money. The main suppliers of financial services in any economy are banks. According to Kapoor (2009), banks are at the heart of any financial system without which the economy will not function effectively. The question this paper seeks to answer is, if banks are the main suppliers of financial services and products, could the manner in which they are regulated affect their ability to provide financial services? It is for this reason that this paper sought to examine how financial regulation impacts financial inclusion. The key challenge is how financial inclusion goals can be achieved while maintaining financial stability.

Financial stability has become a predominant objective for the world economy due to recent global financial crisis. In the early 1970s, banks deregulation and supervision mainly focussed on minimum capital requirements. The most important function of

minimum capital requirements is to maintain financial stability according to the Basel Capital Accord. However, the relevance attached to regulatory capital requirements in banking supervision raises many questions. This was as a result of the increase in the number of bank failures world-wide. In the past two decades, the attention of regulatory bodies has focused on how to determine the correct ways to facilitate the performance of the financial systems of countries. Other international financial institutions such as the International Monetary Fund and the World Bank responded to recent troubling situations by attempting to enhance economic development and financial stability through vigorously encouraging countries to adopt and implement the right supervisory practices and financial regulations for their financial systems.

The relevance of an efficiently regulated financial system in an economy cannot be over-emphasized. Various studies have found evidence of an affirmative relationship among financial systems operations, financial inclusion, economic development and growth (Levine, 2002). However, financial systems do not often perform in the manner that is profitable. Thus, they sometimes fall short of obtaining this relevant objective of expanding financial services, economic development and growth. The recent global financial crunch is just a reminder of this unfortunate situation. Policymakers' response to financial crisis in time past, normally, was to do assessment of what had caused the crisis and what restructuring and reforms could be used to enhance the financial systems to function better to promote financial inclusion while maintaining financial stability. The length and breadth of most recent financial crisis definitely underscore the relevance of assessments of this kind. Despite the numerous extant literatures on financial systems' effectiveness, a detailed study on whether financial supervision, regulation, and monitoring will promote or hinder financial inclusion and bank efficiency is limited (Berger, 2007; Berger and Humphrey, 1997).

Capital regulation of financial institutions is seen as one of the determinants of profitability and performance of banks as long as it indicates the amount of capital requirement that banks must have in order to reduce risk. Were the owners of financial institutions obliged to hold more risk capital, the gain they would get from taking higher risk would be offset by the potential losses of their capital (Barth et al., 2008). As a consequence, capital adequacy requirements are considered to play critical role by aligning owners of financial institutions' interest with creditors and other depositors by compelling them to be prudent in their lending activities (Kaufman, 1992; Barth et al., 2008; Keeley and Furlong, 1990).

3. Methodology

This study employed linear mixed effect models' method to investigate the causal relationship between financial regulation and financial inclusion. Linear mixed models, also called multilevel models or hierarchical models, are a type of regression model that considers variations explained by independent variables (fixed effects) and variations not explained by independent variables of interest (random effects). The advantage of the Mixed-effect Regression Models over fixed and random effect models is that they explicitly model individual change across time. In terms of repeated measures, they are more flexible. This implies that the same number of observations per subject is no longer required and time can be continuous rather than fixed. The covariance structure has flexible specification among repeated measures and procedures for testing specific determinants of this structure than the use of fixed and random effect models. The general linear mixed effect model can be specified as:

$$Y_{it} = X_{it} \beta + Z_{it} u + e_i \tag{1}$$

Where Y_{it} is an n_i -dimensional vector of responses Y_{it} for unit i X_{it} an $n_i \times p$ matrix of covariate with fixed effects β , Z_{it} an $n_i \times q$ matrix of covariates with the random effects u_i and e_i a vector of residual errors. For a given j , the linear mixed model can be expressed as;

$$Y_{ij} = X'_{ij} \beta + Z'_{ij} u_i + e_{ij} \tag{2}$$

Where Y_{ij} is the vector of observations; X'_{ij} is the incidence matrix for fixed effects; β is the vector of fixed effects (to be estimated); Z'_{ij} is the incidence matrix for random effects; u_i is the vector of random effects, such as individual country values (to be estimated); e_{ij} is the vector of residual errors (random effects). Where X'_{ij} and Z'_{ij} are the j th rows of the corresponding matrices X_j and Z_i respectively

In this study, Y_{ij} is given as $Y_{ij} = [FINDEX_{ij}]$

$$X'_{ij} \text{ and } Z'_{ij} \text{ are also given as } X'_{ij} = \begin{bmatrix} FINREG_{ij} \\ REGSTA_{ij} \\ BALEDESP_{ij} \\ COMP_{ij} \\ NPL_{ij} \end{bmatrix} \quad Z'_{ij} = \begin{bmatrix} FINREG_{ij} \\ REGSTA_{ij} \\ BALEDESP_{ij} \\ COMP_{ij} \\ NPL_{ij} \end{bmatrix}$$

Note: All the variables are defined in Table .1below.

3.1. Empirical models

Following the base line model in Eq. (2) we specify the empirical model involving financial inclusion and financial regulation in this section, as the two most important variables in this study. Financial inclusion is stated as a function of financial regulation, the controlled variables and the vector of residual errors. All the variables are defined in Table 1 below

Table 1
Data and Variable Selection.

Variable	Notation	Description	Data source
Financial Inclusion Index	FINDEX	An index of number of bank accounts, number of ATMs, borrowers from commercial banks, number of bank branches, number of depositors with commercial banks and number commercial bank branches	
Financial Inclusion	ATMSPHTA	ATMs per 100,000 adults	IFS
Financial Inclusion	BAPTA	Bank accounts per 1000 adults	IFS
Financial Inclusion	BFCB	Borrowers from commercial banks per 1000 adults	IFS
Financial Inclusion	BRPHTA	Bank branches per 100,000 adults	IFS
Financial Inclusion	CBB	Commercial bank branches per 100,000 adults	IFS
Financial Inclusion	DCBPTA	Depositors with commercial banks per 1000 adults	IFS
Financial Regulation	FINREG	Capital Adequacy Ratio (CAR)	bankscope
Financial Stability	FINSTA	Bank Z-score	GFD
Interactive term	REGSTA	Financial Regulation and Financial Stability Interactive term	
Bank Lending-Deposit Spread	BALEDESP	Bank lending and deposit spread	GFD
Competition	COMP	Boone indicator	GFD
Non-performing Loans	NPL	Bank non-performing loans to gross loans (%)	GFD

Note: IFS: International Financial Statistics GFD: Global Financial Development.

$$\begin{aligned}
 FINDEX_{ij} = & \beta_0 + \beta_1 FINREG_{ij} + \beta_2 REGSTA_{ij} + \beta_3 BALEDESP_{ij} + \beta_4 COMP_{ij} + \beta_5 NPL_{ij} + u_{0j} + u_{1j} FINREG_{ij} + u_{2j} REGSTA_{ij} \\
 & + u_{3j} BALEDESP_{ij} + u_{4j} COMP_{ij} + u_{5j} NPL_{ij} + e_{ij}
 \end{aligned}
 \tag{3}$$

$e_{ij} \approx N(0, \delta_e^2)$, u_{0j} and u_{ij} are normally distributed with mean 0

3.2. Data source and description of variables

All variables of financial inclusion were obtained from the IFS database while the bank variables were taken from the GFD database. The financial regulation variable was taken from bankscope database. The full sample consists of 217 countries of which 48 constitute the Sub-Saharan Africa sample. Though the concentration of this paper is on Sub-Saharan Africa, the study considered the full sample made up of 217 countries to see if the results of Sub-Saharan African countries differ significantly from the results of the full or world sample. We use an unbalanced panel annual data spanning from 1990 to 2014. The study constructed a financial inclusion index (FINDEX) from six variables of financial inclusion as shown in Table 1 using principal component analysis (PCA). Then we ran separate mixed effect regression models for each data set with the index as well as the six variables of financial inclusion used in this paper.

3.3. Principal component analysis (PCA)

The paper employed panel Principal Component Analysis (PCA) method to generate financial inclusion index using the six variables of financial inclusion. Based on this method, the j^{th} factor Index can be written as:

$$FINDEX_j = W_{j1} X_1 + W_{j2} X_2 + W_{j3} X_3 + \dots + W_{jP} X_P$$

where $FINDEX_j$ is the Index of financial inclusion; W_j is the factor score weight of the parameter; X is the respective initial value of the constituents; and P is the number of variables in the equation. Here, two dimensions of financial inclusion constituted the composite financial inclusion index where each dimension is made up of three factors. The first-dimension constituents are the supply side factors which include ATMs per 100,000 adults, bank branches per 100,000 adults and commercial bank branches per 100,000 adults. The second-dimension constituents are the demand side factors which include bank accounts per 1,000 adults, borrowers from commercial banks per 1,000 adults and depositors with commercial banks per 1,000 adults. In short, six variables constitute the Financial Inclusion Index (FINDEX). The index can be stated as:

$$FINDEX = f(ATMSPHTA, BRPHTA, CBB, BAPTA, BFCB, DCBPTA)$$

4. Empirical results and discussion

4.1. Descriptive statistics

The descriptive statistics of the Sub-Saharan African sample and the full sample are reported in Table 2. However, since predictive power of the mean is affected by outliers, the median of the distribution is used for the discussion. ATMs per 100,000 adults (ATMSPHTA), which is a measure of financial inclusion, has a median of 3.20 per 100,000 adults in Africa while the world average is 30.33 ATMs per 100,000 adults (ATMSPHTA). This indicates that the degree of financial inclusion in Sub-Saharan Africa is lower compared to the full sample. The rest of the measures of financial inclusion which includes bank accounts per 1,000 adults (BAPTA), borrowers from commercial banks per 1,000 adults (BFCB), bank branches per 100,000 adults (BRPHTA), commercial bank branches per 100,000 adults (CBB) and depositors with commercial banks per 1,000 adults (DCBPTA) have median values of 87.13, 2.84, 2.97,

Table 2

Descriptive Statistics.

Source: Authors estimate from research data.

	ATMSPHTA	BAPTA	BRPHTA	CBB	BFCB	DCBPTA	FINREG	FINSTA	BALEDESP	COMP	NPL
Sub-Saharan Africa Sample											
Mean	7.953	156.789	4.161	5.662	40.979	216.665	18.394	8.846	12.010	-0.065	11.060
Median	3.198	87.126	2.841	2.973	17.417	106.481	17.100	7.732	10.148	-0.059	7.990
Maximum	66.198	834.275	24.195	54.167	257.667	1777.706	43.400	89.932	80.333	1.607	74.100
Minimum	0.000	0.000	0.126	0.122	0.000	0.000	1.800	-12.025	0.167	-0.986	0.964
Std. Dev.	12.563	170.184	4.369	8.470	55.497	293.870	6.841	7.080	9.371	0.141	10.062
Skewness	2.394	1.598	2.378	3.290	1.885	2.885	0.821	3.523	3.358	1.995	2.000
Kurtosis	8.330	4.952	9.380	14.511	5.861	12.886	4.041	31.638	18.390	46.217	9.409
Jarque-Bera	763.626	195.874	1158.354	3604.226	262.307	2074.388	33.839	24426.540	7553.755	40890.530	706.350
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	357.000	335.000	439.000	492.000	281.000	380.000	215.000	674.000	643.000	521.000	297.000
Full (World) Sample											
Mean	41.478	512.871	20.171	19.372	171.537	520.124	16.103	11.345	8.426	-0.073	7.845
Median	30.330	337.765	13.026	12.574	97.182	339.503	15.100	9.691	6.441	-0.054	4.868
Maximum	290.661	3368.388	285.002	289.835	1156.048	3371.491	48.600	89.932	80.333	2.129	74.100
Minimum	0.000	0.000	0.126	0.122	0.000	0.000	1.800	-21.224	0.025	-2.000	0.010
Std. Dev.	44.282	559.673	27.378	26.406	208.888	545.971	5.084	8.170	7.866	0.160	8.346
Skewness	1.859	1.897	5.367	5.679	1.971	1.783	1.666	1.361	3.687	-0.785	2.477
Kurtosis	7.588	7.814	45.387	50.648	7.128	7.381	7.737	7.886	22.360	38.693	12.516
Jarque-Bera	2423.501	1277.585	144111.000	195843.000	1217.616	1145.907	2253.296	3959.252	53757.230	125891.500	9313.254
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	1668.000	816.000	1809.000	1959.000	897.000	862.000	1612.000	3038.000	3006.000	2367.000	1942.000

17.42 and 106.48, respectively in the Sub-Saharan sample, while their world sample median values are 337.76, 13.03, 12.57, 97.18 and 339.50, respectively. From the median distribution of the other measures of financial inclusion above, the Sub-Saharan African values are lower compared to the world or full sample values. This shows that the degree of financial inclusion in Sub-Saharan Africa is lower relative to countries in the full sample.

The capital adequacy ratio which is a proxy of financial regulation (FINREG) has a median value of 17.10% in Sub-Saharan Africa but its world median value is 15.10%. This suggests that financial institutions in Sub-Saharan Africa are highly regulated compared to the other sub-regions of the world. This may be partly due to the risky nature of banking operations in Sub-Saharan Africa. Financial stability proxied by the bank Z-score has a median of 7.73% in Sub-Saharan Africa while the world sample value is 9.69%. The Z-score captures a country's banking system's probability of default. The Z-score relates capitalization and returns with the standard deviation (volatility) of those returns. From the figures in Table 2, the probability of default of banks in Sub-Saharan African countries is higher relative to the rest of the world. The median bank lending-deposit spread (BALEDESP) in Sub-Saharan Africa is 10.15%, while that of the full (world) sample is 6.44%. The bank lending-deposit spread (BALEDESP) is the difference between deposit rate and lending rate. Lending rate is the interest rate banks are charging on loans to individual and businesses while deposit interest rate is the interest rate commercial banks are offering on deposits. Based on the median figures of the spread, it can be concluded that lending-deposit spread is higher in Sub-Saharan Africa than in the rest of the world. This means that lending rates in Sub-Saharan African countries are quite high compared to those in other countries in the world. The median value of the Boone indicator in Sub-Saharan Africa is -0.059 while that for the full sample is -0.054. The Boone indicator is a measure of the level of competition and it is computed as profit elasticity with respect to marginal costs. The results suggest that there is higher competition among Sub-Saharan African banks than among banks from the rest of the world. Bank nonperforming loans as a proportion of gross loans median value in Sub-Saharan Africa is 7.99% while the world's median is 4.87%. This is a clear indication that Sub-Saharan African bank loans underperform more than banks in other countries of the world.

4.2. Panel unit root test results

Panel data analysis requires that the variables used in the study are stationary. Stationary test is important because the order of integration of the variables will help choose the right model for the computation of the parameters. Different estimation techniques, such as the Levin et al. (2002 LLC) model and the Im, Pesaran & Shin's (2003, IPS) model, have been developed for testing unit roots in panel data. The IPS and LLC tests both assume that the null hypothesis in each series in the panel has a unit root. However, while the alternate hypothesis of the LLC test assumes each series to be stationary with the same autoregressive parameter for all panel units the alternate hypothesis of the IPS test permits unit roots for some of the individual series if not for all. That is, the autoregressive parameters are not the same. This paper uses four panel unit root tests: Augmented Dickey Fuller (ADF) test, the Levine-Lin Chu (LLC) test, Im, Pesaran & Shin (IPS) test and Philips Perron (PP) test. There are a number of advantages for using panel unit root tests when compared with using individual time series-based unit root tests. First, the use of panel data-based unit root tests has more predictive power compared to their univariate counterparts. The researcher used four panel unit root tests because one of the shortcomings of the conventional Augmented Dickey-Fuller (ADF) is that it has a low statistical power when identifying stationarity, especially in short panels settings. Second, panel unit root tests do not restrict but allow for country level fixed effects and variation in

Table 4
Sub-Saharan Africa Sample Results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FINDEX	ATMS	BAPTA	BRPHTA	CBB	BFCB	DCBPFTA
FINREG	-0.060*** (-2.75)	-0.670** (-2.33)	-1.404 (-0.35)	-0.109 (-1.26)	-0.049 (-0.53)	-2.378** (-2.06)	-3.065 (-0.80)
REGSTA	0.003*** (4.23)	0.048*** (4.58)	0.122 (0.96)	0.014*** (3.47)	0.012*** (2.77)	0.268*** (5.88)	0.245 (1.43)
BALEDESP	-0.177*** (-4.63)	-2.618*** (-6.34)	-32.280*** (-3.52)	-0.748*** (-4.10)	-0.780*** (-3.85)	-8.778*** (-4.09)	-26.582*** (-2.59)
COMP	2.023*** (5.52)	18.091* (1.71)	-97.718 (-0.53)	14.226*** (4.71)	13.939*** (4.47)	9.756 (0.24)	-33.321 (-0.15)
NPL	-0.026*** (-2.75)	-0.370*** (-3.33)	-6.442*** (-2.69)	-0.092** (-2.06)	-0.079* (-1.69)	-1.614*** (-3.49)	-5.681* (-1.87)
_cons	2.622*** (6.25)	44.887*** (9.24)	609.317*** (7.17)	13.488*** (11.46)	12.911*** (10.57)	139.242*** (4.07)	565.545*** (7.16)
Insig_e _cons	-0.496*** (-6.83)	2.465*** (36.65)	5.073*** (57.96)	1.298*** (15.27)	1.337*** (15.58)	3.905*** (32.59)	5.056*** (56.66)
N	52	107	73	114	113	74	74
Wald Test							
Chi2	17.18	167.72	22.76	85.28	70.84	85.43	83.78
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

time for the coefficients across the panels. Besides, panel data approach gives options for estimation ranging from no trend and non-constant estimation to estimations with a constant and deterministic trend testing for similar time effects. These approaches provide a greater degree of flexibility in computing the coefficients (Issahaku et al., 2016).

The panel unit root test results for the Sub-Saharan African sample and the full sample are presented in Table 3. The results from Table 3 indicate that all the variables of financial inclusion are integrated of order one I(1) while the bank variables are integrated of order zero I(0) except the interactive term of financial regulation and stability (REGSTA) which is integrated of order one I(1). This suggests that not all the variables used in the study follow a unit root process. The first difference was used for the variables that are integrated of order one I(1).

4.3. Regression results

The regression results of financial inclusion index (FINDEX) and financial regulation (FINREG) of the Sub-Saharan African sample and those for the full sample are in Tables 4 and 5, respectively. There is a confirmation of a negative relationship between financial regulation (FINREG) and financial inclusion index (FINDEX) in Sub-Saharan Africa as shown in Table 4. Financial regulation measured by capital adequacy ratio significantly impacts the level of financial inclusion in sub-Saharan Africa. This suggests that tightening capital adequacy requirements could be detrimental to financial inclusion. This is to say that increases in financial regulation (capital adequacy) result in a decrease in financial inclusion. Our results concur with other empirical papers that found a negative relationship between financial regulation and financial inclusion (see Kodongo, 2018; Sarma and Pais, 2011; Aiyar et al., 2014). Similarly, unlike Thakor (1996) who showed that capital regulations may increase credit rationing and lower aggregate lending, our results show that capital adequacy could be harmful to accessing financial services. However, Ugwuanyi (2015) appears to have contradicted this finding, showing that an increase in bank capital increases bank risk-taking appetite (potentially resulting in greater inclusion) in Nigeria.

We offer two explanations for this finding. First, high capital adequacy requirement may increase banks' opportunity cost of capital and reduce their return on equity. To decrease the effect of losses coming from the increase in the opportunity cost of capital on their owners' wealth, banks may increase lending rates, decrease interest on deposits, or increase service charges, such as ledger fees and loan initiation costs, all of which are a disincentive to bank usage and access to bank credit by the vulnerable and poor groups typically targeted by financial inclusion policies. Tight regulatory requirements do not only reduce profitability but also tighten the processes involved when opening accounts at financial institutions and getting access to credit and financial services also becomes cumbersome particularly for small income earners. Secondly, financial regulations may hinder the achievement of financial inclusion goals by increasing costs of compliance, mounting regulatory barriers against new service providers and creating eligibility obstacles for new users (Bester et al., 2008; Isern and de Koker, 2009). To enhance and drive the maximum benefit of financial inclusion, Sub-Saharan African countries should employ other non-prudential regulatory measures such as supervision on the part of

Table 5
Full (world) Sample Results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FINDEX	ATMS	BAPTA	BRPHTA	CBB	BFCB	DCBPFTA
FINREG	0.001 (0.18)	-1.718*** (-5.83)	1.112 (0.15)	-0.601*** (-5.39)	-0.351*** (-3.59)	-8.566*** (-3.30)	-1.188 (-0.16)
REGSTA	-0.000 (-0.43)	-0.004 (-0.54)	-0.544** (-2.14)	0.001 (0.33)	-0.003 (-1.07)	0.290*** (3.29)	-0.120 (-0.47)
BALEDESP	-0.012*** (-2.69)	-0.741 (-1.40)	-26.312*** (-5.84)	0.254 (1.57)	-0.481*** (-5.24)	-9.552*** (-5.09)	-25.713*** (-6.74)
COMP	-0.601*** (-3.77)	-5.048 (-0.77)	-254.907** (-2.13)	-17.136*** (-6.17)	-16.682*** (-6.34)	11.250 (0.27)	-220.630* (-1.74)
NPL	-0.020*** (-3.03)	-1.450*** (-5.58)	4.585 (0.53)	-0.341*** (-4.37)	-0.241*** (-3.18)	-9.461*** (-6.11)	7.903 (0.84)
_cons	0.218 (1.55)	89.752*** (15.70)	952.776*** (9.12)	28.305*** (19.02)	28.077*** (20.00)	436.432*** (9.82)	937.902*** (8.44)
Insig_e _cons	-0.122 (-0.41)	3.754*** (68.79)	6.468*** (111.52)	2.881*** (21.27)	2.820*** (18.94)	5.274*** (91.82)	6.455*** (107.78)
N	219	664	331	696	695	378	308
Wald Test							
Chi2	24.00	118.18	46.51	121.90	131.32	56.34	49.14
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

central banks and good corporate governance to ensure soundness, safety and stability of the financial system instead of focusing on capital adequacy requirements. However, the link between financial regulation and financial inclusion is not statistically significant in the full sample results in Table 5. The relationship between financial regulation and some of the individual variable measures of financial inclusion such as the number of ATMS and borrowers from commercial banks (BFCB) is statistically significant and negative as shown in model (2) and model (6) in Table 4. However, the only individual variable measures of financial inclusion that are not significantly affected by financial regulation include bank accounts (BAPTA) and the number of depositors with commercial banks (DCBPFTA) as shown in model (3) and model (7) in Table 5.

This study also introduced financial stability (FINSTA) as a moderating variable to moderate the relationship between financial inclusion index (FINDEX) and financial regulation (FINREG). The paper interacted financial regulation (FINREG) and financial stability (FINSTA) to form a new variable (REGSTA). The purpose of the interactive term was to see whether financial stability could enhance and strengthen the relationship between financial inclusion (FINDEX) and financial regulation (FINREG). It is expected that when financial institutions are stable, tight capital regulatory requirements will not affect their ability to provide financial services. The results indicate that the interactive term is statistically significant. This is evidenced by the positive coefficient of the interactive term of financial regulation and financial stability (REGSTA) in Table 4 in model (1).

This result goes to confirm the fact that, in the midst of tight capital adequacy regulatory requirement of banks, financial inclusion will not be compromised in an environment of financial stability. This suggests that financial stability augments financial regulation to have a positive impact on financial inclusion.

This study controlled for other bank level variables which could influence banks' ability to provide financial services. These variables include bank lending-deposit spread, the level of competition measured by the Boone indicator and nonperforming loans as a percentage of gross loans. The bank lending-deposit spread (BALEDESP) is negative and significant, suggesting that widening spreads (e.g., declines in deposit rates relative to average bank lending rates) are likely to deter people from gaining access to financial services. It is evident that bank lending-deposit spread (BALEDESP) has a negative and significant impact on financial inclusion index (FINDEX) as shown in Table 4 in model (1) through to model (7). Most Sub-Saharan African countries are characterized by low deposit rates and high lending rates. This means that when the lending rate is high, it deters people from borrowing and if the deposit rate is too low it also deters people from depositing their surplus funds with financial institutions. Low deposit rate couple with high lending rate increases the spread. This explains the lower levels of financial inclusion in Sub-Saharan Africa where a lot of people do not access financial services.

Another important determinant of financial inclusion in Sub-Saharan Africa is the level of competition among financial institutions. We believe that keen competition among financial institutions improves efficiency and financial services delivery and eventually enhances financial inclusion. On the other hand, increased competition could reduce profits of financial institutions. As a result, they cannot expand, thereby reducing financial inclusion. The level of competition is measured by the Boone indicator which is computed as profit's elasticity with respect to marginal costs. This study found that competition (COMP) positively relates to

financial inclusion index (FINDEX) and it is statistically significant. This is evident through the positive coefficient of competition (COM) in model (1) of Table 4. This finding indicates that a very keen competition increases financial inclusion. This suggests that regulatory policies should be put in place by governments in Sub-Saharan Africa to encourage competition in the banking sector. This finding concurs with other studies that found a positive link between competition and financial inclusion (Mengistu & Saiz 2018). However, other studies found a negative relationship between financial inclusion and competition (Carbo et al., 2007; Sarma and Pais, 2011) and this concurs with the results in the full sample in Table 5 model (1).

We also found that banks' nonperforming loans (NPL) are also a significant driver of financial inclusion index. They have a negative impact on financial inclusion as shown in Table 4 model (1). This suggests that an increase in nonperforming loans decreases financial inclusion in sub-Saharan Africa and the study found a similar result when using the full sample. The explanation offered for this result is that an increase in non-performing loans reduces financial institutions' profitability. Hence, they are unable to expand to provide financial services. This finding is in consonance with the idea that banks' nonperforming loans might impede financial inclusion, according to Sarma and Pais (2011) who, using data from 49 mostly developing countries, show that nonperforming assets as a percentage of total assets are negatively related to financial inclusion.

4.4. Conclusions and policy implications

Even though financial sector regulation has received considerable attention in recent times engineered by the 2007–2009 global financial crisis, the nexus between financial regulation and financial inclusions has not received much attention in the financial inclusion literature. This study sought to investigate this link using data from Sub-Saharan Africa. The empirical relations between financial inclusion and financial regulation was examined using a panel mixed effect regression approach. Financial inclusion and financial regulation play major roles in Sub-Saharan Africa and they have greater implications for financial and macroeconomic stability.

The results show that financial regulation has a negative effect on financial inclusion in Sub-Saharan Africa, suggesting that tight financial regulation does not enhance financial inclusion.

By analysing the relationship between financial inclusion and the most prominent macro-prudential regulation – capital adequacy – we find that tightening prudential regulations could negatively impact access to finance and therefore conflict with the Sub-Saharan African financial inclusion goals. More specifically, the capital adequacy requirement significantly reduces banks' capacity to provide financial services which may result in credit rationing as observed by Thakor (1996). However, the negative impact of capital regulations on financial inclusion can be curbed with financial stability because financial stability augments financial regulation to have a positive effect on financial inclusion.

For Sub-Saharan Africa economies to drive the maximum benefit from financial inclusion, the regulatory requirement of financial institutions should be reduced in terms of their regulatory capital requirements. Financial stability was introduced in the study as a moderating variable between financial regulation and financial inclusion. The analysis shows that the interaction of financial stability and financial regulation has a positive effect on financial inclusion in sub-Saharan Africa. This suggests that financial stability negates the negative impact of financial regulation on financial inclusion in Sub-Saharan African economies. It implies that financial regulation has no impact on financial inclusion when a financial institution is financially stable. In this regard, policy and regulatory agents should focus on fostering financial stability as an instrument for increasing financial services usage as well as for better financial decision-making at the micro and macro levels. In terms of the effect of bank lending-deposit spread, the results indicate a negative relationship between bank lending-deposit spread and financial inclusion, suggesting that bank lending-deposit spread reduces financial inclusion in Sub-Saharan Africa and therefore discourages borrowers from borrowing and lenders to lend more.

The results of this study also suggest that financial inclusion is linked with the level of competition in the financial sector, meaning that increases in competition results in efficiency and quality service delivery, thereby enhancing financial inclusion. It is evident that nonperforming loans are a significant driver of financial inclusion, suggesting that increases in nonperforming loans drive down financial inclusion in Sub-Saharan Africa.

The findings of this study have a number of implications. Among the implications is the fact that Sub-Saharan African countries can increase and get the most out of financial inclusion by formulating policies that enhance financial stability and reduce regulatory capital of the financial sector. Such policies should be aimed at reducing the capital regulatory requirement of financial institutions and other constraints that limit the operations and efficiency of financial institutions. This study extends the literature on financial inclusion–financial regulation nexus by using a panel multivariate mixed effect model approach to establish their relationship. The contribution of this study to theory development is in the establishment of the link between financial inclusion and financial regulation.

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Appendix A

See Table A1.

Table A1
List of Countries that constitute the Sub-Saharan Africa Sample.

Angola	Congo, Dem. Rep.	Guinea	Mozambique	South Africa
Benin	Congo, Rep.	Guinea-Bissau	Namibia	South Sudan
Botswana	Cote d'Ivoire	Kenya	Niger	Sudan
Burkina Faso	Equatorial Guinea	Lesotho	Nigeria	Tanzania
Burundi	Eritrea	Liberia	Rwanda	Togo
Cabo Verde	Eswatini	Madagascar	Sao Tome and Principe	Uganda
Cameroon	Ethiopia	Malawi	Senegal	Zambia
Central African Republic	Gabon	Mali	Seychelles	Zimbabwe
Chad	Gambia, The	Mauritania	Sierra Leone	
Comoros	Ghana	Mauritius	Somalia	

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