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## Article

# Regulatory capital requirements and bank performance in Ghana: Evidence from panel corrected standard error

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## GENERAL & APPLIED ECONOMICS | GENERAL & APPLIED ECONOMICS

# Regulatory capital requirements and bank performance in Ghana: evidence from panel corrected standard error

Joshua Nsanyan Sandow<sup>1</sup>, Emmanuel Duodu<sup>1\*</sup> and Eric Fosu Oteng-Abayie<sup>1</sup>

**Abstract:** Over the past fifteen years, the Bank of Ghana has revised the minimum capital requirement to stabilize the banking sector. Motivated by the unintended consequences of regulatory capital, this paper provides empirical evidence between minimum capital requirement and bank performance relationship in Ghana. We draw data on a sample of 20 universal banks spanning 2008 to 2017. The Panel Corrected Standard Errors (PCSE) estimation was adopted. The results indicate that the minimum capital requirement has a significant positive impact on bank performance measured by return on assets (ROA) and equity (ROE). However, the effects turned negative after 1.7% and 1.6% performance thresholds for ROA and ROE, respectively. Given this, the study establishes the relationship between capital requirement and bank performance in Ghana to be double-edged. The capital requirement improves bank performance initially, but bank performance worsens after the threshold values. Policy implications for Ghana's banks, regulators, and policymakers have been provided based on the findings.

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## PUBLIC INTEREST STATEMENT

Continuous upward adjustment of minimum capital requirement is notably known as the easiest way to ensure an effective and stabilized banking sector. However, consistent upward adjustments of the regulatory capital could lead banks to an undue liquidity crisis through the high cost of funding and, as a result, affects banks' performance. For the past fifteen years, the Bank of Ghana has reviewed upward the minimum capital requirement of banks to stabilize the banking sector. The review, among other things, has resulted in the folding and takeover of about nine banks. Given this, the critical issue of concern is how minimum capital requirements affect banks' performance. This study empirically shows that minimum capital requirement enhances bank performance (return on assets (ROA) and return on equity (ROE)). However, the effects turned negative after 1.7% and 1.6% performance thresholds for ROA and ROE, respectively. We conclude that capital requirement and bank performance in Ghana have a double-edged relationship.

**Subjects: Economics; Finance; Business, Management and Accounting**

**Keywords: Minimum capital requirements; Bank performance; PCSE; Ghana**

**JEL classification: C23; F38; G21; O55**

## 1. Introduction

Theoretically, capital plays a vital role in promoting banks' performance. Depositors and the general public are more concerned about the sufficiency of banks' capital for the safety of their deposits. Bank capital, amongst other functions, is supposed to help cushion banks against unexpected losses, support the business expansion drive, and help maintain confidence in the banking sector. Mehran and Thakor (2011) argued that higher capital leads to higher survival and profitability for banks in a dynamic environment. Again, banks with a sound capital position can effectively afford business opportunities and have more flexibility in dealing with problems arising from unexpected losses, hence, achieving increased profitability (see Karim et al., 2014; Mayordomo et al., 2019). The implication is that adequate capital of banks ensures the effective intermediation role of channelling funds from surplus spending units to deficit units (see Adu, 2019; Okafor et al., 2010). As documented, Okafor et al. (2010) explained that banks as financial intermediaries obtain their capital from three sources: owner's funds, reserves, and share capital. Thus, the ability of banks to accumulate profit depends on the efficient management of assets and liabilities to meet the solvency and minimum capital requirement set by banking regulators such as Central Banks.

The Bank of Ghana (BoG) exercises regulatory authority on the activities of banks operating in the country (Bank of Ghana Act 2002 (Act 612) and Act 918). In particular, minimum capital adequacy is considered the most strictly regulated aspect of the banking sector in the economy. According to the Bank of Ghana (2018), a bank must hold a minimum capital of GH¢400 million to establish sufficient funds to buffer against unexpected losses. The minimum capital adequacy requirement is crucial in preventing banks from failing. It ensures that banks maintain adequate reserves to protect themselves and depositors in the event of a financial crisis (see Abou-El-Sood, 2016; Karim et al., 2014). Capital adequacy (minimum capital) is a critical measure of the banking sector's solvency position, ability to absorb potential losses from credit and operational risks, and an overall indicator of stability in the banking sector.

To ensure that the banking sector always remains liquid, solvent, and resilient to unexpected losses, the BoG has been issuing directives to banks and specialized deposit-taking institutions operating in Ghana to recapitalize their minimum capital over the past one and a half decades. These directives are to ensure stabilization within the banking sector in Ghana. As part of reforms to liberalize the industry and make it efficient, the BoG in 2003 announced the issuance of universal banking business licenses (UBBL) to all banks that attain a new minimum capital requirement of GH¢7 million. The UBBL effectively abolished compartmentalized banking<sup>1</sup> in Ghana. The new capital requirement was supposed to cushion banks against losses and enhance their capacity to undertake "big ticket" transactions to help grow a more robust economy. In 2008, BoG increased the minimum capital requirement to GH¢60 million and insisted that commercial banks meet this amount to continue holding a class 1 banking license. The amount was further increased to GH¢120 million in 2013, in line with the enhanced Basel II requirements (often referred to as Basel 2.5). After these three recapitalisation directives within 15 years, the sector struggled to remain liquid, resilient, and competitive (see Abakah, 2020; Affum, 2020; BoG, 2017b; Yalley et al., 2018). Therefore, the BoG in August 2017 further increased the minimum capital requirement to GH¢400 million.<sup>2</sup> The BoG revoked the licenses of universal banks that could not meet the new capital requirement stating various reasons. Affected banks included UT Bank, Capital Bank, Beige Bank, Sovereign Bank, Construction Bank, UniBank, Heritage Bank, Premium Bank, and the Royal Bank. Arguably, the banks that met the new capital requirements have the

opportunity to compete for the increased unbanked population to enhance their performance (Yalley et al., 2018).

The regulatory stance of the BoG to resort to upward adjustments of the capital requirement exposes banks to an undue short-run liquidity crisis through increased costs of funding (Le et al., 2020). One key concern is whether the BoG should continue to rely on the upward review of the minimum capital requirement as part of its objective to strengthen the banking sector's resilience. This study provides more robust evidence on the effect of minimum capital requirements on bank performance in Ghana to address this concern.

A couple of studies, primarily unpublished, have been identified in Ghana and other countries that focused on the minimum capital requirement and bank performance (see, Abakah, 2020; Abbas et al., 2019; Adu, 2019; Ametei, 2014; Apawudza, 2019; Kukurah et al., 2014; Saleh & Abu Afifa, 2020; Yalley et al., 2018). From these studies, we identified several limitations. First, the definition of capital adequacy is inconsistent across all studies. A number of the studies defined the concept using equity capital or Tier-1 capital as a measure of regulatory capital (Abbas et al., 2019; Ametei, 2014; Apawudza, 2019; Kukurah et al., 2014; Saleh & Abu Afifa, 2020). However, this definition is narrow as bank regulatory capital comprises a feast of capital ingredients to satisfy regulatory capital requirements. In other words, aside from Tier-1 capital, Tier-2 capital (e.g., asset revaluation reserves, hybrid capital, loan-loss reserves, and subordinated debt) is equally adjusted for asset risk using risk-weighted assets in determining regulatory capital (see Conlon et al., 2020). We are only aware of two unpublished studies (Abakah, 2020; Adu, 2019) in Ghana that considered the ratio of Tier-1 and Tier-2 capital to risk-weighted assets as a measure of regulatory capital.

Second, the existing studies (especially Ghana) also suffer from methodological weaknesses and call for more robust investigations. For instance, Adu (2019) used the Pearson correlation to study the relationship between capital requirements and bank performance. This approach is inefficient and fails to account for changes in capital requirements on bank performance. Correlation analysis accounts for only the pairwise strength of association or the co-movement between two variables but does not account for cause and effect. Abakah (2020), for example, employed fixed effects and random effects estimation methods but did not control for cross-sectional dependencies among the cross-sectional units (banks) in the panel data. According to Pesaran (2007) and De Hoyos and Sarafidis (2006), failure to control cross-sectional dependencies in panel data could lead to biased and inefficient estimates. Moreover, Doku et al. (2019) also employed ordinary least squares (OLS) to estimate the effect of minimum regulatory capital on bank performance. However, they failed to address autocorrelation, cross-sectional dependence, and heteroscedasticity issues that characterised panel data and rendered their results unreliable.

This study addresses two gaps from the weaknesses elucidated above. First, we address the methodological flaws and contribute to the literature by employing a Panel Corrected Standard Errors (PCSE) approach. The PCSE simultaneously corrects autocorrelation, cross-sectional dependence, and heteroscedasticity to improve parameter efficiency (Beck & Katz, 1995). Second, we defined minimum capital requirement by measuring the capital adequacy ratio as Tier-1 capital plus Tier-2 capital divided by risk-weighted assets (Conlon et al., 2020). Compared to employing only Tier-1 capital as a measure of regulatory capital, this measure will help assess the depth of how minimum capital requirement influences bank performance in Ghana.

Empirical evidence on the relationship between minimum capital requirement and bank performance has been inconsistent and remains unresolved to a more considerable extent. On the one hand, higher capital enables a bank to compete effectively for deposits and loans, implying a positive relationship between capital adequacy requirements and bank performance (A. N. Berger & Bouwman, 2013;

Ernovianti et al., 2016; Karim et al., 2014). On the other hand, the minimum capital requirement can expose banks to an undue liquidity crisis through increased cost of funding, hence, lower performance (Abou-El-Sood, 2016; Le et al., 2020; Mayordomo et al., 2019). We seek to reconcile the two positions on the relationship between minimum capital requirement and bank performance by augmenting our baseline linear model specifications with a quadratic term to check for nonlinear effects. Does minimum capital requirement increase bank profitability up to a specific requirement level and, after that, decrease bank profitability? Siamat et al. (2005) note that an upward increase in banks' capital would result in an initial rise in banks profitability. However, as trade-off levels rise, increased banks' capital decreases banks' return. Abou-El-Sood (2016) further noticed that the relationship between capital adequacy ratio and bank failure in the US becomes significant only when a bank has a capital adequacy ratio of less than 6 percent. These indicate that the relationship between capital adequacy and bank performance could be nonlinear and, for that matter, the augmentation of our linear model specification.

## 2. Literature review

The section provides the theoretical basis for the capital and bank performance relationship and concludes by delving into some empirical literature in Ghana and beyond.

### 2.1. Theoretical review

The theory of optimal capital structure gained prominence when Modigliani and Miller (1958) published the capital structure irrelevant theory, where they assumed a perfect market situation without corporate taxes. They posited that if firms operate in the same industry with similar operational risks, they (firms) will have the same total value irrespective of differences in their capital structure. However, the weakness of the perfect market assumption is that, in reality, there are frictions in every market. Therefore, Modigliani and Miller in 1963 relaxed the no-tax proposition and stated that interest on debt is a tax-deductible expense and that firms with more debt are likely to pay fewer taxes, which turn to increase firms' value. This means that market imperfections such as transaction and bankruptcy costs are duly considered under the relaxation of no tax assumption, thus making the capital structure relevant in firm value maximization. Modigliani & Miller, 1963 noticed that the optimal capital structure of a firm occurs at a point where the weighted average cost of capital (WACC) is at its lowest while the firm's value is at its highest and beyond which, the WACC starts to rise.

Berger and Ofek (1995) explored the standard one-period theory of perfect capital markets by Modigliani and Miller (1958). They found strong evidence of a negative relationship between capital and bank performance in the presence of symmetric information between a bank and its investors. This is because a higher capital ratio reduces the risk on equity and therefore lowers the equilibrium expected return on equity required by investors. Furthermore, Saona Hoffmann (2011) argued that the perfect market assumption by Modigliani and Miller (1958) results in a negative relationship between bank profitability and capital ratio, especially if investors are risk-averse and cannot wholly diversify bank risks since increasing equity in the capital structure reduces risk and lowers the market required rate of return for both debt and equity. In their study, Dietrich and Wanzenried (2011) also supported the negative relationship between capital ratio and bank profitability under the risk-return hypothesis.

Another vital theory to explain the capital adequacy requirements and bank performance is the buffer theory. Banks will strive to have excess capital to avoid regulatory costs associated with non-compliance to minimum capital requirements (see Adu, 2019). As proponents of buffer theory (Caleb & Rob, 1996) indicated, adequately capitalized, banks can engage in risky ventures that have higher profit returns, implying a positive relationship between higher capital adequacy requirements and profitability.



## 2.2. Empirical review

Primarily, policymakers use the minimum capital requirement (recapitalization) as a tool to clean up the banking sector to achieve efficiency, liquidity, and profitability. Therefore, various studies have been conducted, especially within the last one and a half-decade, to assess the impact of recapitalization on bank performance. Despite that, this subsection reviews past studies related to the subject both in Ghana and beyond.

Sani and Alani (2013) did a comparative analysis of the pre-and post-recapitalization financial performance of banks in Nigeria for the period 2002–2008. The study employed Wilcoxon signed-rank test and found no significant effect of recapitalization on pretax profit margin, return on total assets, earning per share, and dividends per share but a significant effect on net interest income and return on equity. However, the Wilcoxon signed-rank test is ordinal, and therefore, a t-test would have been a better technique to adopt. Consequently, Adegba and Olokoyo (2008) used a t-test and test of equality and found strong evidence of statistical differences between pre-and post-recapitalization bank performance in Nigeria. In other words, recapitalization has a significant impact on bank performance. However, Ibrahim et al. (2012) employed an independent t-test as the analytical tool and found an insignificant (a significant) decrease in ROA (ROE) after bank recapitalization.

Similarly, Ernovianti et al. (2016) undertook a study on recapitalization and performance of banks in Malaysia using Panel Least Square and Random effect model. Results indicate that recapitalization is critical for the survival of Malaysia's banking sector. However, Kukurah et al. (2014) used ratios to conduct a comparative analysis of the performance of Ghana Commercial Bank and Ecobank (Ghana) Limited vis-à-vis the first phase of the 2009 recapitalization deadline and found that recapitalization does not necessarily improve bank performance. However, their study lacks depth and scope because the ratio analysis adopted was too superficial, and mainly, using only two banks for the study is unrepresentative of the Ghanaian banking industry. Therefore, the conclusion could have been erroneous. Oleka and Mgbodile (2014) also employed ratio analysis to analyze the annual reports of 17 out of 25 banks in Nigeria and argued that bank performance improved post-recapitalization significantly. This is inconsistent with the findings of Kukurah et al. (2014) but consistent with Ernovianti et al. (2016). Consequently, Tomec and Jagrič (2017) introduced timing in assessing the impact of recapitalization on bank profitability in European Union (EU) countries and the United States (US) of America. They argued that the immediate effect of recapitalization on bank profitability is negative but becomes positive when banks are out of a crisis.

Gadagbui & Amoah (2016) investigated the relationship between bank equity capital and profitability using a purposive sampling technique to sample 14 banks out of the 28 universal banks in Ghana between 2005 and 2015. Results revealed a significant positive relationship between bank equity capital and profitability as determined by net interest margin and return on equity. This is, however, inconsistent with the findings of Madugu et al. (2020) that argue that the capital adequacy ratio negatively influences Ghanaian foreign banks and found no impact on local banks. Stovrag (2017) employed a mixed model approach (quantitative and qualitative) to explain the relationship between changes in capital requirements and profitability of Swedish banks. Results showed that capital requirements have a significant negative relationship with ROE. Moreover, Kenn-Ndubuisi and Akani (2015) found recapitalization as a critical component of a sound and stable banking sector. However, ensuring good corporate governance practices and curbing fraud in the sector is equally important.

Recently, studies have shown that effective minimum capital requirements enhanced bank performance. For instance, Mujtaba et al. (2021) in Asian emerging markets indicated that regulatory capital improves bank profitability positively. Also, in sub-Saharan Africa, Yakubu and Bunyaminu (2021) provided evidence of a positive effect of capital requirement on bank stability.

Their study further pointed that stringent regulatory capital ensures a sound and stable banking sector as desired by regulatory authorities. The positive effect of capital requirement on bank performance accords with the buffer theory, which argued that adequately capitalized banks experienced higher profit returns as they engaged in risky ventures. However, Nayak (2021), in his studies across 129 countries, provided contrary evidence against the buffer theory as his study shows that capital requirement stringency within the 129 countries negatively affects financial performance. Thus, providing evidence under the risk-return hypothesis.

Although empirical findings on the impact of recapitalization on bank performance are conflicting, it is observed from the review that most studies are bereft of depth, scope, and context, as shown in the review. Besides, very little research has been published in Ghana on the subject, and this gap also calls for empirical studies.

### 3. Data and methodology

This section of the study focuses on the methodological approach used to analyze the impact of recapitalization on bank performance. The section comprises the sampling technique, data and variable descriptions, empirical model specification, and the econometric technique employed to ascertain the empirical estimates.

#### 3.1. Sampling, data, and variable description

We employed a purposive sampling technique to select 20 universal banks<sup>3</sup> out of the 34 banks that operated in the country as of December 2017. The decision to limit the scope of the study to 20 banks and the period 2008–2017 is primarily due to data availability and the fact that most banks were not in existence as of 2008, which is the starting point for our analysis. In all, we used a total of 200 observations for the study. Data for return on asset (ROA), return on equity (ROE), capital adequacy ratio (CAR), bank size (BSIZE), and non-performing loans (NPL) is obtained from the audited financial statements of the selected banks over 2008–2017 period. However, we extracted the GDP growth rate data from World Development Indicators [WDI] (World Bank, 2018). We calculated ROA as the net operating profit before interest and tax but after depreciation and amortization divided by average total assets. In contrast, we calculated ROE as net profit after tax divided by shareholders' funds. CAR is expressed as a ratio of regulatory capital to risk-weighted assets that measure the ability of a bank to absorb losses prior to becoming insolvent. The Basel framework and the Capital Requirement Directive (CRD) identified three risk-based capital ratios (CET 1 ratio, Tier 1 capital ratio, and total capital ratio). However, CAR is often called the total capital ratio and is calculated as Tier 1 capital plus Tier 2 capital divided by risk-weighted assets (Adu, 2019; Conlon et al., 2020). A brief explanation of each variable is given in Table 1.

#### 3.2. Model specifications

To estimate the relationship between minimum capital requirement (recapitalization) and bank performance, we specified our generalized model as shown in equation (1) following Le et al. (2020) and Abou-El-Sood (2016), with some modifications of the variables.

$$BP_{i,t} = \beta_0 + \beta_1 CAR_{i,t} + \theta_1 Z_{i,t} + \varrho GDP_t + \varepsilon_{i,t} \quad (1)$$

$$\varepsilon_{i,t} = \eta_i + \gamma_t + v_{i,t} \quad i = 1 \dots N, t = 1 \dots T$$

where  $BP_{i,t}$  denote the bank performance (measured by ROA and ROE) for bank  $i$  at time  $t$ ,  $CAR_{i,t}$  represents capital adequacy ratio (a measure of minimum capital requirements), the primary independent variable of interest,  $Z_{i,t}$  is a vector of bank-level control variables such as bank asset quality



**Table 1. Variables Description and Measurement**

Variable (Notation)	Description
Return on asset (ROA)	The ROA is calculated as net operating profit before interest and tax but after depreciation and amortization divided by average total assets. It represents the amount of profit generated for every unit of total assets.
Return on equity (ROE)	The ROE is calculated as net profit after tax divided by shareholders' funds, and it measures the efficiency level at which management is using shareholders' funds to generate after-tax earnings.
Capital adequacy ratio (CAR)	It is expressed as the ratio of regulatory capital to risk-weighted assets, which measures the financial strength of a bank. It is often referred to as the total capital ratio, which is calculated as Tier 1 capital plus Tier 2 capital divided by risk-weighted assets.
Non-performing loan ratio (NPL)	It is calculated as total non-performing loans plus advances divided by gross loans and advances. It is used as a measure of bank asset quality.
Loan-deposit ratio (LDR)	It is calculated as gross loan and advances divided by total customer deposits, and it measures bank liquidity risk or credit risk.
GDP growth rate (GDPGR)	It is measured as the annual % growth rate of gross domestic product.
Bank size (BSIZE)	The size of a bank is expressed as the natural logarithm of the bank's total assets.

(non-performing loan ratio), liquidity risk (loan-deposit ratio), and bank size (natural logarithm of total assets). GDP growth rate indicates the country-level control variable. The GDP growth rate is included in our model to capture the effects of the macroeconomic environment on bank performance since the growth of an economy can influence customer demand for bank products and services (see Doku et al., 2019).  $\beta_i$ ,  $\theta_i$  and  $\varrho$  are parameters to be estimated,  $\beta_0$  is a constant term and  $\varepsilon_{i,t}$  is the error term which is further decomposed as  $\varepsilon_{i,t} = \eta_i + \gamma_t + v_{i,t}$ , where  $\eta_i$  represents bank-specific effects,  $\gamma_t$  is time-specific fixed effects, and  $v_{i,t}$  is the disturbance term assumed to be independent but not necessarily identically distributed across the selected banks.

The linear model [equation (1)] is further modified to examine the nonlinear effect of minimum capital requirement on bank performance. We augmented the linear model with a quadratic term (i.e.,  $CAR^2$ ) as shown in equation (2). This is done to assess whether the minimum capital requirement positively affects bank performance to a certain level and, after that, negatively influences or vice versa.

$$BP_{i,t} = \beta_0 + \beta_i CAR_{i,t} + \beta_j CAR_{i,t}^2 + \theta_i Z_{i,t} + \varrho GDP_t + \varepsilon_{i,t} \quad (2)$$

Here,  $\beta_j$  is the coefficient of the squared capital adequacy ratio ( $CAR^2$ ) variable while the other denotations are defined as before. The nonlinear relationship between minimum capital requirement and bank performance is assumed to exist if the estimated coefficient of  $CAR$  ( $\beta_i$ ) is significantly positive and the coefficient of squared  $CAR$  ( $\beta_j$ ) is significantly negative. In that case, the threshold value can be calculated as defined in equation (3). It is worth noting that both the linear and nonlinear equations (equations 1 and 2) are estimated twice. Where in each equation, we estimate the equation with ROA and ROE. This is done to ensure robustness findings of how minimum capital requirement influences banks' performance since both ROA and ROE are used to measure bank performance.

$$CAR^* = -\frac{2\beta_j}{\beta_i} \quad (3)$$

where  $CAR^*$ ,  $\beta_i$ , and  $\beta_j$  represent the threshold value of capital adequacy ratio, the CAR parameter, and the coefficient of squared CAR, respectively.

### 3.3. Econometric technique

In this study, we employed the Panel Corrected Standard Errors (PCSE) approach for estimation. This estimation simultaneously corrects autocorrelation, cross-sectional dependence, and heteroscedasticity to improve parameter efficiency (see Chen et al., 2010; Doku et al., 2019). Ordinary Least Squares (OLS) estimator is optimal (best linear unbiased) for cross-section time-series data (panel data) only if the errors are assumed to be generated in an uncomplicated (spherical) manner. In particular, for OLS to be efficient, it is necessary to assume that all error processes have the same variance (homoscedasticity) and that the errors are independent of each other (no serial correlation).

However, it is noteworthy to expect the errors in panel data models to exhibit heteroscedasticity where the variances of the errors differ from unit to unit. In our case, panel heteroscedasticity can be problematic since the scaling of our dependent variables (ROA and ROE) may differ between the selected banks. Also, contemporaneous correlation can be a problem in our models, in that, errors for unit  $i$  at time  $t$  can be correlated with errors for unit  $j$  at time  $t$ . The presence of these problems renders estimates inefficient and biases the standard errors of the traditional OLS estimator (see Reed & Ye, 2011). The PCSE approach developed by Beck and Katz (1995) is regarded as an efficient alternative since it can overcome the above problems associated with OLS. In PCSE, Beck and Katz propose to retain OLS parameter estimates but replace the OLS standard errors with panel corrected standard errors. Based on the Monte Carlo analysis, Beck and Katz argued that the PCSE estimator is very robust regarding the efficiency obtained from the standard errors.

The PCSE approach involves two-step estimation. In the first step, the data is transformed to eliminate serial correlation. In the second step, OLS is applied to the transformed data, and the standard errors are corrected for autocorrelation, cross-section dependence, and heteroscedasticity to improve parameter efficiency. It is worthy to also acknowledge the Feasible Generalized Least Squares (FGLS) estimator as one of the estimators that correct for autocorrelation, cross-sectional dependence, and heteroscedasticity associated with panel data models (Parks, 1968; Reed & Ye, 2011). However, FGLS is only efficient and appropriate for panel data with time dimension ( $T$ ) greater than or equal to the number of cross-sections ( $N$ ), rendering it inappropriate for our model since in our case, the cross-sectional units (20 banks) exceed the time dimension (2008–2017). Moreover, it is argued that the FGLS estimator can underestimate standard errors, especially in finite samples (Reed & Ye, 2011). Thus, we estimated our generalized models using the two-step modified version of the OLS estimator (i.e., PCSE), which performs better than the FGLS in several circumstances especially, when  $T$  is lesser than  $N$ .

Before estimating the PCSE, we test for cross-sectional dependencies among the variables (see De Hoyos & Sarafidis, 2006; Le et al., 2020; Pesaran, 2004). The cross-sectional dependency test by Pesaran (2004, 2007), as specified in equation (4), is employed.

$$\Delta Y_{it} = \theta_i Y_{i,t-1} + \gamma_i \xi_{it} + \sum_{j=1}^{\rho-1} \theta_{ij} Y_{i,t-j} + \varepsilon_{it} \quad (4)$$

where  $\xi_{it}$  is a deterministic factor,  $\sum_{j=1}^{\rho-1} \theta_{ij} Y_{i,t-j}$  is Augmented Dickey-Fuller test and  $\varepsilon_{it}$  is the error term, which is considered cross-sectional for object  $i$  when they have common factors. The object is formalised in equation (5) as:

$$\varepsilon_{it} = \theta_i f_i + \mu_{it} \quad (5)$$

Here,  $\theta_i$  indicates the different effect of individual units while  $\mu_{it}$  shows that there exists no cross-sectional dependence. We then substituted equation (5) into equation (4) and obtained equation (6):

$$\Delta Y_{it} = \theta_i Y_{i,t-1} + \gamma_i \xi_{it} + \sum_{j=1}^{\rho-1} \theta_{ij} Y_{i,t-j} + \theta_i f_i + \mu_{it} \quad (6)$$

Following Pesaran (2004, 2007) and Le et al. (2020), we write the null hypothesis of no cross-section dependence among variables within panel data as  $H_0 : \theta_i \neq 0$  and is tested against the alternate hypothesis of the presence of cross-sectional dependencies.

As argued in literature (see Abbas et al., 2021; Mujtaba et al., 2021; Nguyen, 2021a, 2021b), there is the likelihood of an endogeneity issue to exist in relationship between capital, performance (ROA and ROE) and bank risk. Given that, the study further performs a robustness test using the two-step system-GMM, which controls any potential endogeneity to ensure consistency of the estimates.

## 4. Results and discussion

This section of the study focused on the analysis of the estimated results. It includes descriptive statistics, correlations among the variables, and a discussion of the PCSE results.

### 4.1. Descriptive statistics

Table 2 presents a summary of the descriptive statistics of the variables used in the study and the correlation matrix. The statistics give an overall description of the data employed, making it easier to interrogate the dataset. Mean, standard deviation, minimum, and maximum values are considered key descriptive measures to evaluate the data. The average performance (profitability) of the selected banks in terms of ROA and ROE is 3.57% and 17.28%, respectively, while the maximum (minimum) value of profitability in terms of ROA and ROE is 11.29% and 51.38% (−5.29% and −9.83%) respectively for the selected banks. The capital adequacy ratio's maximum (minimum) value is 89.82% (6.01%), with a mean value of 11.49%. The minimum value of 6% indicates regulatory and statutory breaches in the banking sector regarding the 10% minimum CAR requirement in Ghana. However, an average CAR of about 11.5% signifies the sector's robustness since it is slightly above the 10% statutory minimum requirement.

Concerning the dispersion of the variables around their mean values, it is clear that the research variables exhibit lower dispersion around their means except for bank size. Now to the linear association (correlation) among the variables in the study, it is noticed from Table 2 that CAR has a positive correlation with both ROA and ROE, implying a positive association between capital adequacy ratio and bank profitability. We observed that the correlations among the variables are less than 0.90, which gives evidence of the absence of multicollinearity in our dataset (Dohoo et al., 1997). Furthermore, there exists a positive correlation between ROA and ROE. The correlation coefficient of 0.85 suggests a strong positive association between ROA and ROE, implying significant similarity in measuring bank performance.

**Table 2. Descriptive statistics and correlation**

Variable	Mean	Standard deviation	Maximum value	Minimum value			
ROA	0.0357	0.0285	0.1129	−0.0529			
ROE	0.1728	0.1814	0.5138	−0.9828			
CAR	0.1977	0.1149	0.8982	0.0601			
NPL	0.1574	0.1136	0.4923	0.0043			
LDR	0.6276	0.2386	1.7112	0.1804			
GDPGR	0.0673	0.0328	0.15	0.037			
BSIZE	13.9937	0.9449	16.0108	11.5497			
Correlation Among Variables							
	ROA	ROE	CAR	NPL	LDR	GDPGR	BSIZE
ROA	1						
ROE	0.8516	1					
CAR	0.2108	0.1032	1				
NPL	−0.1967	−0.2275	0.2976	1			
LDR	−0.0887	−0.0466	−0.3218	−0.3076	1		
GDPGR	−0.0423	−0.0282	−0.0600	−0.0098	−0.1325	1	
BSIZE	0.3936	0.3044	−0.1564	0.0765	−0.1946	−0.1761	1

Note: ROA, ROE, CAR, NPL, LDR, GDPGR, and BSIZE represent return on asset, return on equity, capital adequacy ratio, non-performing loans ratio, loan-deposit ratio, growth rate of gross domestic product, and bank size, respectively.

#### 4.2. Cross-sectional dependence test results

Table 3 presents the results of the cross-sectional dependence test. We rejected the null hypothesis because the CD test statistic (2.633) is significant at a 1% error level. The results imply the existence of cross-section dependence among the banks. Given the oligopolistic nature of the universal banking industry, the results mean universal banks in Ghana react to each other's policies. The presence of cross-sectional dependencies called for the selection of the PCSE estimation method.

#### 4.3. The PCSE estimation results

Table 4 presents the estimation results on the relationship between the variables of interest using the PCSE estimator. The results reveal a significant positive relationship between the minimum capital requirement (CAR) and bank performance in Ghana. The indication is that a higher minimum capital requirement leads to higher profitability in terms of ROA and ROE for the universal banks in Ghana. We could attribute the outcome to the fact that banks with the capacity to meet the minimum capital requirement turn to have higher credibility. A situation of this nature builds up depositors' confidence and attracts depositors and investors to the banks, generating higher profitability (ROA and ROE). The coefficients of CAR at a 5% significance level in models 1 and 2 indicate that a 1% increase in minimum capital requirement induces an increase in ROA and ROE by about 7.82% and 35.59%, respectively.

The finding is associated with the buffer theory. Financial institutions will strive for adequate capital to meet unforeseen operational losses and engage in risky ventures with higher returns (Caleb & Rob, 1996; Adu, 2019). As A. N. Berger and Bouwman (2013) and Karim et al. (2014) explained, higher minimum capital can enable a bank to compete effectively for deposits and loans, hence, increase profitability. Our finding is consistent with most empirical evidence on the subject (see Abakah, 2020; Adu, 2019; Ernovianti et al., 2016; Okafor et al., 2010). However, it contradicts the findings of Abou-El-

**Table 3. Results of cross-section dependence tests**

Test	Test Statistic	P-value	Decision
Pesaran	2.633	0.0085	Reject $H_0$ at 1% significance level

Notes: The null hypothesis is that: there is no cross-sectional dependence ( $H_0 : \theta_i \neq 0$ ). The Average absolute correlation (abs) value = 0.28.

**Table 4. Panel Corrected Standard Errors Estimation results**

Variable	Model (1)	Model (2)	Model (3)	Model (4)
CAR	0.0782*** (0.0210)	0.3559** (0.1086)	0.2500*** (0.0445)	0.9739** (0.3686)
NPL	-0.0751*** (0.0171)	-0.4940*** (0.1166)	-0.0627*** (0.0157)	-0.4473*** (0.1190)
LDR	0.0086 (0.0097)	0.0342 (0.0746)	0.0123 (0.0089)	0.0473 (0.0738)
GDPGR	0.0441 (0.0587)	0.1776 (0.5025)	0.0344 (0.0579)	0.1385 (0.5054)
$\ln BSIZE$	0.1811*** (0.0381)	0.8899** (0.2629)	0.1598*** (0.0368)	0.8094*** (0.2659)
$CAR^2$	-	-	-0.2167*** (0.0499)	-0.7852** (0.3719)
Constant	-0.4537*** (0.1020)	-2.1957** (0.7025)	-0.4237*** (0.0988)	-2.0774*** (0.7085)
CAR*			1.7336	1.6125
$N$	200	200	200	200
$R^2$	0.225	0.159	0.291	0.176

Note: Standard errors shown in the parenthesis are corrected for autocorrelation and cross-section heteroscedasticity. \*\*\* and \*\* denote 1% and 5% significance levels, respectively, while CAR, NPL, LDR, GDPGR,  $\ln BSIZE$  and  $CAR^*$  represent capital adequacy ratio, non-performing loan ratio, loan-deposit ratio, growth rate of gross domestic product, bank size (natural log of bank total assets), and capital adequacy ratio threshold value, respectively. Model 1 and 2 are the linear models with ROA and ROE as dependent variables, respectively, while models (3 and 4) are the nonlinear models with ROA and ROE as the dependent variable, respectively.

Sood (2016), Mayordomo et al. (2019), and Le et al. (2020), who argued that minimum capital requirement rather exposes banks to an undue liquidity crisis through increased cost of funding and results in lower profitability.

In models (3 and 4) of Table 3, we introduced the quadratic term ( $CAR^2$ ) to check for the nonlinear relationship between minimum capital requirement and bank performance. We used the ROA and ROE as the dependent variables in models 3 and 4, respectively. The results reveal the coefficient of the quadratic term to be significantly negative in both models (3 and 4), indicating the presence of an inverse U-shaped relationship (nonlinear effect) between the capital adequacy ratio and profitability of the selected banks in Ghana. The implication is that the positive effect of the regulatory capital adequacy ratio on bank profitability diminishes and eventually becomes negative as the regulatory capital adequacy ratio exceeds a certain optimal level (thresholds of 1.7% and 1.6%).

The coefficients of the square of CAR in models 3 and 4 denote that bank performance (profitability) in Ghana falls by about 0.22% and 0.79% after regulatory capital adequacy ratio (or minimum capital requirement) exceeds 1.7% and 1.6% in models 3 and 4 and are significant at

1% and 5% significance level, respectively. This outcome suggests that although the minimum capital requirement improves bank performance in Ghana, the effect worsens bank performance after the threshold values of 1.7% and 1.6%, respectively. The more significant magnitudes of CAR<sup>2</sup> in models 3 and 4 compared to that of CAR in models 1 and 2 corroborate the threshold effects. These optimal capital ratios (1.7% and 1.6%) lie within the 2.5% capital conservation buffer recommended by Basel III and the 3% capital buffer by the Bank of Ghana.

Concerning the control variables, the results showed that bank size positively impacts the profitability of universal banks in Ghana. In contrast, non-performing loans negatively affect bank performance in Ghana in all models. The coefficients relating to non-performing loans in all models show that an increase in non-performing loans by 1% is associated with 0.08%, 0.49%, 0.06%, and 0.45% decrease in bank performance (ROA and ROE) in all the models (1, 2, ..., 4), respectively. Indeed, non-performing loans lead to lower profitability or performance of banks as non-performing loans result in loan default. The coefficient of bank size at a 1% and 5% significance level in models (1, 3, and 4) and model 2, respectively, reveals that bank performance (or profitability) increases by about 0.18%, 0.89%, 0.16%, and 0.18% for a percent increase in bank size in models 1, 2, 3 and 4, respectively. The bigger the size of a bank (in terms of total assets and branches), the higher the bank's profitability. More bank branches make financial services accessible and hence, higher profit, all things being equal. This outcome is also consistent with Doku et al.'s (2019) findings, who argued that bigger banks tend to be more profitable because they are more diversified in terms of investments and are cost-efficient relative to smaller banks. Furthermore, the results revealed that the loan-deposit ratio and GDP growth rate did not significantly impact bank profitability in Ghana.

#### 4.4. Robustness test (system-GMM results)

Reported in Table 5 is the system-GMM results.

It is observed from Table 5 that the system-GMM results after controlling for potential endogeneity do not differ from the PCSE results. Indeed, the results in Table 5 emphasize that minimum capital requirement increases bank performance (both ROA and ROE). Furthermore, nonlinear models (3 and 4) revealed that the effect of the minimum capital requirement on ROA and ROE became negative after a threshold value of 1.6% and 1.5%, respectively. The Arellano-Bond [AR(2)] and Hansen p-values indicate that the estimates are efficient and consistent.

#### 5. Conclusions

In this study, we have investigated the influence of the minimum capital requirement on bank performance using a sample of 20 Ghanaian commercial banks over the period 2008–2017. The Panel Corrected Standard Errors (PCSE) estimation method was employed for the analysis. The results indicate that the minimum capital requirement measured by capital adequacy ratio has a significant positive impact on bank profitability (or performance) in terms of return on assets and return on equity. However, the nonlinearity estimations reveal that the positive effect of minimum capital requirement on bank profitability diminishes and eventually becomes negative as the capital adequacy ratio exceeds an optimal level of 1.7% and 1.6% for ROA and ROE, respectively. Interestingly, these optimal capital ratios lie within the 2.5% capital conservation buffer recommended by Basel III and the 3% capital buffer by the Bank of Ghana. Given the outcome, the study establishes that the impact of minimum capital requirement on bank performance in Ghana is a double-edge. It improves bank performance and, after the threshold values, worsens bank performance.

Our findings have policy implications for banks and regulators in Ghana. The positive effect of the minimum capital requirement suggests that banks able to meet the minimum capital restore trustworthiness and boost confidence in depositors and investors. This, therefore, attracts more clients and hence, higher profitability. The negative outcome of the minimum capital requirement



**Table 5. The System-GMM Results**

Variable	Model (1)	Model (2)	Model (3)	Model (4)
$ROA_{t-1}$	0.1157 (0.1673)		0.3503*** (0.0973)	
$ROE_{t-1}$		-0.2782*** (0.0820)		-0.1988*** (0.0669)
CAR	0.4293*** (0.0951)	1.9672*** (0.5073)	0.3937*** (0.1153)	2.9314*** (0.8572)
NPL	-0.1699** (0.0776)	-2.1077*** (0.4277)	-0.0612 (0.0682)	-1.9308*** (0.2396)
LDR	0.1191*** (0.0285)	0.2492* (0.1295)	0.0990*** (0.0231)	0.2929** (0.1329)
GDPGR	0.3350*** (0.0862)	0.6072 (0.3796)	0.1936*** (0.0542)	0.8610** (0.4101)
$\ln BSIZE$	0.3496*** (0.0929)	1.3206*** (0.3091)	0.1667** (0.0691)	1.1628*** (0.2552)
$CAR^2$			-0.3064** (0.1355)	-2.1403** (0.8563)
Constant	-1.0488*** (0.2530)	-3.4867*** (0.8604)	-0.5430*** (0.1733)	-3.2698*** (0.7038)
CAR*			1.5565	1.4603
Number of groups	20	20	20	20
Number of instruments	16	16	17	17
AR(2) p-value	0.459	0.404	0.156	0.486
Hassen p-value	0.229	0.719	0.207	0.571

Note: Standard errors reported parenthesis. \*\*\*, \*\* and \* denote 1%, 5% and 10% significance level respectively while CAR, NPL, LDR, GDPGR,  $\ln BSIZE$  and  $CAR^2$  represent capital adequacy ratio, non-performing loan ratio, loan-deposit ratio, growth rate of gross domestic product, bank size (natural log of bank total assets) and capital adequacy ratio threshold value, respectively. Model 1 and 2 are the linear models with ROA and ROE as dependent variable, respectively while models (3 and 4) are the non-linear models with ROA and ROE as dependent variable, respectively.

after the optimal value from models 3 and 4 implies that, although strictly regulated capital can cushion banks against unexpected losses and improve performance, it can also expose banks to undue liquidity crisis through the high cost of funding. The study, therefore, suggests that baking regulators such as Central Bank should complement capital regulatory with other stringent regulations such as repricing of loans, the repricing of deposit liabilities, diversifying the lending portfolio, and lengthening the maturity of liabilities. Doing so will help strengthen banks' solvency position, improve banks' performance, and hence, an efficient and stable banking sector in Ghana.

In conclusion, the study recommends future studies to measure bank performance using the z-score approach, which captures the number of standard deviations by which returns must be reduced to deplete the equity of a bank. Furthermore, future studies should also expand the study beyond Ghana to ensure that we can generalise findings across sub-Saharan Africa.

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#### Notes

1. Retail, merchant, and development banking segments.
2. An increment of over 230% from GH¢120 million to GH¢400 million (BoG, 2017).
3. Access Bank Ghana (Intercontinental Bank), Agricultural Development Bank, Bank of Africa (Amal Bank), Barclays Bank, Cal Bank, Ecobank Ghana, FBN Bank (International Commercial Bank), Fidelity Bank, First Atlantic Bank, Ghana Commercial Bank, Guaranty Trust Bank, HFC Bank, National Investment Bank, Prudential Bank, SG Bank (SG-SSB), Stanbic Bank, Standard Chartered Bank, United Bank for Africa, Universal Merchant Bank, and Zenith Bank.

#### Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

#### Authors' contributions

All authors made significant contributions at each stage of the manuscript, including the topic, problem statement, literature reviews, methodology, data collection, data analysis, and conclusions. All authors read and approved the final manuscript.

#### Disclosure statement

The authors declare that they have no competing interests.

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