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Do board characteristics moderate capital adequacy regulation and bank risk-taking nexus in Sub-Saharan Africa?

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Abstract

Purpose – The purpose of this paper is to examine whether board characteristics moderate the relationship between capital adequacy regulation and bank risk-taking of universal banks in Sub-Saharan Africa (SSA).

Design/methodology/approach – The paper uses 700 bank-year observations of universal banks in SSA between 2009 and 2019. The paper further uses the two-step generalized method of moments as the baseline estimator.

Findings – The paper finds that capital adequacy regulation is positively related to overall bank and liquidity risks. Nonetheless, capital adequacy regulation increases credit risk in the sampled banks. The paper further reports that board characteristics individually and significantly moderate the relationship between capital adequacy regulation and risk-taking.

Practical implications – The findings have implications for regulators of universal banks that board characteristics matter for capital adequacy regulation to impact risk-taking behavior.

Originality/value – The paper extends the existing literature on the effect of board characteristics on the capital adequacy regulations and risk-taking behavior nexus of universal banks.

Keywords Capital adequacy, Risk-taking, Universal banks, Sub-Saharan Africa (SSA)

Paper type Research paper

1. Introduction

Banks' risk-taking behavior has received significant investigation in recent years following the collapse of universal banks and other depository institutions in some emerging economies (Dwekat *et al.*, 2020; Nguyen, 2021). Evidence exists to conclude that excessive risk-taking coupled with regulatory failures is partly responsible for the recent financial crisis in financial institutions. Over the years, various theoretical prepositions and interventions have been suggested to reduce the level of various risks for banks and to strengthen and sustain the financial systems of emerging economies. These prepositions include the adoption of capital

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adequacy regulation. Following its wide adoption, its effectiveness in reducing the risk-taking behaviors of banks has received a lot of attention. Several empirical studies have shown interest in investigating the relationship between capital adequacy policy and the risk-taking behavior of banks (Dwekat *et al.*, 2020; Guerrero-Villegas *et al.*, 2018). However, the findings of these studies have been inconsistent and contradictory. Dwekat *et al.* (2020) find a positive but insignificant association between bank regulations and supervision on banks' risk-taking. However, other studies (Guerrero-Villegas *et al.*, 2018; Shrieves and Dahl, 1992; Jacques and Nigro, 1997) report a negative relationship between bank regulation and the risk-taking of banks. Given the mixed findings, there have been recent calls (see Nwude and Nwude, 2021; Nguyen *et al.*, 2021; Govindan *et al.*, 2021) for the relationship between capital adequacy regulation and risk-taking to be re-examined to gain additional insight on the capital adequacy regulation and risk-taking nexus.

Moreover, prior studies adopt a simple model to investigate the direct relationship between capital adequacy regulation and bank risk-taking while ignoring the corporate board structure that can affect the effectiveness of the bank to successfully implement policies. In particular, prior studies did not consider the potential moderating role of board characteristics on the relationship between capital adequacy regulation and risk-taking relationships. This noticeable limitation in prior studies has motivated this paper. In this paper, we conjecture that board characteristics moderate the relationship between capital adequacy regulation and a bank's risk-taking behavior. We further conjecture that a failure to account for board characteristics as a moderating mechanism might be responsible for the mixed findings between capital adequacy regulation and bank risk-taking in the prior empirical literature. There is a convincing theoretical and conceptual basis to argue that capital adequacy regulation and risk-taking nexus is influenced by board characteristics. Many studies (see Agyemang and Appiah, 2017) argue that board characteristics play an important role in the successful implementation of regulations and supervision policies, including capital adequacy regulations. Board of directors, as part of their responsibilities, is to ensure that the bank complies with all the regulatory requirements. This includes capital adequacy regulation. However, achieving such a regulatory requirement is dependent on the effectiveness of the board. The preposition of capital adequacy theory is that the main objective of capital regulation in the banking sector is to prevent managers and owners from taking excessive risks (Kim, 2015; Zhongming *et al.*, 2019).

Also, evidence exists to demonstrate that effective board characteristics are able to reduce managers' excessive risk-taking behavior. Considering the fact that board characteristics can influence compliance with regulatory requirements and risk-taking, board characteristics can be expected to moderate the relationship between capital adequacy regulation and bank risk-taking. Nonetheless, prior studies related to the influence of various board characteristics on the relationship between capital adequacy regulation and bank risk-taking behavior are rare. Accordingly, the paper aims to investigate the influence of various board characteristics on the relationship between capital adequacy regulation and bank risk-taking behavior in selected universal banks in Sub-Saharan Africa (SSA). We include Board size (BODSIZE), board independence (BIND) and board gender diversity (BGD) as keyboard characteristics because they are mostly used in prior board, bank risk-taking behaviour and capital regulation studies.

Consequently, this paper contributes to the literature in several ways. First, the paper adds to the existing literature by demonstrating that capital adequacy regulation is a significant driver of risk-taking behavior reduction. Although extensive literature exists, the findings have been mixed, ambiguous and inconclusive. Hence, this paper provides further evidence. Second, the paper extends the dynamic relationship between capital adequacy regulations and risk-taking behavior. Unlike prior studies that examined the direct relationship between capital adequacy regulation and bank risk-taking, this paper further examines how board size, independence and gender diversity potentially influence the relationship between capital adequacy regulation and risk-taking behavior. This will provide further insight into how capital adequacy regulations impact on banks' risk-taking. Third, the study was conducted in selected developing economies. There are unique features of SSA that provide a compelling case to examine the moderating role of board characteristics in the relationship between capital adequacy regulation and bank risk-taking. SSAs are characterized by weak corporate governance and a fragile financial system. In recent years, many developing economies have implemented various forms of capital adequacy regulation policies to ensure that the banking sector is stable and sound in line with the requirements of the Basel Accord by the Basel Committee. Despite these massive reforms in the form of capital requirements, the banking sector in SSA seems to be still weak and experiencing a high level of failure due to high risk. This puts doubt on the effectiveness of the capital adequacy requirement (CAR) in reducing bank risk-taking. Therefore, investigating the influence of board characteristics on the CAR policy and the bank's risk-taking behavior is expected to have implications for bank executives and regulators on how to identify board characteristics that can positively influence the relationship between CAR and bank risk-taking.

The paper finds that capital adequacy regulation is positively related to overall bank and liquidity risks. Nonetheless, capital adequacy regulation increases credit risk in the sampled banks. The paper further reports that board characteristics individually and significantly moderate the relationship between capital adequacy regulation and risk-taking.

The paper proceeds as follows: Section 2 presents theoretical framing and empirical review. Section 3 captures the research design. Section 4 presents the results and discussion whereas Section 5 captures the conclusion and implications of the study.

2. Theoretical framing

Capital adequacy theory argues that banks should hold capital buffers to safeguard banks' vulnerability to liquidity risk against panic withdrawal (Zhongming *et al.*, 2019). The main objective of capital regulation in the banking sector is to prevent managers and owners from taking excessive risks (Santomero, 1997). Nonetheless, critics of capital adequacy theory argue that CARs may increase a bank's risk appetite (Calem and Rob, 1999; Milne, 2002). They posit this because it is costly for banks to hold higher capital ratios. Therefore, banks ought to incur more risk to compensate for costs associated with maintaining higher capital ratios. Following this theoretical preposition, empirical evidence on the relationship between capital adequacy and bank risk-taking appears to be contradictory and mixed.

Bank shareholders have a high tendency to engage in higher risk behaviors because of moral hazard problems and convex payoff (Jensen and Meckling, 1976; John and Scholes, 1991). Due to the higher information asymmetry level in the banking industry, using debt contracts *ex ante* is not effective in curbing shareholders from taking more risks (Dewatripont and Tirole, 1994). Also, risk-adjusted capital increases the problem of moral hazard by encouraging shareholders to take more risky investments and failing to control banks' incentives (Jensen and Meckling, 1976; Merton, 1977; John and Scholes, 1991).

Moreover, according to agency theory, the principal–agent relationship should use information in the organization efficiently to minimize information asymmetry and risk-bearing costs (Eisenhardt and Cathleen, 1989). Agency theory suggests two potential problems (moral hazard and adverse selection) that may arise within the manager–shareholder relationship for low-disclosure banks. Agency theory and corporate governance are used to recognize or regulate the role of agents in satisfying their part of the contractual relationship governing agency relationships. The basic view held by agency theorists of corporate governance is that the board of directors has a role to ensure that they comply with regulatory requirements, including CARs and risk-taking. Hence, this study examines the moderating role of board characteristics in the relationship between CARs and risk-taking.

2.1 Empirical review of capital regulation and risk-taking of banks

When managers' decisions and activities are highly regulated and supervised by authorities, too much risk-taking and its adverse effect on banks are reduced (Demsetz and Lehn,1985). In the public interest view, banking regulation and supervision policies are geared towards reducing bank risk-taking and ensuring bank sustainability (Petitjean, 2013; Pakhchanyan, 2016; Basel I, 1998; Basel II, 2011; and Basel III, 2015; Rachdi and Bouheni, 2016). Relating to banking regulation, supervisory policies and the level of risk-taking in banks, there are varying findings. Aggarwal and Jacques (2001) and Matejašák *et al.*, 2009 attribute the variation in findings to the country, time period and variables studied. Heid and Krem (2003) discover a positive relationship between capital regulation and bank risk-taking in their study of the relevance of capital regulation and bank behavior. Bank regulations and supervision on banks' risk-taking are positive but insignificant associations between bank regulations and supervision. However, Shrieves and Dahl (1992) report a negative relationship between bank regulation and the risk-taking of banks, and Jacques and Nigro (1997) report a negative association between bank regulation and supervisory policies and bank risk-taking. Heid and Krem (2003) find that capital stringency marginally impacts bank risk. Their findings indicate that activity restrictions and deposit insurance (DI) increase bank risk. However, the findings are consistent with previous studies by Demerguç-Kunt and Detragiache (2002) and Barth *et al.* (2004).

Contrary, some studies establish that capital requirements increase banks' risk-taking behavior (Blum, 1999; Calem and Rob, 1999). Alam (2012) finds that tighter restrictions reduce risk-taking. Klomp and De Haan (2012) establish that banking regulation and supervision impact the risk of banks. Rachdi and Bouheni (2016) report that improvement in the regulatory and supervisory policies will decrease the level of risk-taking in commercial banks in Europe.

Consequently, the review of prior studies has concentrated in developed economies with strong supervisory capabilities. This SSA case may be different. Beck *et al.* (2015) argue that banks in SSA are characterized by weak supervisory capabilities and governance framework. In recognition of these weaknesses, Beck *et al.* (2015) observe that corresponding banks in developed countries required banks operating in SSA maintain high regulatory standards including CAR. Failure to maintain these regulatory standards may risk isolation from global trade. Considering the fact SSA countries are import-driven economies, banks in SSA may not risk isolation from the international trade. Accordingly, this paper conjectures that banks in SSA will comply with capital adequacy regulation and this will positively affect the risk-taking of universal banks. We, therefore, hypothesized that

H1. Capital adequacy regulation policy positively affects the risk-taking of universal banks in SSA.

2.2 The moderating role of board characteristics on capital adequacy requirements and risk-taking

Poor corporate governance structures in banks do not ensure proper monitoring and management of risk, which leads to excessive risk-taking in banks (Jensen, 1993). According to Conyon *et al.* (2011), weak governance structures have contributed largely to unnecessary risk-taking in banks during the financial crunch. Abou-El-Sood (2017) supports this by establishing that weak corporate governance structures in banks lead to inadequate risk monitoring by the board, which ultimately leads to unnecessary risk-taking. Kirkpatrick (2009) establishes that the board's disclosures of foreseeable risk factors and systems for monitoring and managing risk were severely lacking in many failed banks. But Otero *et al.* (2019) argue that in order to maximize shareholders' worth, boards of directors and managers of banks take excessive risk. This assertion by Otero *et al.* (2019) brings about a conflict of interest between shareholders' maximization theory and stakeholders' theory vying for the stability of banks.

The size of the board of directors in banks matters in terms of risk-taking in the banks. Larger boards breed inefficiencies and hinder communication, coordination and decision capabilities to address excessive risk-taking (Jessen, 1983). Further to this, Jensen (1993) emphasizes that larger boards and more regulatory restrictions on outside directorship of banks outweigh the benefits of these governance mechanisms, which eventually undermine performance. As larger boards may exhibit inefficiencies, it is a feature that hinders board communication, coordination and decision-making abilities to mitigate excessive risks in the organization. Rachdi and Ben Ameur (2011) report that smaller boards lead to excessive risk-taking by commercial banks in Tunisia, but BIND (nonexecutive directorship) has no effect on the banks' risk-taking when they examine 11 commercial banks in Tunisia from 1997 to 2006. Loh and Sok-Gee (2017) examine listed commercial banks in Malaysia between 2001 and 2012 and report that bigger boards lead to excessive risk-taking by commercial banks in Malaysia. Kusi *et al.* (2018) examined 215 banks from 29 African countries to establish a relationship between corporate governance and bank risk-taking in Africa, using board size as a measure that was negatively correlated with bank risk-taking in Africa. They conclude that larger boards lead to excessive risk-taking by banks in Africa. Meijer (2017) studying 127 commercial banks selected from developed countries between 2002 and 2016 using ordinary least square (OLS) reports that bigger boards and gender diversity lead to less risk-taking. The independence of boards of directors is negatively associated with bank risk-taking in developed countries. Palavia *et al.* (2015) study banks in America and report that banks with female board chairpersons take less risk and, however, have high solvency ratios. Zhu *et al.* (2018) argue that women, by their nature, are risk-averse and serving on banking boards will influence risk decisions positively.

Notwithstanding the seemingly contradictory evidence on the relationship between board size, independence and gender diversity on risk-taking, there is a consensus on the impact of these board characteristics in improving board monitoring effectiveness in SSA (see Agyemang and Appiah, 2017; Agyemang and Assabil, 2021). Accordingly, this paper contends that effective configuration of the board in terms of board size, BIND and BGD will influence the relationship between capital adequacy regulation policy and bank risk-taking. Consequently, the paper hypothesized that

H2a. Board size has a positive and significant moderating effect on the relationship between capital regulation policy and risk-taking of universal banks.

H2b. Board independence has a positive and significant moderating effect on the relationship between capital regulation policy and risk-taking of universal banks.

H2c. Board gender diversity has a positive and significant moderating effect on the relationship between capital regulation policy and risk-taking of universal banks.

3. Research design

3.1 Dataset and source

A data set on banking capital adequacy regulation, financial ratios and board characteristics (board size, BIND and gender diversity) was manually extracted from annual reports of the banks for the study period (2009–2019). The use of panel data would avoid the problem of multicollinearity, aggregation bias and endogeneity problems (Solomon *et al.*, 2000;

Bouheni, 2014). This study used unbalanced dynamic panel data for regulation and supervision, financial ratios and board size regression analysis to measure, establish and analyze the effect of regulation and supervision on bank performance and risk and also the moderating effect of board size on the relationship between regulation and supervision and performance on one hand and risk on the other hand of universal banks from Ghana, Nigeria and Kenya between 2009 and 2019.

The focus of the study is all the universal/commercial banks in Ghana, Nigeria and Kenya. In all, 70 universal/commercial banks representing 82% of the banks in selected countries were considered for the study. This consists of 22 from Ghana, 16 from Nigeria and 32 from Kenya. Appendix 1 shows the sampled universal banks used for the study from each of the three countries.

3.2 Measurement of variables

In this paper, our variable of interest is risk-taking of commercial/universal banks. Consistent with prior studies, the risk-taking of commercial and universal banks is proxied by Z-score, liquidity risk and credit risk. Z-score is the ratio of ROA plus EAR to the standard deviation of ROA, where ROA is the return on assets and EAR is the proportion of equity to assets (Higher Z-scores indicate lower chance of default and hence better performance with regard to risk management). Z-score used is the banking insolvency risk measure developed by Boyd *et al.*, 1993.

$$\log \mathrm{ZSCORE} = log\left(ROA + \frac{\mathrm{EAR}}{\delta ROA}\right)$$

Liquidity Risk is measured using Loan-to-Deposit Ratio (LDR) which is the comparison of the total loans of the bank to the total deposit of the banks. Basically, the ratio is expressed as a percentage. Higher LDR ratio is not healthy for the banks because a slight increase in the demand for deposits by the depositors may lead to liquidity problems.

$$\mathrm{LDR} = \frac{gross\ loans}{total\ deposit}$$

Credit Risk is measured using loan loss provision to gross loans which is the comparison of loan loss provision or loan impairment charge to the gross loans granted at the end of the year. Higher ratio surfaces when the nonperforming loans are on the increase. Higher ratio depicts high credit risk and lower ratio indicates lower credit risk (Epure and Lafuente, 2015 and Muriithi, 2016).

$$loan\ loss\ provision\ ratio = loan\ loss\ provision / gross\ loans\ and\ advance$$

The independent variable of the study is the capital adequacy regulation. CAR is measured using regulatory capital requirement ratio which is

$$\mathrm{CAR} = \mathrm{Tier\ 1(core\ capital)/\ RWA}$$

The moderating variables in this paper are corporate governance characteristics proxied by board size, BIND and BGD. Board size is measured as the number of individuals serving on the banking boards at the end of each financial year whereas BIND is measured as proportion of nonexecutive directors on board. BGD is measured as proportion of females on board.

We also include in our model control variables. These include bank size for bank-specific variables and countries' macroeconomics indicators which include inflation rate, prime interest rate and GDP growth rate. Bank size is measured as the natural log of total assets of the banks. Size might be an important determinant of bank performance if there are increasing returns to scale in banking. The total assets for each bank for each year were reported in the local currency in the financial report of the sampled banks. Therefore, we used the average exchange rate at the end of each year to convert the value of total asset to USD. This approach is consistent with prior empirical literature (see Dietrich and Wanzenried (2011), Louzis *et al.* (2012) and Tan (2015)). The full details of the proxies used to measure the variables considered in this paper are captured in Appendix 2.

3.3 Model specification

The basic model to be estimated takes the form of

$$RISK - TAKING = f\{(CAR, BSIZE, INTRA, INFLA, GDP)\} \quad (1)$$

Incorporating error term and variable coefficients, the model for the dynamic generalized method of moments (GMM) short-term run measure of risk-taking becomes

$$R_{jit} = \beta_0 + \beta_1 R_{jit-1} + \beta_2 CAR_{jit} + \beta_3 Bsize_{jit} + \beta_4 INTRA_{jit} + \beta_5 IFLA_{jit} + \beta_6 GDP_{jit} + yt + \varepsilon \quad (2)$$

where R_{jit} is the measure of banks' risk-taking (using banking insolvency's *Z-score, credit and liquidity risks*) and R_{jit-1} is the lagged bank risk which emphasizes that the current year's risk-taking depends on the previous year's risk level. *CAR* – capital adequacy requirement policy, *Bsize* – bank size, $INTRA_{jit}$ – interaction term (board size, independence and gender diversity), $IFLA_{jit}$ – inflation rate, *GDP* – growth rate, yt – year dummy and ε – error term. Where $j = 1–3$, $i = 1–70$ and $t = 1–10$.

Considering variables and dataset for the study and empirical analysis to be done, other commonly used estimation techniques are inappropriate for this study. SYS-GMM is regarded as the finest estimation method with reference to econometric setting of the study (De Vita and Luo, 2018).

The GMM is a statistical method that combines observed economic data with the information on population moment conditions to produce estimates of the unknown parameters of this economic model (Muriithii, 2016). Method two-step GMM-in-System estimator is used for this study and as suggested by Roodman (2009) and Bouheni (2014), this study considers a number of banks – 70 – and a time period of 11 years – 2009–2019. In studies like this, featuring such dataset, GMM estimator works well.

This study considers time lag in view of that dynamic regression to test hypotheses. As suggested by Wooldridge (2010), the study adopts dynamic panel models because time lags are considered in the study and also there is likelihood of presence or absence of autocorrelation dynamics, in such situations, dynamic panel analysis is useful. The appropriate estimating technique for dynamic panel analysis as suggested by Verbeek (2004) is GMM estimator. As postulated by De Vita (2018) and Kyaw (2017), the two-step SYS-GMM estimator accounts for the fundamental dynamics of the data generation procedure while also dealing with country-specific effects, measurement error and endogeneity problems as compared to other estimating techniques such as fixed effect, random effect OLS and even one-step SYS-GMM. The GMM estimator also addresses the problem of reversal causality and simultaneity bias (Hansen, 1982; Liang *et al.*, 2013; Tan, 2015; Hakimi *et al.*, 2018). Two-step SYS-GMM estimation technique is widely used in corporate governance and finance studies since it deals with perceived endogeneity by using lagged variables (De Vita and Luo, 2018). Among such studies are Wintoki *et al.* (2012), De Mendonça *et al.* (2012), Adams and Mehran (2012), Liang *et al.* (2013), Kyaw (2017), Bouheni (2014), Haque (2017) and De Vita and Luo (2018).

4. Results and discussion

4.1 Descriptive statistics

Table 1 shows the descriptive statistics of the study variables, that is, observations, mean, standard deviation, minimum and maximum values.

From Table 1, the minimum assets stood at as low as \$57,146 and the maximum at \$9,085,662, with a mean of \$670,682.20. From Table 1, majority of the banks have an LDR at the threshold of 70.9%, but ideally, 50–60% should be expected. Higher LDR might translate into growth of banks' average profits during the period under study since an increase in liquidity of banks reduces credits, hence profits (Sahyouni and Wang, 2019). The standard deviation of 59.1% lying below the mean is an indication that the dispersion is not all that much. But the maximum exceeding 100%, that is 1102.1%, is alarming. The loan loss provision on average stood at 3.6%, which indicates that credit risk is well managed, though it is dispersedly distributed among the banks, having a standard deviation of 19.5%, which is greater than the mean value. Again, some banks exhibit a credit risk of 488.9%, which is dangerous and can endanger the liquidity position of the banks. Notwithstanding, some banks making savings from loan loss provisions is an indication of proper management of credit risk during the study period.

From Table 1, the banks are adequately capitalized considering the mean of 24% compared to the 8% threshold recommended by the Basel II accord and implemented by most regulators. The standard deviation of 27% indicates a high level of dispersion. Also, the number of members on the banking boards is too wide; thus, a difference of 15 between the minimum and maximum with an average of 10 members. The extreme is the presence of too-big-to-fail banks, which have other investment opportunities and for which more expertise is needed to manage various business ventures. From study observations, most banks are focused on traditional banking activities and, therefore, do not have larger boards. The minimum of five is consistent with the findings of Atuahene (2016) and Kyeneboah-Coleman and Bierpe (2006). Outside directorship is strongly advocated in the subregion, thus an average of seven independent directors to the average board size of ten. On the contrary, the proportion of women on the banking boards is very low, comparing an average of two to that of an average board size of ten. It can be observed that the BGD was sticky notwithstanding the fact that there were some variations with some banks from one year to another. This is consistent with the observations made by Ntim (2016) that board attributes such as BGD turn out to be sticky. This implies that do not easily change unless there is a change in policy

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
ZSCORE	650	1.225	0.358	−0.308	3.783
LDR	665	0.709	0.591	0	11.022
CDR	661	0.037	0.195	−0.045	4.889
CAR	598	0.216	0.270	−1.98	2.618
BODSIZE	589	10.13	3.165	5	20
NED	589	6.996	2.287	4	13
FEMALES	589	1.740	1.257	0	6
ASSETS(\$)	770	670682.20	10,556,908	57,146	9,085,662
PRIME RATE	770	0.127	0.052	0.014	0.26
INFLATION	770	0.096	0.043	0.032	0.189
GDP	770	0.058	0.0308	−0.016	0.174

Note(s): ROAs – Return on Assets; ROE – Return on Equity; NIM – Net Interest Margin; LDR – Liquidity Risk; CDR – Credit Risk; CAR – Capital Adequacy Requirement; BODSIZE – Board Size; BIND – Board Independence; BGD – Board Gender Diversity; GDP – Gross Domestic Product Growth

Table 1. Descriptive statistics of the study variables

relating to macroeconomic indicators as control variables, it can be observed that the indicators were evenly distributed during the study period. The mean values are, respectively, 2.7%, 9.6% and 5.8% for the prime rate, inflation and GPD. The standard deviations also lie below their mean values, indicating that there is not too much dispersion in the dataset.

4.2 Correlation matrix

The presence of multicollinearity is tested using Pearson correlation matrix. The results of the Pearson correlation matrix are shown in Appendix 3. The presence of multicollinearity among explanatory variables renders the estimated results somehow unreliable.

According to Kennedy (1985) and Gujarati (2004), the acceptable coefficient of a correlation between two "explanatory variables" is 0.8. However, if two variables exhibit a coefficient greater than 0.8, one of the variables must be released or the two should not enter the study model developed at the same time. From the coefficients, all the figures are below the acceptable level of 0.8 as emphasized by Kennedy (1985) and Gujarati (2004). Therefore, there are no issues with multicollinearity of the variables used for the study.

From the table, CAR significantly correlates at 1% with only ZSCORE. The correlation coefficient is −0.335 and *p*-value less than 0.001 implies that the coefficient of CAR in the regression will be significant and negative. However, having a significant positive or negative effect cannot be predicted for other dependent variable. DI significantly correlates with Z-score at 1% level of significance. The respective coefficients are −0.089 and +0.186. The relation with other dependent variables cannot be predicted. The correlation coefficient is −0.185, it indicates that the regression coefficient will be negative and significant. For others, the signage and the direction cannot be predetermined. Board size did not show any significance with any of the dependent variables. Besides, its relationship with one of them cannot be told.

Considering the control variables, only prime rate correlates significantly and negatively at 1% level of significance with Z-score. It means that prime rate entering the regression model will have significant inverse relationship with Z-score. The direction and significance of the rest of the control variables and the dependent variables cannot be forecasted with precision.

4.3 Regression results

Table 2 presents the empirical results for CARs and risk-taking. It further shows the moderating effect of board characteristics on the relationship between capital adequacy regulation and risk-taking. It also shows that the specifications used to test AR (2) for serial correlation of models are valid with *p*-values for AR (2) all greater than 0.10. It thus implies that the empirical models have been correctly specified. Furthermore, Hansen J-test tests for the instruments for the models are valid with *p*-values greater than 0.10, which indicates that over-identifying restrictions are valid. However, the model specifications are correct.

4.3.1 Capital adequacy regulation and risk-taking. The paper seeks to examine the relationship between capital adequacy regulation and risk-taking. It can be observed from Models 1a, 2a and 3a in Table 2 that capital adequacy regulation is positively related to ZSCORE and LDR but inversely related to CDR. ZSCORE, LDR and CDR with coefficients of +0.128, +0.190 and −0.401, respectively. However, an increase in capital adequacy regulation by a unit means the overall banking and liquidity risks will rise separately by 0.128 and 0.190 units, whereas credit risk declines by 0.401 units. This result partly supports Hypothesis 1, which suggests that capital adequacy regulations positively affect bank risk-taking behavior. It can also be inferred that the relationship between capital adequacy regulation and risk-taking is sensitive to the nature and type of risk. This is evident from the

Table 2. Capital adequacy regulation and risk-taking and moderation effect of board characteristics

Variables	Model 1a	Model 1b	Model 1c	Model 1d	Model 2a	Model 2b	Model 2c	Model 2d	Model 3a	Model 3b	Model 3c	Model 3d
	ZSCORE				LDR				CDR			
LAG	0.610***	0.627***	0.943***	0.949***	−0.054***	−0.033***	−0.031***	−0.048***	−0.192***	−0.618***	−0.209***	0.102***
	(44.19)	(35.74)	(38.92)	(38.65)	(−24.30)	(−4.73)	(−7.33)	(−7.16)	(−46.65)	(−48.04)	(−17.50)	(20.10)
CAR	0.128***	−0.230***	0.186***	0.279***	0.190***	0.361***	−0.196***	0.842***	−0.401***	−1.402***	−0.499***	−0.020***
	(19.48)	(21.68)	(11.05)	(11.27)	(8.88)	(−4.30)	(−3.03)	(8.82)	(−42.15)	(−85.78)	(−3*.08)	(−9.32)
BODSIZE		−0.004**				−0.031***				−0.007***		
		(−2.45)				(−4.97)				(−4.14)		
BIND			−0.007***				0.014***				0.015***	
			(−2.71)				(2.91)				(4.81)	
BGD				−1.032***				0.587***				0.009*
				(−8.26)				(7.44)				(1.81)
CAR*BODSIZE		0.029***				−0.096***				−0.110***		
		(9.70)				(−4.87)				(−11.18)		
CAR*BIND			0.037***				−0.261***				−0.040***	
			(4.21)				(−9.26)				(−5.69)	
CAR*BGD				−0.805***				−0.996**				−2.241***
				(−4.07)				(−2.05)				(−13.40)
BSIZE	0.086***	0.070***	0.143***	0.114***	−0.029***	−0.050	−0.009	−0.251***	−0.082***	−0.110***	−0.220***	−0.008***
	(8.15)	(4.57)	(7.47)	(5.05)	(−2.88)	(−1.32)	(−0.32)	(−5.95)	(−17.91)	(−8.31)	(−9.25)	(−5.57)
PRIME RATE	−0.996***	−1.665***	−2.141***	−2.163***	−1.720***	−4.679***	−0.351**	−6.087***	0.453***	1.778***	0.958***	0.338***
	(−13.35)	(−12.83)	(−9.67)	(−10.23)	(−12.28)	(−8.94)	(−1.97)	(−14.39)	(16.20)	(16.17)	(14.71)	(14.13)
INFLATION	0.638***	0.513***	0.434*	0.939***	0.915***	2.945***	−0.403	1.443***	1.128***	2.851***	0.143***	−0.338***
	(5.18)	(4.05)	(2.07)	(3.40)	(6.31)	(8.74)	(−1.14)	(5.61)	(15.60)	(12.75)	(4.68)	(−13.75)
GDP	1.262***	0.947***	3.949***	2.746***	−0.599*	−6.350***	−0.068	−9.286***	−0.760***	−0.021	−1.333***	−0.519***
	(7.93)	(6.61)	(10.98)	(5.77)	(−1.96)	(−9.01)	(−0.16)	(−13.91)	(−13.52)	(−0.15)	(−9.68)	(−20.46)
CONS	−0.250***	0	0.000	0	0.991***	0	0.713*	4.038***	0.874***	0.000	0	0.130***
	(−2.52)	(0)	(0.000)	(0)	(9.97)	(0)	(2.68)	(9.75)	(17.30)	(0.00)	(0)	(8.28)
N	448	448	448	432	458	453	437	437	452	452	452	431
F-statistics	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instruments	60	60	60	60	60	60	60	60	60	60	60	59
Groups	65	65	65	65	65	65	65	65	65	65	65	65
AR(2)	1.41	1.38	1.12	1.53	−0.92	0.63	−0.49	0.25	−1.11	−1.38	−1.19	−1.52
PV AR(2)	0.160	0.169	0.228	0.126	0.357	0.531	0.623	0.799	0.266	0.169	0.233	0.128
Han test	53.63	42.29	40.24	37.40	43.20	45.55	45.08	44.01	47.35	45.53	44.29	46.56
PV Hans	0.108	0.372	0.460	0.588	0.420	0.252	0.268	0.306	0.263	0.253	0.295	0.189

Note(s): ZSCORE – Boyd and Graham banks' insolvency measure; LDR – Loan-to-Deposit Ratio; CDR – Credit Risk; LAG – Lag Variable; CAR – Capital Adequacy Regulation; BODSIZE – Board Size; BIND – Board Independence; BGD – Board Gender Diversity; CAR*BODSIZE – Interaction of Capital Adequacy Regulation and Board Size; CAR*BIND – Interaction of Capital Adequacy Regulation and Board Independence; CAR*BGD – Interaction of Capital Adequacy Regulation and Board Gender Diversity; BSIZE – Bank Size (log assets). I centered the interaction terms CAR and governance variables by subtracting the mean from each observation because of high possibility of collinearity of the interaction terms, and *t* statistics are, respectively, reported in parenthesis; ***, ** and * indicate statistical significance, respectively, at the levels 1, 5 and 10%. Models 1, 2 and 3 consider the proxies for measuring bank risk-taking namely Z-score, liquidity risk and credit risk, respectively. Models 1a to 3a capture the relationship between CAR and the three proxies for measuring bank risk-taking. Models 1b, 2b, 3b, 1c, 2c, 3c,1d, 2d and 3 d consider the interaction term of the BODSIZE – Board Size; BIND – Board Independence and BGD – Board Gender Diversity on bank risk-taking results that suggest different relationships for liquidity risk and credit risk. The findings do not support the capital hypothesis that suggests that adequate capital regulation policy reduces banking risk (Petitjean, 2013; Pakhchanyan, 2016; Basel I, 1998; Basel II, 2011; Basel III, 2015; Rachdi and Bouheni, 2016). Empirically, the findings lend support to Van Roy (2005), Faizul (2018) and Seid and Tumin (2013). On the contrary, the results contradict Barth *et al.* (2004), Laeven and Levine (2009), Alam (2012), Bouheni *et al.* (2014) and Bouheni and Rachdi (2014), which suggest a negative relationship between capital adequacy regulation and risk-taking.

The control variables bank size (log of assets), prime interest rate, inflation and gross domestic product entering model 5, along with capital adequacy regulation, all have a significant impact on the risk assumed by universal banks. Specifically, with an increase in banks' assets, liquidity and credit risks will fall, but the overall risk of the bank will increase; a rise in prime interest rate will cause total banking as well as liquidity risk to fall, while credit risk upsurges. An increase in the inflation rate leads to an insurgency in liquidity, credit and overall banking risks. Lastly, growth in gross domestic product of the economy ensures declines in liquidity and credit risks but total risk of the banks upsurges.

4.3.2 Capital adequacy regulation and risk-taking: the moderating role of board characteristics. In this section, we investigate whether the relationship between capital adequacy regulation and bank risk-taking behavior is dependent on onboard characteristics. To test this hypothesis, we constructed an interaction term between capital adequacy regulation and different board characteristics that have been widely accepted as key determinants of an effective board. The results of the moderating effect of board characteristics and risk-taking behavior are reported in Models 1b, 2b, 3 b, 1c, 2c, 3c,1d, 2d and 3d of Table 2. Table 2 shows ***the effect of the interaction of board characteristics and capital adequacy regulation on risk-taking***. From the result of Model 2, the interactive term of capital adequacy regulations and board size relates inversely with LDR and CDR but positively with ZSCORE at a 1% level of statistical significance. The coefficients for ZSCORE, LDR and CDR are +0.029, −0.090 and −0.110, respectively. Comparing this result with results in models 1b, 2b and 3b, it is observed that board size interacts with capital adequacy regulation; reduction in Z-score of 12.8% comes down to only 2.9% reduction; liquidity risk, which is a positive association with a coefficient of +0.19, changes to an inverse relationship with a coefficient of -0.096; whereas credit risk exhibits the same negative relationship but the coefficient of -0.401 goes down to -0.110. The above results suggest that the relationship between capital adequacy regulation and various measures of bank risk-taking behavior is dependent on the board size. This implies that the size of the board will influence the extent to which capital adequacy regulations affect bank risk-taking behavior.

The CAR policy is aimed at reducing banking risk. And as emphasized by Seid and Tumin (2013), the primary objective of capital regulation in the banking sector is to prevent managers and owners from taking excessive risks. Capital adequacy theory also suggests that banks should have enough funds to cater to any unforeseen circumstances that may arise in the course of bank operations (Zhongming *et al.*, 2019). The findings considering liquidity and credit risks support the capital hypothesis and the public interest view (Alam, 2012; Barth *et al.*, 2005). Empirically, this finding on the score of liquidity and credit risks agrees with De Vita and Luo (2018), Kusi *et al.* (2018), Rachdi and Ben Ameur (2011) and Meijer (2017). However, the finding disagrees with Loh and Sok-Gee (2017).

Models 1c, 2c and 3c show the results of the moderating effect of BIND on the relationship between capital adequacy and risk-taking. According to the regression results, CAR*BIND has an indirect relationship with LDR and CDR but a direct relationship with ZSCORE at the 1% level of statistical significance. The coefficients of the model for the dependent variables ZSCORE, LDR and CDR are, respectively, +***0.037, −0.261 and −0.040***. Matching this result with the results of model 5, it is perceived that BIND interacts with capital adequacy regulation; ZSCORE continues to exhibit a positive relationship but the coefficient reduced from +0.128 to +0.037; the liquidity risk relationship changes from a positive coefficient of +0.190 to an inverse relationship with a coefficient of −0.261; lastly, credit risk shows the same line of direction but the coefficient of −0.401 reduces sturdily to −0.04. With the above results, evidence is obtained to suggest that BIND moderates the relationship between capital adequacy regulation and bank risk-taking behavior. This is not surprising because, according to Agyemang and Assabil (2021), BIND is a key determinant of an effective board. Therefore, if the board of a bank is effective, ensuring compliance with capital adequacy regulations will impact on bank risk-taking.

The results of the investigation into the moderating effect of BGD on the relationship between capital adequacy regulation and bank risk-taking are shown in Models 1d, 2d and 3d of Table 2. From the regression results, CAR*BGD relates inversely with all the risk measurement variables at a 1% level of statistical significance with ZSCORE and CDR but 5% with LDR. The resulting coefficients for ZSCORE, LDR and CDR are −0.805, −0.996 and −2.241, respectively. Comparing these results and the results in models 1c, 2c and 3c, Z-score with a positive coefficient of +0.128 changes to an inversely associated coefficient of -0.805; liquidity risk also changes from a positive relationship with a coefficient of +0.190 to an inverse association with a coefficient of −0.996; credit risk continues to exhibit an inverse relationship but coefficients improve from-0.401 to −2.24. The above results show that the relationship between capital adequacy regulation and bank risk-taking is dependent on the gender diversity of the board. As emphasized by Zhu *et al.* (2018), women by their nature are risk-averse, and serving on banking boards will influence risk decisions positively. And the results, as demonstrated, vehemently support the assertion by Zhu *et al.* (2018). Empirically, the result is consistent with Meijer (2017) and Palavia *et al.* (2015).

4.4 Conclusions and policy implications

The board's characteristics on the relationship between bank capital regulation and risk-taking are not sufficiently addressed in emerging economies especially SSA. Despite the theoretical preposition of the role of board characteristics in ensuring policy implementation and mitigating banks' risk level, prior studies appear to ignore the effectiveness of the internal governance structure which implements the regulatory and supervisory policies enacted by governments and regulators. The focus of some of these studies has been on the relationship between capital adequacy regulation policy and performance and risk. In this paper, we argue that irrespective of the effectiveness of capital adequacy regulation, if the board characteristics are not appropriately configured to be effective to ensure compliance, the purpose of the policy will not be achieved. Using 700 firm-year observations in SSA and adopting a two-step system GMM as the baseline estimator, the paper finds that capital adequacy regulation is positively related to overall risk and liquidity but inversely related to credit risk. Capital adequacy regulation reduces overall risk and liquidity risk. Nonetheless, the capital adequacy regulation policy increases credit risk in the sample banks. The paper further reports that board characteristics individually and significantly moderate the relationship between capital adequacy regulation and risk-taking. Specifically, board size, independence and gender diversity strongly moderate the relationship between capital adequacy regulation and risk-taking of sampled banks. Considering the effect of capital adequacy regulation on risk-taking, Bouri and Ben (2006), Faizul (2018) and Lavine (2009) reported positive associations while Rachdi and Bouheni (2016) and Bouheni (2014) established an inverse relationship.

The above findings have a number of policy and regulatory implications. Enforcement of capital adequacy regulation by central banks and regulators leads to a reduction in credit risk but causes increases in overall banking risk. It is implied that the capital hypothesis and the public interest view on regulation are not supported in the subregion. However, governments, central banks and regulators are encouraged to focus on other banking regulations and supervision policies while continuing to insist on the maintenance of regulatory minimum capital by the managers and owners of the banks at all times. The major risks that affect banks are mainly credit risk and liquidity risk. When there is an abundance of cash, liquidity crises are rare; however, the banks' solvency is weakened. Again, managers of the banks will also be in a better position to pursue bad loans to address credit risk. The findings suggest that board characteristics moderate banks' capital adequacy policy and risk-taking in SSA, while also supporting resource dependency, agency and shareholder theoretical perspectives. Notwithstanding, regulators and owners must insist on the right board size, more independent directors and gender diversity on the banking boards to adequately manage and assume proportionate risk to ensure the survival of the banks in SSA. These findings support recent board reforms in the subregion, especially by the central banks of Nigeria and Ghana that seek to promote gender diversity and BIND.

Despite the significant contribution of the paper to theory and practice, there are some limitations that could be addressed in future research. First, only three board characteristics, namely board size, independence and diversity, were considered, although other board attributes such as board structures could moderate the relationship between capital adequacy regulation and bank risk-taking behavior. The inclusion of the effectiveness of board committees could produce interesting contributions. The paper also uses only data from universal banks in Ghana, Nigeria and Kenya because of data availability. As and when data from other universal banks in other countries in SSA becomes available, many more countries could be included.

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Appendix 1

Name of the bank	ID	Country
Access Bank	1	Ghana
Agricultural Development Bank	2	Ghana
Bank of Africa	3	Ghana
Barclays Bank	4	Ghana
Sahel Sahara Bank	5	Ghana
CalBank	6	Ghana
Ecobank	7	Ghana
First Atlantic Bank	8	Ghana
Fidelity Bank	9	Ghana
FBN Bank	10	Ghana
First National Bank	11	Ghana
GCB Bank	12	Ghana
Guaranty Trust Bank	13	Ghana
HFC (Republic) Bank	14	Ghana
Universal Merchant Bank	15	Ghana
National Investment Bank	16	Ghana
Prudential Bank	17	Ghana
Standard Chartered Bank	18	Ghana
Societe Generale Bank	19	Ghana
Stanbic Bank	20	Ghana
United Bank for Africa	21	Ghana
Zenith Bank	22	Ghana
Access Bank	23	Nigeria
Citi Bank	24	Nigeria
Diamond Bank	25	Nigeria
Ecobank	26	Nigeria
Fidelity Bank	27	Nigeria
First Bank	28	Nigeria
First City Bank	29	Nigeria
Guaranty Trust Bank	30	Nigeria
Skype/Polaris Bank	31	Nigeria
Stanbic IBTC Bank	32	Nigeria
Sterling Bank	33	Nigeria
United Bank for Africa	34	Nigeria
Union Bank of Nigeria	35	Nigeria
Unity Bank Plc	36	Nigeria
Wema Bank	37	Nigeria
Zenith Bank	38	Nigeria
KCB Bank Kenya Ltd	39	Kenya
Equity Bank Kenya Ltd	40	Kenya
The Co-operative Bank	41	Kenya
Barclays Bank of Kenya	42	Kenya
Standard Chartered Bank Kenya Ltd	43	Kenya
Diamond Trust Bank	44	Kenya
Stanbic Bank Kenya Ltd	45	Kenya
Commercial Bank of Africa	46	Kenya
I&M Bank Ltd	47	Kenya
NIC Bank Plc	48	Kenya
Bank of Baroda	49	Kenya
Prime Bank Ltd	50	Kenya
National Bank of Kenya Ltd	51	Kenya
Citibank N.A. Kenya	52	Kenya

(*continued*)

Table A1. Universal banks used for the study

Name of the bank	ID	Country
Bank of India	53	Kenya
Family Bank Ltd	54	Kenya
Ecobank Kenya Ltd	55	Kenya
Bank of Africa (K) Ltd	56	Kenya
Victoria Commercial Bank	57	Kenya
Gulf African Bank Ltd	58	Kenya
Guaranty Trust Bank Ltd	59	Kenya
African Banking Corporation Ltd	60	Kenya
Sidian Bank Ltd	61	Kenya
Credit Bank Ltd	62	Kenya
Guardian Bank Limited	63	Kenya
First Community Bank Ltd	64	Kenya
UBA Kenya Bank Ltd	65	Kenya
M-Oriental Commercial Bank Ltd	66	Kenya
Transnational Bank Limited	67	Kenya
Consolidated Bank Limited	68	Kenya
Paramount Bank Ltd	69	Kenya
Spire Bank Limited	70	Kenya

Table A1.

Appendix 2

Research variables		Expected signs			
Dependent variables	Proxies	ROA/ ROE/ NIM	Liquidity/credit	Measurement	Data Source
Risk	ZSCORE Liquidity risk Credit risk			$\log \text{ZSCORE} = log\left(ROA + \frac{\text{EAR}}{\delta ROA}\right)$ LQR = ***gross loans/deposit*** CDR = ***loan loss provision/gross loans***	Bank Scope/Audited Annual Report 2009–2019
Independent variables					
Regulation	Capital Adequacy Requirement (CAR) or Stringency	+	−	CAR = TIER 1/RWA	Bank Scope/ Audited Annual Report 2009–2019
Bank-specific variables	Banks Size (Log of total assets)	+	+	Log of banks' total assets	
Corporate governance characteristics	Board Size (BSIZE), Board independence (BIND) and Board Gender Diversity (BGD)	+	−	BSIZE = number of individuals on board at the end of the financial year; BIND = proportion of nonexecutive directors on board; BGD = proportion of females on board	
Macroeconomic variables – countrywide data	Inflation, GDP, prime interest rate	+/−	+/−		Central Banks, World Bank, IMF, IFSM and WDI

Source(s): Researcher's field survey

Table A2. Measurement of variables, expected signs and data source

Appendix 3

Table A3. Person correlation matrix of the study variables

Variables	ROA	ROE	NIM	ZSCORE	LDR	CDR	CAR	BODSIZE	BIND	BGD	CAR*BODS	CAR*BIND	CAR*BGD	Assets	ITRA	Inflation	GDP
ROA	1.000																
ROE	0.774	1.000															
NIM	0.058	0.022	1.000														
ZSCORE	0.360	0.264	0.008	1.000													
LDR	−0.129	−0.119	−0.011	0.036	1.000												
CDR	−0.241	−0.177	−0.002	−0.159	−0.036	1.000											
CAR	−0.175	−0.044	−0.012	0.105	0.062	−0.010	1.000										
BODSIZE	−0.012	−0.020	−0.020	0.080	−0.026	0.053	−0.212	1.000									
BIND	−0.003	−0.050	−0.085	0.110	0.015	−0.001	−0.189	0.733	1.000								
BGD	0.072	0.138	−0.022	−0.008	0.010	0.021	−0.256	0.185	0.043	1.000							
CAR*BODS	0.296	0.151	0.017	0.003	−0.139	−0.037	−0.779	0.167	0.205	0.176	1.000						
CAR*BIND	0.267	0.124	0.029	0.077	−0.116	−0.065	−0.629	0.173	0.303	0.088	0.906	1.000					
CAR*BGD	0.099	0.069	−0.023	0.0249	0.022	−0.242	0.172	−0.271	−0.150	0.132	0.104	0.141	1.000				
ASSETS	0.305	0.272	−0.032	0.285	−0.003	−0.077	−0.321	0.634	0.501	0.372	0.343	0.332	−0.028	1.000			
PRIME RATE	0.061	0.082	0.016	−0.212	−0.153	0.226	0.160	−0.175	−0.180	−0.007	−0.069	−0.130	−0.332	−0.182	1.000		
INFLATION	0.035	0.070	0.038	−0.167	0.003	0.245	0.058	0.175	0.023	0.007	−0.016	−0.080	−0.376	0.021	0.402	1.000	
GDP	0.029	0.043	0.038	−0.034	−0.137	−0.084	0.023	−0.206	−0.099	−0.126	0.090	0.119	0.085	−0.238	−0.198	−0.380	1.000

Note(s): ROA – Return on Assets; ROE – Return on Equity; NIM – Net Interest Margin; LDR – Liquidity Risk; CDR – Credit Risk; CAR – Capital Adequacy Regulation; BODSIZE – Board Size; BIND – Board Independence; BGD – Board Gender Diversity; CAR*BODS – Interaction of Capital Adequacy Regulation and Board Size; CAR*BIND – Interaction of Capital Adequacy Regulation and Board Independence; CAR*BGD – Interaction of Capital Adequacy Regulation and Board Gender Diversity; GDP – Gross Domestic Product Growth; ITRA – Interest rate