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The Impact of Changes in Basel Capital Requirements on the Resilience of African Commercial Banks

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Abstract

Focusing on a panel sample of 41 commercial banks over the period of 2000-2018, this study examined the effect of capital adequacy on the resilience of commercial banks in Africa under changing Basel levels (II, III, and the proposed Basel IV). The study created sample representative banks for the proposed Basel IV and used two measures, namely Z-score and CAMELS, to capture bank resilience. Using the panel logistic regression and fixed effect model, we found that capital adequacy, liquidity, earnings, management efficiency, and macroeconomic conditions are key determinants of the resilience of commercial banks in Africa. Additionally, Basel compliant banks tend to be less prone to macroeconomic factors. Based on the positive and significant impact of all Basel capital ratios on Zscore, the results suggest that a high level of capital requirements increases African banks' resilience, and banks with higher capital can absorb risk exposures.

Keywords: bank risk; Basel capital requirements; resilience; African Banks.

JEL classification: G01; G21; G28.

1. INTRODUCTION

Bank resilience is the ability of a bank to absorb unexpected losses should they occur (Papadimitriou, Gogas, & Agrapetidou, 2020). Higher CAR aims to strengthen the resilience of the banking system (BCBS, 2017). The globalization and expansion of financial services in response to the growing international trade have increased the inter-connectedness of the banking industry globally. This creates the need for increased and standardized banking regulations to improve banking regulations for bank regulators in their jurisdiction (Parrado, 2016). Adequate capital increases the ability of banks to manage all kinds of risk to reduce

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the probability of bank failures. The 2008 financial crisis prompted renewed interest in banking regulations and made bank regulators to review what else is needed to safeguard the global banking system (Parrado, 2016; Triki, Kouki, Dhaou, & Calice, 2017). This led to a broad consensus that further regulations for higher capital are important to strengthen the resilience of banks (Chiaramonte & Casu, 2017). This necessitated the Basel II framework's revision to provide a foundation for a resilient banking system that will help avoid the build-up of systemic vulnerabilities in the financial system (Gabriel, 2016). As a result, the Basel III accord was introduced in 2009 (BCBS, 2009). To further increase the resilience of banks, the Basel Committee introduce the Basel IV accord in 2016 to standardize the calculation of capital ratios (BCBS, 2017).

Since banks are in the business of taking risk, they are obliged to hold an appropriate level of capital as a cushion against unexpected losses (Lotto, 2016; Stolz, 2002). Risk-taking by banks, if successful, makes banks profitable. Otherwise, it may affect the stability of the banks in the form of distress, lead to failures and loss of depositors' funds and other losses with adverse effects on the economy as evidenced by the 2008 financial crisis (Chalermchatvichien, Jumreornvong, & Jiraporn, 2014). As a result, the regulators use CAR as a tool necessary to increase the resilience of banks against bank risk exposure and minimize the probability of bank failures (BCBS, 2009, 2017). This study aims to analyse the determinants of capital adequacy on the resilience of banks in Africa.

The 2007-08 financial crisis, which began in the United States, spilt over to many banking systems in Europe, Asia, and Latin America, including Australia. There was a high perception that Africa's banking system would be affected due to its fragility (Allen & Giovannetti, 2011). On the contrary, African banks were sheltered from the financial crisis's effects because of their low integration with the global financial markets (Abdel-Baki, 2012; Allen & Giovannetti, 2011). Yet, many African banks are not resilient. They are characterised by bank failures, fragility, poor corporate governance, poor asset quality, and lack of financial depth due to capital inadequacy and non-compliance to changes in Basel regulations (Sanusi, 2010; Triki et al., 2017). These factors above create the emergence of weak banks in Africa that are limited in the provision of lending to small businesses and corporations, prone to distress and failures despite the opportunities for revenue growth, and cannot compete favourably (Chironga, Cunha, Grandis, & Kuyoro, 2018). For instance, three banks collapsed in Kenya in 2015 as a result of management incapacity to effectively assess the bank credit risks (Gathaiya, 2017). Eight banks collapse in Ghana between 2016 and 2018 due to capital inadequacies, declining asset quality, ineffective regulatory supervisions (Benson, 2019). Three banks were distressed but bailed out in Nigeria in 2016 due to capital inadequacies (Sanusi, 2010). With frequent bank failures and distress, the resilience of a banking system becomes crucial for regulators in African countries for the growth and sustainability of their economy (Gathaiya, 2017; Sanusi, 2010).

From the foregoing, there is a history of bank distress and failure in the African banking system. This suggests a need to improve the resilience of African banking systems. Despite the lack of resilience in the African banking system, it was not seriously affected by the 2008 financial crisis that affected banks in the developed world. Since Basel III and IV accords were introduced following the 2008 financial crisis in developed countries, this study questions the impact of a stronger regulatory capital on the resilience of banks in Africa that were not worse hit by the financial crisis.

Many African countries are yet to implement Basel II CAR introduced in 2004, yet there is Basel III accord introduced after the 2008 financial crisis and the recently proposed Basel IV accords. The Basel III accord was introduced to provide a foundation for a resilient banking system to avoid the build-up of systemic vulnerabilities in the financial system (Gabriel, 2016) as bank failures have systemic costs not entirely borne by the banks (Ljung & Schennings, 2018). The Basel III accords take care of systemic risk to reduce potential economic impact that banks do not take into account in their decision-making and to ensure that a bank failure does not affect an entire banking sector's stability (Hossain & Islam, 2017; Walter, 2019). To further increase the resilience of banks, the Basel Committee introduce the Basel IV accord to standardize the calculation of capital ratios (BCBS, 2017). The aim of the new Basel IV is to establish a strong banking system that can withstand and recover quickly from difficult positions, such as crisis or failures (Oughton, 2017).

The new Basel IV CAR is set to be adopted in 2022 (BCBS, 2017) but postponed to 2023 due to Covid-19 (BCBS, 2020). It is pertinent to determine whether higher capital increases the resilience of banks that adopted Basel regulations in Africa, given that some countries in Africa lag in compliance with changes to higher Basel CAR. Consequently, this study ascertains how Basel II and III CAR affected bank resilience and how the proposed Basel IV CAR would have impacted banks' resilience in Africa as if the Basel IV CAR had been implemented during the sample period. The study is relevant to Africa because there is a history of bank distress and failure, and some countries in Africa lag in compliance with changes in Basel capital requirements (CAR).

2. EMPIRICAL STUDIES ON THE IMPACT OF BASEL CAR ON BANK RESILIENCE

In literature, capital has been a valuable regulatory tool used by regulators and policymakers to strengthen the financial stability and resilience in the banking system (Chiaramonte & Casu, 2017; Hossain, Khan, & Sadique, 2018). All else being equal, a bank's probability of default declines with its level of capital (Bichsel & Blum, 2004). The existing literature suggests that well-capitalised banks performed better during the 2008 financial crisis (Sahut & Mili, 2011). Such banks continue to perform in the post-financial crisis and lend more and better absorb risk (Cohen & Scatigna, 2016). A bank's resilience also relates to the quality and quantity of capital adequacy needed to absorb shocks to the financial system (Bui, Scheule, & Wu, 2017).

There are disagreements about higher CAR improving the resilience of banks (Admati, DeMarzo, Hellwig, & Pfleiderer, 2013; Stolz, 2002). On the one hand, equity capital represents the stake a bank will lose in the event of insolvency; therefore, a bank's incentive may be to lower its risk at higher capital levels. On the other hand, it is argued that capital is expensive (Perrone, Ferreira, & Securato, 2015), as higher capital through issuing of shares will dilute shares and may reduce the expected return on equity. Thus, to generate adequate returns on equity and maximise shareholders' wealth, banks may be forced to increase their investment in risky portfolios to generate higher returns creating a positive relationship between investing in risky assets and acquiring high level of capital (Bichsel & Blum, 2004; Stolz, 2002).

Additionally, poorly capitalised banks may increase risk-taking as their capital declines to generate returns to shareholders, creating a negative relationship between capital and bank risk (Altunbas, Carbo, Gardener, & Molyneux, 2007). This phenomenon is known as a moral

hazard hypothesis that can arise due to agency problems between bank managers and the shareholders (Kwan & Eisenbeis, 1997). Such agency problems arise from the nature of bank ownership structure and the comparative power between owners and managers which often result in bank managers taking excessive risk above their available capital (Kwan & Eisenbeis, 1997; Laeven & Levine, 2009). The negative relationship between capital and bank risk is harmful because, many poorly capitalised banks may reduce lending or move to loan with lower risk weight which could be misinterpreted as higher CAR that increases resilience. Nevertheless, poorly capitalised banks are expected to be affected by higher CAR. Studies have acknowledged that the negative relationships between capital and bank risk may come from a diversification effect such as securitisation that is not captured by credit risk (Lindquist, 2004).

Banks are usually unwilling to increase capital with higher risk-taking. When banks increase capital ratios arising from an increase in risk-taking, this can be partly due to efficient regulatory monitoring by bank authorities in their jurisdictions (Altunbas et al., 2007). Higher CAR can effectively influence banks to be more cautious in their financing (risk) decisions which lower bank risk exposure (Altunbas et al., 2007; Giordana & Schumacher, 2017; Mamatzakis & Bagntasarian, 2019). According to Tanda (2015), the extent of higher CAR effect on bank risk varies with country, depends on existing capital level, time period, among others.

Under Basel I & II accords, poorly capitalised banks may create systemic risk that affects the entire banking system, as witnessed in the 2008 financial crises (Hossain & Islam, 2017; Lindquist, 2004). The new Basel CAR III adequately links capital to bank risks (BCBS, 2017; Walter, 2019). As banks attempt to increase portfolio risk, Basel III requirements force banks to increase capital ratio or decline the portfolio risk in the absence of adequate capital (Hossain & Islam, 2017). Examining the link between bank capital and resilience, Giordana and Schumacher (2017) used data from 2003q2 to 2011q3 for a panel of Luxembourgish banks. Their study found that the banks would have seen a decline in their default risk during a crisis episode if they had previously complied with Basel III requirements. Bui et al. (2017) also found that a moderate increase in Basel CAR is adequate for the resilience of banks in Australia. However, Bui et al. (2017)'s study caution that too high CAR may affect bank lending, which lowers economic activity. Studies such as Adesina and Mwamba (2016); Chalermchatvichien et al. (2014); Chiaramonte and Casu (2017); Papadimitriou et al. (2020), have evaluated the impact of Basel CAR on bank resilience and found that Basel III CAR has a positive and significant impact on bank resilience. Thus, suggesting that a bank's probability of default declines with higher capital. However, it was also found that the Basel III CAR tends to be more effective for bank resilience in developed economies (Chalermchatvichien et al., 2014).

Mamatzakis and Bagntasarian (2019) found that raising CAR may improve resilience in the EU banking system, and the impact is not homogenous across all banks. This was supported by Gehrig and Iannino (2021) who analysed EU banks' exposure to systemic risk and found that systemic risk may be contained, but the findings are not the same for the largest EU banks. Their study further shows that internal models used in calculating risk-weighted assets for capital ratios by large banks are the sources of the systemic risk. These challenges of different models are addressed by Basel IV which introduces standardised calculation of risk-weighted assets and eliminates the use of internal models.

The impact of Basel CAR on bank resilience has been extensively studied in developed countries such as Australia, Europe, the US, Canada (Bui et al., 2017; Chiaramonte & Casu, 2017; Gehrig & Iannino, 2021; Giordana & Schumacher, 2017; Papadimitriou et al., 2020).

Some studies are from emerging markets (Chalermchatvichien et al., 2014; Hossain & Islam, 2017; Tan & Floros, 2013). However, very limited studies (Adesina & Mwamba, 2016; Lotto, 2016) focused on Africa. In developing countries, higher Basel CAR increases bank resilience through the reduction of probability of default risk as shown by Mamatzakis and Bagntasarian (2019) and Sahut and Mili (2011) for MENA countries; Hossain et al. (2018) for BRICS countries and Banerjee and Majumdar (2017) for UAE. However, too many regulatory restrictions in developing nations may hinder the functions of banks (Banerjee & Majumdar, 2017). Contrary to the aforementioned studies in developed nations, Bichsel and Blum (2004) found that higher capital has no significant impact on default risk for Swiss banks.

A negative relationship between capital and bank risk implies that an increase in CAR increases Z-score, therefore decreasing the risk of default (Mamatzakis & Bagntasarian, 2019; Tan & Floros, 2013). A negative relationship also arises where the cost of equity is expensive; thus, banks reduce risk-taking activities to achieve higher CAR (Mamatzakis & Bagntasarian, 2019). According to Mariathasan and Merrouche (2014), bank risk appetite declines with new CAR. Such effect is particularly pronounced among poorly capitalised banks, especially those from countries with weak supervisory, legal, and regulatory frameworks. This is further supported by Chalermchatvichien et al. (2014) who found that using capital to achieve resilience is more effective in countries with better economic development. This phenomenon provides the motivation for the current study that examines the impact of Basel III and Basel IV CAR on bank resilience in Africa where there is fragility, weakly and poorly capitalised banks. In addition, since the inception of Basel regulations in 1988, the quality of capital has improved in Basel III and IV but the Basel IV CAR has more risk coverage (BCBS, 2017). The current study's findings provide insights into the likely impact of Basel III and Basel IV CAR for policymakers, bank regulatory authorities, shareholders, banks, relevant stakeholders, and researchers.

From the foregoing, studies on the possible impact of CAR on bank risk-taking and resilience remain inconclusive, especially with the proposed implementation of Basel IV. The contributions of this study are two-fold. First, the study extends Giordana and Schumacher (2017) and Adesina and Mwamba (2016), who studied the potential effect of Basel III CAR on bank resilience in Luxembourg and South Africa respectively. The CAR has undergone a significant revolution ever since due to the new Basel IV regulations. As the Basel IV CAR requires tangible common equity, different risk weightings in the calculation of risk-weighted assets (RWA) and standardization of RWA calculation, this study makes new contributions by not only examining the existing Basel II and III but also focusing on the possible impact of proposed Basel IV CAR on the resilience of banks in Africa. The study results offer key insight to policymakers and regulators on the implication of Basel IV for bank resilience in the African context.

3. METHODOLOGY

3.1 Data and Sample selection

The study uses a panel dataset sourced from multiple online databases. The annual data on the dependent variable Z-score, capital ratios, and other financial data are obtained from Bloomberg and S&P Capital IQ databases. The macroeconomic data are collected from the Reserve Bank of selected African countries, the World Bank, and the Infront database. The

macroeconomic conditions are controlled for using Gdpgrowth, Repo rate, and Inflation. The total population from Bloomberg and S & P Capital IQ database consists of 137 commercial banks that are listed on stock exchanges in Africa. The study employs two sample selection criteria for the study. First, the study included all commercial banks from each African country, with consistent and reliable data for the entire sample period 2000-2018. The sample period is considered because BCBS introduced Basel II in 2004. This allows the study to draw a conclusion on the impact of Basel IV as if it had been adopted in the period considered vis-à-vis existing Basel regulations. Second, each bank included in the sample must have complied with Basel II or Basel III CAR. The final sample is an unbalanced panel of 41 banks that have adopted Basel II or III from 13 African countries, as shown in Table no. 1.

Table no. 1 – Panel data of banks from selected African countries

Country	No of banks	Cum.
Botswana	3	7.32
Egypt	6	21.95
Ghana	2	26.83
Kenya	7	43.90
Mauritius	1	46.34
Morocco	1	48.78
Namibia	1	51.22
Nigeria	9	73.17
South Africa	6	87.80
Swaziland	1	90.24
Tanzania	2	95.12
Uganda	1	97.56
Zimbabwe	1	100
Total	41	

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

To evaluate the impact of Basel IV capital ratios, the study creates a representative balance sheet to provide answers to how Basel IV will impact the resilience of commercial banks in selected African countries. The representative bank is created to enable the study to analyse the potential impact of Basel IV CAR on resilience in line with previous studies such as Giordana and Schumacher (2017) for Luxembourg banks and Swamy (2018) for Indian banks. Furthermore, the study dataset enables the study to observe the resilience of commercial banks under different Basel levels. This enables the study to reach a conclusion on the ability of Basel IV CAR to improve the resilience of banks in Africa.

3.2 Measure of bank resilience

Several measures have been employed in the empirical literature to capture bank resilience (Chiaramonte & Casu, 2017; Hossain et al., 2018; Sahut & Mili, 2011). Notable amongst these measures is the Z-score and CAMELS rating system. The two measures are relevant to the study to examine how changes in Basel CAR impact the resilience of African banks. CAMEL is an acronym where C represents capital adequacy measured by equity to total asset ratio; A represents asset quality measured by non-performing loan/total asset; M represents management efficiency measured by cost/income; E represents bank earnings

measured by ROA, ROE and NIM; and L represents liquidity measured by loan to deposit ratio and loan growth (Munir, Salwa, & Bustamam, 2017; Sahut & Mili, 2011). CAMEL was initially adopted by the US bank regulators in 1979 for uniform rating of US banks to predict bank distress (Boateng, 2019). In 1996, the sensitivity to market risk was added into CAMEL to become CAMELS (Munir et al., 2017). Nurazi and Evans (2005); Sahut and Mili (2011) use CAMELS as a prediction for bank distress or failure, among other studies. A bank with a declining CAMELS rating is a distressed bank (Boateng, 2019). In this study, CAMELS is used to access commercial banks' resilience in Africa to determine whether banks with higher Basel capital compliance improve their CAMELS ratings.

Z-score is a measure for predicting bank failure or distress and is a common measure of bank resilience (Chalermchatvichien et al., 2014; Laeven & Levine, 2009). Z-score measures the extent to which a bank-level of capital can cover losses arising from variability in returns without becoming bankrupt (Giordana & Schumacher, 2017). A higher Z-score indicates more stability (Bonner, Streitz, & Wedow, 2016; Gehrig & Iannino, 2021). Studies such as Adesina and Mwamba (2016); Chalermchatvichien et al. (2014); Gehrig and Iannino (2021) have employed Z-score to access the effect of Basel CAR on bank resilience. The two resilience measures complement each other to provide robust conclusions and hence are used to examine the impact of higher capital on the resilience of banks in Africa.

3.3 Estimated models

The impact of capital adequacy on the resilience of banks is examined using static panel models. The specific model to achieve the current objective can be presented as:

$$Y_{it} = f(Baselcap_{it}, Lev_{it}, Bankspec_{it}, Macroeco_t) \quad (1)$$

where Y_{it} represents a proxy for bank resilience (Z-score or CAMEL). The explanatory variables represent determinants of capital adequacy that can influence the resilience of banks in Africa. $Baselcap$ represents Basel IV capital ratio, and Lev represents non-risk leverage ratio. $Bankspec$ represents the bank-specific ratios which include a proxy for bank size, measured using total asset quintiles; Loan-Deposit ratio, a proxy for liquidity ratio; and *Nplta*, a proxy for the ratio of non-performing asset/total asset. $Macroeco$ controls for the macroeconomic variables that can affect the stability of a bank (Oino, 2018). $Macroeco$ include- Gdpgrowth, interest rates and inflation rates of individual countries.

3.3.1 CAMELS modeling of bank resilience

The study uses a panel logistic regression model following Chiaramonte and Casu (2017); Sahut and Mili (2011). The study employs logistic model because the dependent variable is a binary outcome that compares the resilience of banks that are in compliance with higher Basel CAR against banks that are not Basel compliant. Logistic regression allows the model to be flexible without restrictions (Nurazi & Evans, 2005). The Logistic regression model is expressed as:

$$Y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_j X_{itj} + u_{it} \quad (2)$$

$$Y_{it} = \begin{cases} 1 \; if \; bank \; is \; non-Basel \; compliance \\ 0 \; otherwise \end{cases} \quad (3)$$

where Y_{it} represents the binary variable. β_j represents the coefficient of the independent variables X_{it}. X_{it} represents the explanatory variables -CAMELS and macroeconomic variables. The study control for macroeconomic effects. u_{it} is the error term. The logistic regression model maximizes the logarithm of the likelihood of banking distress (Chiaramonte & Casu, 2017).

$$Log\left[\frac{Non - Basel \; compliance = 1}{Basel \; compliance = 0}\right] = \beta_0 + \sum_{j=1}^{k} \beta_j X_{itj} \quad (4)$$

Model 2 tests separate hypothesis for each element of CAMELS X_{it}. In other words, it tests the null hypothesis of no relationship between CAMELS (capital adequacy, asset quality, management efficiency, earnings, liquidity, and sensitivity to market risk) and resilience, respectively. The dependent variable Y_{it} is a binary outcome that takes the value 1 where a bank i have not adopted at least Basel II CAR (non-Basel compliant banks) and 0 otherwise (Basel compliance banks). CAMELS measures are defined below:

Capital adequacy is measured by a ratio of total equity to total assets (ETA). For CAMELS ratings, this study considers ETA instead of risk-weighted Basel capital ratio. ETA is not influenced by the risk-weighting system of the regulatory requirements; thus, it captures the highest quality of equity capital in each bank in the sample (Tanda, 2015). Capital adequacy is expected to be positively related to resilience (BCBS, 2017; Gunsel, 2007). Asset quality is measured by non-performing loan/total asset (Nplta). Asset quality is a reflection of the efficiency of bank's credit decision (Boateng, 2019). A bank's resilience becomes threatened when its asset quality declines (Sahut & Mili, 2011).

Hence, the higher the non-performing loan ratio, the more it reduces resilience (Chiaramonte & Casu, 2017; Gunsel, 2007). Therefore, a negative relationship is expected. Management efficiency is measured by efficiency ratio proxy by cost to income ratio. It is usually difficult to measure the quality of bank management. However, management efficiency is critical to the going concern of a bank (Boateng, 2019). A higher cost to income ratio reduces bank resilience. Earnings is the most important performance measurement required for bank survival and growth (Geroski & Jacquemin, 1988). Earning measures in banks include return on assets (ROA), return on equity (ROE), and net interest margin (NIM). Earnings are expected to have a positive relationship with resilience. Liquidity is the ability of a bank to meet unexpected demand from depositors and borrowers (Boateng, 2019). Liquidity is measured by loan to deposit ratio and loan_growth (Sahut & Mili, 2011). A high liquidity ratio can either positively or negatively impact the resilience of banks. Sensitivity to market risk, also referred to as interest rate risk is measured by net interest income to total income (netintinc). It measures how resilient the bank assets are to changes in market conditions such as interest rates, exchange rates, commodity prices, and equity prices can affect banks' earnings, affecting banks' resilience (Boateng, 2019). A negative relationship is expected between sensitivity to market risk and the probability of bank distress.

3.3.2 Z-core model for the determinants of bank resilience

In line with Hossain et al. (2018), the study examines the resilience of banks using regression model 5.

$$Z - score_{it} = \beta_1 + \beta_2 Cap_{it} + \beta_3 Lev_{it} + \beta_4 Bankspe_{it} + \varphi' macroec_t + \dot{\theta} Year_i + \epsilon_{it} \quad (5)$$

where $Z - score$ is

$$Z - score = \frac{CAP + \mu ROA}{sd(ROA)} \quad (6)$$

where CAP Basel IV capital ratio. μROA is the mean of return on asset, and $sd(ROA)$ is the standard deviation on ROA. Banks with high Z-score are considered more stable and resilient (Hossain et al., 2018). This study compares the resilience of banks with changes in Basel CAR. Three Z-score models (Zsore2, Zscore3, and Zscore4) are generated for different Basel levels Basel II, III, and IV. Zscore2 and Zscore3 represent Z-score calculated using Basel II and III CAR, respectively. Zscore4 represents the hypothetical Z-score calculated using Basel IV CAR in line with studies such as Giordana and Schumacher (2017). Zscore4 is calculated using simulated Basel IV CAR from historical bank data for the sample period to examine its potential impact on resilience. Subsequently, the result of Z-score4 is compared to Zscore2 and Zscore3 to provide insight as to whether Basel IV will improve the resilience of banks in Africa. The variables used in this study are detailed in Table no. 2.

After the calculation of the three Z-scores, the Z-score is logged using [Ln(1+Z-score)]. Adesina and Mwamba (2016); Laeven and Levine (2009) advocated for using the log of the Z-score over the use of simple Z-score because the latter is heavily skewed, and the former is not. Lepetit and Strobel (2015) state that simple Z-score is meaningfully defined on the interval [0, ∞], limiting estimation techniques that can be used when the simple Z-score is used as a dependent variable. The log of Z-score is meaningfully defined on the interval [-∞, ∞], meaning that outliers have been removed, thus making it unproblematic in standard regression analysis (Lepetit & Strobel, 2015).

Table no. 2 – Definition of variables in equation 5

Variable	Definition	Formula	Expected sign
$Z - score$	Resilience	Cap+roa/sd(roa)	Dependent variable
Lev	Non-risk leverage	Tier1/avg-assets	Negative
Cap	Basel IV capital ratios	Tangible common equity/RWA	Positive
$Bankspe$ size	Bank size	Quintiles of total assets	Positive
$Bankspe$ Loan ratio	Loan-Deposit	Loan/Deposit	Negative
$Bankspe$ Nplta	Non-performing loan		Negative
$macroec$ Repo_rate	Govt interest rate to banks		Negative
$macroec$ Inflation	Inflation rate		Negative
$macroec$ Gdpgrowth	Real Gdpgrowth	Gdpgrowth rate	Negative

4. RESULTS AND DISCUSSION

4.1 Descriptive statistics analysis

Table no. 3 reports summary statistics for CAMELS variables. The statistics show how compliance with Basel capital increases the resilience of African banks using CAMELS indicators. The commercial banks are grouped into Non-Basel compliance and Basel compliance banks. The column labeled Non-Basel compliance banks include banks that are yet to adopt either Basel II or III. The column labeled Basel compliance includes banks that have adopted Basel II or Basel III. For instance, if a bank adopted Basel II CAR in 2008, such bank will fall under Basel compliance but will take the value of zero in the years before adopting Basel II CAR. Results in Table no. 3 suggest that compliance with Basel CAR increased the resilience of the banks. The average minimum capital represented by equity to total asset ratio (ETA) increased from 0.180 for non-Basel compliant banks to 5.130 for Basel compliant banks. The maximum ETA of 23.896 for Basel compliant banks compared to ETA of 785.98 for non-Basel compliant banks suggests that higher capital increased the total assets of the African banks that implemented Basel CAR. Asset quality improved when banks complied with Basel CAR. Nplta declined by 11.3percent when African banks implemented Basel capital. This suggests the implementation of Basel higher CAR tends to increase the asset quality of banks.

For management efficiency, the average cost to income ratio declined from 61.143 for non-Basel compliant banks to 60.746 for Basel compliant banks. The result suggests that management efficiency marginally improved by 0.65 percent when banks complied with Basel CAR. However, since the cost to income ratio is still high for banks that comply with Basel CAR, the results show that African banks are still challenged with efficient management staff. Basel compliant banks have higher liquidity, as shown from the loan_deposit ratio. Both loan and deposit of banks increased, but the increase in loan_deposit ratio did not increase loan_growth. Firstly, Basel CAR compliance increases a bank discipline avoiding careless lending, which may decrease non-performing loans. Secondly, compliance limits banks from lending so much with little capital. These reasons may have slowed down loan growth even though loan volume increased. The earnings of banks that are Basel compliant on average decreased. NIM, ROE, and ROA decreased on average by 4.1 percent, 18.9 percent, and 16.6percent, respectively. The decline in ROE and ROA have more to do with strategic management decisions of the African banks to use higher capital to generate more returns on equity and assets within the regulatory best practices. For sensitivity, netintinc of banks declined by 9.3percent when banks complied with Basel CAR. This shows that banks' earnings declined with compliance to Basel CAR, suggesting that the banks became sensitive to interest rate environment and market factors. Alternatively, banks take effective decisions before engaging in market activities when banks comply with Basel regulations; as a result, declined the netintinc.

Tables no. 4 and no. 5 presents the summary statistics of three Z-scores under the three different Basel capital ratios, Basel II, III, and IV. The three Z-scores enable us to examine how the Z-score would potentially evolve when the sampled African banks adhere to different Basel capital ratios, according to Giordana and Schumacher (2017). The higher the Z-score ratio away from zero, the better the bank resilience, and the farther away such banks are from bankruptcy (Chalermchatvichien et al., 2014). There is a Z-score benchmark to classify banks into stable, caution, or distressed. Z-score of <1.81 represents a bank in distress, while

between 1.81 and 2.99 represents the "caution zone." A Z-score of over 3 represents a bank with safe balance sheet (Chiaramonte & Casu, 2017).

Table no. 3 – Summary of CAMELS for African Banks Resilience

Variable	Non-Basel Compliant Banks				Basel Compliant Banks			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ETA	14.942	45.054	0.180	785.984	12.356	3.894	5.130	23.896
Nplta	3.724	5.529	0.029	48.526	3.301	3.215	0.033	25.051
loan_growth	28.492	62.767	-89.955	640.049	9.659	30.715	-50.525	168.692
cost_income	61.143	21.816	-167.844	242.034	60.746	15.665	22.288	141.561
loan_deposit	84.130	46.090	7.939	574.305	101.073	51.661	29.692	300.753
Netintinc	5.919	7.420	0.349	77.417	5.368	2.877	1.931	16.726
NIM	29.304	14.770	-42.964	92.306	28.098	12.612	-33.778	78.415
ROE	22.838	15.273	-76.001	92.900	18.513	8.568	-21.100	46.360
ROA	2.906	3.936	-4.811	41.002	2.423	1.483	-1.300	7.900

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

Tables no. 4 presents the summary statistics of the dependent variables without and with log form of z-score2, z-score3, and z-score4. On average, the result of the pooled data shows that African banks in compliance with Basel II CAR are, on average, relatively in the caution zone as the Z-score2 average is 2.62. Notwithstanding, higher CAR increased the Z-score rating from 2.62 in Basel II to 5.8 in Basel III and further to 6.3 in Basel IV. Moving from Basel II to Basel III, the resilience of banks in Africa moved from caution zone to stable zone.

Table no. 4 – Z-score descriptive statistics

	Non-logged Z-scores			Logged Z-scores		
Stats	Z-score2	Z-score3	Z-score4	z-score2	z-score3	z-score4
Mean	2.6250	5.8317	6.2790	0.8620	0.8895	0.9312
Min	0.4546	1.2925	0.8239	0.6341	0.5542	0.4752
Max	11.6918	22.3009	89.7891	1.1413	1.2709	1.6711
Range	11.2372	21.0083	88.9651	0.5071	0.7167	1.1961
Sd	2.5440	2.1275	6.4284	0.0768	0.0863	0.1522
Variance	6.4718	4.5262	41.3245	0.0059	0.0074	0.0232
Skewness	0.767	2.1738	8.6691	0.557	0.2154	0.481
N	449	477	589	449	477	589

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

In addition, Table no. 5 presents the summary statistics of three Z-scores for Basel II, III, and IV capital ratios, for individual African countries represented in the sample. The results show that banks from Botswana, Egypt, and Namibia have a Z-score2 of <1.81. The Z-score average values show that bank distress occurred relatively frequently in these countries. While Ghana, Kenya, South Africa, and Tanzania have mean Z-score2 less than 2.99 representing a caution zone. Morocco, Uganda, Nigeria, and Zimbabwe have Z-score2 of above 3, representing that the banks are more stable and on the safe zone under Basel II. The resilience of all the banks in the sample increased under Z-score3, with a slight increase in resilience under Z-score4. However, Morocco is still in the cautious zone in the Z-score4 model. The size of the banks in terms of total assets may be a reason for the low Z-score performance, according to Altman, Iwanicz-Drozdowska, Laitinen, and Suvas (2017). The

improvement in the Z-score from Basel III upward can be explained by higher CAR, according to Giordana and Schumacher (2017).

Table no. 5 – Summary statistics: Z-score mean by categories of country

Country	Z-score2	Z-score3	Z-score4
Botswana	0.718	5.343	5.392
Egypt	0.627	6.008	4.268
Ghana	2.080	6.147	8.537
Kenya	2.869	6.044	6.333
Mauritius	.	4.716	6.019
Morocco	3.133	2.823	2.140
Namibia	0.479	5.432	5.567
Nigeria	4.413	6.655	7.171
South Africa	2.265	5.052	6.570
Swaziland	.	5.687	6.676
Tanzania	2.698	6.122	5.489
Uganda	4.927	6.005	7.701
Zimbabwe	4.388	8.882	8.245
Total	2.625	5.832	6.279

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

4.2 Analysis of African commercial banks resilience: Z-score and CAMELS Results

The descriptive statistics show some patterns such as capital adequacy, asset quality, and loan_deposit ratio improved with Basel compliance. Management efficiency marginally improved with Basel compliance. However, earnings, loan_growth, and sensitivity declined for Basel compliant banks. Z-score also increased with a higher Basel level. This section presents the results obtained using the estimation techniques for equation 2 and equation 5.

4.2.1 Panel logistic regression results: CAMELS analysis of African banks Resilience

This section presents the logistic regression results (in Table no. 6) obtained by estimating equation 2. The CAMELS variables are not logged as the odd ratios become difficult to interpret with logs. ETA is a significant determinant of bank resilience in Africa at the 10 percent level of significance. The odds of higher equity capital among non-Basel compliant banks are 13.2 percent less than the corresponding odds for Basel compliant banks. The negative relationship confirms that lack of Basel compliance reduces the resilience of banks. The result is consistent with the empirical findings of Chiaramonte and Casu (2017), which show that increase in CAR plays a role in reducing the probability of failure. For asset quality, Nplta is not a significant determinant of the resilience of commercial banks in Africa. This is inconsistent with Chiaramonte and Casu (2017) findings, which indicate that Nplta is a significant determinant of bank failure and distress in Europe. Nevertheless, the findings in Table no. 6 indicate that the odds of Nplta among non-Basel compliant banks is 2.6 percent times the corresponding odds for African banks that are Basel compliant. The result suggests that compliance with Basel CAR reduces non-performing loans.

Liquidity is expected to have a positive or negative impact. Loan_growth is not a significant determinant to explain the resilience of banks in Africa. Still, on liquidity, the odds

of high loan_deposit ratio among non-Basel compliant are 1.2 percent times the corresponding odds for African banks that are Basel compliant. Loan_deposit is positive and significant at the 1 percent level of significance. The result is consistent with Sahut and Mili (2011) that a high loan_deposit ratio increases the probability of bank distress for banks in MENA countries. A high loan_deposit ratio reduces banks' ability to withstand unexpected deposit withdrawals. For management efficiency, the cost to income ratio is not a significant determinant of resilience. The result is consistent with Chiaramonte and Casu (2017), who found that the cost to income ratio is insignificant in determining banks' resilience in Europe. For earnings, ROE is not a significant determinant of resilience. The odds of return on equity are 3.8 percent less than the corresponding odds for Basel compliant banks. This suggests that banks that are Basel compliant have higher ROE than non-Basel compliant banks. ROA has a positive and significant at the 5 percent level of significance. The odds of ROA are 50.2 percent times the corresponding odds for banks that are Basel compliant. This suggests that non-Basel compliant banks generate more returns on assets than Basel compliant banks. NIM has no significant impact on resilience. The odds of a higher net interest margin for non-Basel compliant banks is 4.5 percent less than the corresponding Basel compliant banks. In terms of earnings, the result suggests that the implementation of Basel CAR increases the income-generating ability of banks in terms of NIM, which also increases ROE, although insignificantly. In addition, by observing the Tier1 capital ratios in the sample, many African banks have equity capital disproportionate to the level of risk undertaken. As a result, equity capital is not efficiently utilised to generate adequate returns on assets, and this is probably the reason why non-Basel compliant banks generate more ROA.

Sensitivity risk results show a negative and insignificant relationship to bank distress. The result is consistent with Sahut and Mili (2011) findings that net interest income has no significant impact on resilience for MENA countries. The odds of sensitivity risk is 0.1 percent less than the corresponding odds for Basel compliant banks. African banks operate traditional banking models of a deposit-loan model, less market activities such as obtaining financing from capital markets; thus, sensitivity risk may be low. With the new Basel III and IV CAR, the traditional banking model for African banks can change to the capital model of those obtained in the developed countries where liquidity is sourced from capital markets using instruments such as securitisation.

Macroeconomic variables-Gdpgrowth is not a significant determinant. However, the odds of the impact of Gdpgrowth is 11.9 percent less than the corresponding odds for Basel compliance banks. The result suggests that African banks that are non-Basel compliant during economic boom are limited to take advantage of revenue opportunities compared with Basel compliant banks. Repo rate is 9.8 percent times the corresponding odd for Basel compliant banks. Inflation is 6.6 percent times the corresponding odds for Basel compliant banks. For macroeconomic variables, according to Chiaramonte and Casu (2017), a high Gdpgrowth and a negative inflation rate is expected to signal a more stable macroeconomic environment to relatively reduce bank distress. The results show that the inflation rate positively and significantly impacts bank distress, consistent with Chiaramonte and Casu (2017). Therefore, the result indicates that banks in Africa operate in volatile and unstable macroeconomic environments, affecting banks' resilience. According to Sahut and Mili (2011), for Reporate, a positive relationship is expected to signal that in a worsening economic environment, the higher the non-performing loans, the higher banks need to borrow funds to write off the bad loans, which in turn increases the distress of banks. The results in Table no. 6 show that Reporate has

a positive and significant impact on bank distress. This suggests that non-Basel compliant banks in Africa are more affected by macroeconomic variables compared to Basel compliance banks.

Table no. 6 – Logistic Regression Results: CAMELS

	Basel compliance
ETA	-0.132*
	(0.068)
Nplta	0.026
	(0.045)
loan_growth	-0.002
	(0.006)
cost_income	-0.006
	(0.022)
loan_deposit	0.012***
	(0.004)
Netintinc	-0.001
	(0.105)
ROE	-0.038
	(0.036)
ROA	0.502**
	(0.238)
NIM	-0.045
	(0.036)
Gdpgrowth	-0.119
	(0.075)
Reporate	0.098**
	(0.039)
Inflation	0.066*
	(0.034)
_cons	1.801
	(2.518)
N	389
Year effects	Yes

Note: The dependent variable is the non-Basel compliance that takes the value of 1 when a bank is non-Basel compliant in time t and 0 when a bank is Basel compliant to Basel II and/or Basel III. Odd ratio are presented. Standard errors are in parentheses. The superscripts * denotes coefficients *p<0.1, ** p<0.05, *** p<0.001, respectively, and positive and negative signs on odd ratios represents signs for coefficients.

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

In summary, ETA, loan_deposit, ROA, Reporate, and Inflation are important determinants for the resilience of banks in Africa. Nplta, loan_growth, cost_income, netintinc, ROE, NIM, and Gdpgrowth have an insignificant impact. According to Nurazi and Evans (2005), banks should focus on the variables to increase the resilience of banks. Banks that are non-Basel compliant had ETA less than banks that are Basel compliant. They are expected to have more bail-out from governments over concerns of solvency than Basel compliant banks during worsening economic conditions, as shown with the Repo rate. Overall, CAMELS results show, compliance to higher Basel CAR increases the resilience of commercial banks in Africa.

4.2.2 Analysis of resilience of African commercial banks based on Z-score results

This session presents the regression analysis results for equation 5 to examine the impact of Basel CAR on the resilience of commercial banks in Africa using Z-score as a measure of resilience. Before interpreting the results, the Hausman test was carried out to select the appropriate model to estimate equation 5 between random (RE) and fixed effect (FE) models.

The study selected the FE model to estimate equation 5, and the results are in Table no. 7. The results for RE model are also presented in Table no. 8. Robustness checks were performed using pooled regression to examine the consistency of the FE results. The OLS results are presented in Table no. 8 and are similar and consistent with the FE results. Thus, the subsequent interpretation focuses on FE results in Table no. 7. In addition to the robustness checks, Table no. 9 substitute Basel capital ratios with equity to total assets (equity_ta), and also created three dummy variables as a proxy for non-Basel compliant banks, Basel II compliance and Basel III compliance banks. The Table no. 9 result show that equity capital has negative impact on resilience for non-Basel compliant banks, while equity_ta has positive impact on resilience (Zscore2 and Zscore3) for Basel 2 and Basel 3 compliance banks.

Table no. 7 – The impact of Basel CAR on resilience: Z-score (FE result)

	Basel 2 Zscore	**Basel 3 Zscore**	**Basel 4 Zscore**
BIIcap	0.243***		
	(0.001)		
BIIIcap		0.249***	
		(0.001)	
BIVcap			0.244***
			(0.002)
_Isize_2	-0.002**	-0.002**	-0.004**
	(0.001)	(0.001)	(0.002)
_Isize_3	-0.003***	-0.003***	-0.004*
	(0.001)	(0.001)	(0.002)
_Isize_4	-0.002	-0.003**	-0.005*
	(0.002)	(0.001)	(0.003)
_Isize_5	-0.001	0.000	-0.003
	(0.002)	(0.002)	(0.004)
leverage	-0.001	-0.002*	0.000
	(0.001)	(0.001)	(0.002)
loandp	-0.002**	-0.002**	0.003
	(0.001)	(0.001)	(0.002)
Nplta	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Gdpgrowth	0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)
inflat	0.000	-0.002***	-0.002
	(0.001)	(0.001)	(0.001)
Reporate	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
_cons	0.230***	0.216***	0.217***
	(0.005)	(0.005)	(0.011)
N	429	452	455
R-squared	0.9963	0.9968	0.9932

Note: Standard errors are in parentheses, * p<0.1, ** p<0.05, *** p<0.001

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

The capital variables are calculated according to Basel II, Basel III, and Basel IV capital requirements. The results in Table no. 7, BIIcap, BIIIcap, and BIVcap, are positive and significant, indicating that changing from BIIcap to BIIIcap increased the Z-score (resilience) by 2.5 percent. The results also show that change from BIIIcap to BIVcap led to a 2 percent decrease in the Z-score (resilience). Nevertheless, the resilience of the banks under Basel 4 model is higher than banks in Basel 2 model. The result suggests that higher CAR increase the resilience of banks in Africa. The results are consistent with Adesina and Mwamba (2016); Giordana and Schumacher (2017); Hossain et al. (2018) findings that higher CAR positively impacts on banks' resilience. The quintiles of size (Isize 2, 3, 4 & 5) were intended to capture the expectation that large banks can diversify and enjoy economies of scale, reduce risk and increase resilience relative to smaller banks. Size has a negative and significant impact on resilience in Africa. The negative and significant impact of size on Z-score models for small (Isize2) and medium (Isize3 & 4) banks suggests that size contributes to bank distress in Africa. These results are consistent with Chiaramonte and Casu (2017) findings that size is positively correlated with the probability of bank distress.

Leverage has a negative and significant impact on resilience under Basel 3 model. The results are inconsistent with Hossain et al. (2018) findings that leverage has a positive and significant relationship on Z-score in BRICS countries. The leverage ratio was expected to be negative to act as a backstop to constrain banks from financing more loans against available capital (Brei & Gambacorta, 2014; Psillaki & Georgoulea, 2016). Such that to finance more loans, banks will either increase capital buffers or leverage ratio increases. Loandp has a negative and significant impact on resilience under Basel 2 and Basel 3 model at the 5 percent level of significance. This suggests that less liquidity risk increases the resilience of banks in Africa and vice versa. *Nplta* has a positive and significant relationship. The result suggests that an increase in non-performing loans increases the probability of bank distress in Africa. In summary, the positive and significant impact of all the Basel capital ratios on Zscore shows that banks with higher capital can absorb risk exposures.

Table no. 8 – The impact of Basel CAR on resilience: Z-score (RE and OLS result)

Random effects				**OLS**			
	Basel 2 Zscore	**Basel 3 Zscore**	**Basel 4 Zscore**		**Basel 2 Zscore**	**Basel 3 Zscore**	**Basel 4 Zscore**
BIIcap	0.243***			BIIcap	0.245***		
	(0.001)				(0.001)		
BIIIcap		0.249***		BIIIcap		0.250***	
		(0.001)				(0.001)	
BIVcap			0.242***	BIVcap			0.238***
			(0.002)				(0.002)
_Isize_2	-0.002**	-0.002***	-0.004**	_Isize_2	-0.002***	-0.004***	-0.007***
	(0.001)	(0.001)	(0.002)		(0.001)	(0.001)	(0.002)
_Isize_3	-0.003***	-0.003***	-0.003	_Isize_3	-0.002***	-0.004***	-0.004**
	(0.001)	(0.001)	(0.002)		(0.001)	(0.001)	(0.002)
_Isize_4	-0.002	-0.002*	-0.004*	_Isize_4	-0.002***	-0.002***	-0.004*
	(0.001)	(0.001)	(0.003)		(0.001)	(0.001)	(0.002)
_Isize_5	-0.001	0.000	0.000	_Isize_5	-0.002**	-0.002*	-0.005**
	(0.001)	(0.001)	(0.003)		(0.001)	(0.001)	(0.003)

Random effects				**OLS**			
	Basel 2 Zscore	**Basel 3 Zscore**	**Basel 4 Zscore**		**Basel 2 Zscore**	**Basel 3 Zscore**	**Basel 4 Zscore**
leverage	0.000	-0.002**	-0.001	leverage	-0.001	-0.002***	-0.005***
	(0.001)	(0.001)	(0.002)		(0.001)	(0.001)	(0.002)
loandp	-0.001	-0.001	0.005**	loandp	0.002***	0.003***	0.015***
	(0.001)	(0.001)	(0.002)		(0.001)	(0.001)	(0.002)
Nplta	0.000***	0.000***	0.000***	Nplta	0.000***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Gdpgrowth	0.000	0.000	0.000	Gdpgrowth	0.000	0.000	0.001
	(0.000)	(0.000)	(0.001)		(0.000)	(0.000)	(0.001)
inflat	0.000	-0.001**	-0.001	inflat	0.000	0.000	0.005***
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Reporate	0.000	0.000	0.000	Reporate	0.000	0.000	0.000*
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
_cons	0.228***	0.213***	0.221***	_cons	0.220***	0.207***	0.222***
	(0.005)	(0.005)	(0.011)		(0.005)	(0.006)	(0.015)
N	429	452	455	N	429	452	455
R-squared	0.9962	0.9967	0.9929	R-squared	0.9975	0.9976	0.9937

Note: Standard errors are in parentheses * p<0.1, ** p<0.05, *** p<0.001.

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

Table no. 9 – The impact of Basel CAR on resilience: Z-score (FE-Robustness test)

	Non-Basel Zscore	**Basel 2 Zscore2**	**Basel 3 Zscore3**
Basel_n	0.012		
	(0.009)		
Basel_2		0.000	
		(0.006)	
Basel_3			0.006
			(0.010)
equity_ta	-0.003***	0.006***	0.011***
	(0.001)	(0.001)	(0.001)
_Isize_2	0.110***	-0.011	0.036***
	(0.015)	(0.012)	(0.011)
_Isize_3	0.214***	-0.004	0.054***
	(0.016)	(0.014)	(0.013)
_Isize_4	0.326***	0.021	0.067***
	(0.021)	(0.018)	(0.016)
_Isize_5	0.438***	0.027	0.022
	(0.031)	(0.026)	(0.025)
leverage	0.243***	0.087***	0.051***
	(0.012)	(0.011)	(0.012)
loandp	0.011	-0.017	-0.021*
	(0.014)	(0.012)	(0.011)
Nplta	-0.002***	-0.001*	-0.001**
	(0.001)	(0.001)	(0.000)
Gdpgrowth	0.013***	-0.009**	-0.019***
	(0.005)	(0.004)	(0.004)

	Non-Basel Zscore	Basel 2 Zscore2	Basel 3 Zscore3
inflat	-0.046***	-0.011	0.007
	(0.008)	(0.007)	(0.007)
Reporate	0.002***	-0.000	0.000
	(0.001)	(0.001)	(0.001)
_cons	0.713***	0.650***	0.679***
	(0.072)	(0.056)	(0.056)
N	495	429	452
R-squared	0.8644	0.4806	0.5771

Note: Standard errors are in parentheses * p<0.1, ** p<0.05, *** p<0.001.

Source: Author's calculation based on data obtained from Bloomberg databases (2019)

4.3 Discussion of the findings

The study's objective was to examine the impact of capital adequacy on the resilience of commercial banks in selected African countries. The objective was achieved using two risk measures as proxy for resilience. The first risk measure was CAMELS ratings to examine whether compliance to Basel CAR impacts the resilience of African banks using CAMELS indicators. The second risk measure uses Z-score model to examine the impact of changes in Basel CAR and other determinants on the resilience of banks in Africa. The ETA results establish that lack of compliance to Basel CAR reduces the resilience of banks in Africa. The result is consistent with Adesina and Mwamba (2016); Chiaramonte and Casu (2017); Giordana and Schumacher (2017) that higher CAR increases the resilience of banks. The implication of these findings for African banks is that banks that are not Basel compliant will not have adequate capital to cover for loan losses; such banks are limited in their operations to carry out investment activities.

Furthermore, the results show that banks that are not Basel compliant are affected by liquidity, earnings, and macroeconomic factors than Basel compliant banks. This means that Basel compliant banks are more liquid, generate more net interest margin, and return on equity to shareholders. Yet, from the results, African banks that are Basel compliant have management efficiency issues. Also, Basel compliant banks in Africa have less return on assets, low loan growth, and tend to be less prone to macroeconomic factors. For policymakers and regulatory authorities, implementing higher CAR should complement credit policies to stimulate banks' lending ability. Credit policies such as credit bureau for assessing borrowers' credit score, low-interest rate environment that reduces cost of loans and non-performing loans. Securitisation laws to enable banks access liquidity through the marketing of their book loans, higher equity capital, and stable macroeconomic environment should be addressed to promote resilience of commercial banks in Africa.

Still, on the impact of higher capital on resilience for banks, the persistent positive impact of higher capital on Z-score for BIIcap, BIIIcap, and BIVcap suggests that higher capital adequacy increases the resilience of banks in Africa. The results are consistent with studies such as Adesina and Mwamba (2016); Chiaramonte and Casu (2017); Papadimitriou et al. (2020), who found that Basel III CAR has a positive and significant impact on bank resilience. Secondly, the comparison of the results across the three Basel levels shows a slight increase in bank resilience when banks move from Basel II CAR to Basel III CAR. Simulated Z-score4 for Basel IV shows that Basel IV CAR will also increase the resilience of banks but

at a declining rate. These findings imply that the adoption of Basel IV CAR has a similar impact on the resilience of African banks as under Basel III CAR. Based on our findings, it is suggested that bank regulators adopt the Basel IV accord for other reasons, such as eliminating the internal approach in calculating capital ratios, enhanced supervisory powers, and additional requirements for global systemically important banks (G-SIBs).

For leverage ratio, the negative results suggest that compliance to Basel III leverage ratio in addition to the capital ratio will contribute to increased resilience of African banks. The findings show that bank size contributes to fragility and distress in Africa. The total assets of African banks are low; thus, many African banks fall into small and medium-sized banks. Compliance with Basel higher CAR will increase the total assets of banks. Nigerian banks' total assets increased with compliance to Basel II CAR, also as South Africa complies with Basel II and Basel III CAR. Thus, compliance with Basel IV requirements is expected to increase African banks' assets.

At the current state, African banks have a high loan to deposit ratio. A higher loan-deposit ratio reduces bank resilience. Thus, tighter loan requirements are crucial in improving the resilience of African banks. In summary, the positive and significant impact of all the Basel capital ratios on bank resilience shows that based on the African banks' characteristics and current historical data for the sample period of 2000 and 2018, adoption of higher Basel CAR increases the banks' resilience and reduces the banking distress or failures.

5. CONCLUSIONS

The aim of Basel III and IV regulations by the Basel Committee is to improve the resilience of banks. For these reasons, the study examined the impact of capital adequacy on the resilience of banks in Africa using historical data from the period 2000-2018 and two risk measures as a proxy for resilience. The empirical findings show a positive relationship between capital adequacy and resilience. These findings are consistent with *a priori* expectation because banks whose capital ratio is low are prone to distress, while a higher CAR increases banks' resilience and prevents banking distress. Non-Basel compliant banks showed a negative impact of capital on resilience. Banks that complied with Basel II and III CAR showed positive impact of CAR on resilience. Compliance with Basel IV CAR shows a similar impact to Basel III CAR on resilience providing evidence that the newly proposed Basel IV will benefit African banks. In other words, implementing higher Basel levels reduces the probability of bank failures and fosters bank stability. More importantly, it increases the banks' capital adequacy. It enables African banks to take on more risks to support growing African economies. For banks to take on more risk to support African growing economies, regulatory authorities and policymakers need to agree to and encourage the implementation of changes in Basel CAR, more specifically, the adoption of the upcoming Basel IV. This will eliminate moral hazard problems where banks operate with low capital buffers, causing distress and failures that have negative consequences in the economy. Also, implementing higher Basel regulations empowers regulators' supervisory functions to monitor banks adequately.

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