Risk-Weighted Capital Regulations and Bank Risk-Taking Behaviour: Evidence from Kenya

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By

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CBK	Central Bank of Kenya
COVID-19	Corona Virus Disease 2019
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
NPLs	Non-Performing Loans
OLS	Ordinary Least Squares
ROA	Return on Assets
ROE	Return on Equity
TCRWAR	Total Capital to Total Risk-Weighted Assets Ratio
TRWA	Total Risk-Weighted Assets
USD	United States Dollar

Abstract

This paper analysed the effect of risk-weighted capital regulation policies on bank risk-taking behaviour in Kenya. The dynamic system Generalized Method of Moments (GMM) model was invoked to estimate plausible models, using a balanced panel data of 30 commercial banks for the period 2011–2018. The main findings of this study suggest significant changes in capital regulations incentivize banks to make fast portfolio adjustments, particularly if they are capital restricted. Bank capital, on the other hand, is a necessary but insufficient criterion for a bank's stability and solvency. Effective capital regulations may be very hard to achieve in countries where accountability, deterrence, and transparency are severely lacking. Therefore, to ensure the efficacy, the Kenyan Government must address the institutional shortcomings that exist in order to meet regulatory capital requirements. This can also apply in the prevailing COVID-19 pandemic that has brought economic consequences which are bound to last much longer, requiring monetary authorities to devise effective policy interventions such as liquidity support, borrower assistance, and monetary easing.

Key words: *Capital regulations; Capital adequacy; Financial risk; Portfolio risk; Stability.*

JEL classification codes: *E58, G38*

1. Introduction

A growing and dynamic economy necessitates a financial system capable of transferring funds between various agents with the purpose of encouraging capital development through a variety of financial services (Ang, 2008). Through the supply of credit and other services to consumers in the economy, the financial sector contributes to the formation of capital (Ang, 2008). However, because the financial sector deals with risks while performing its activities, it must be stable in order to properly accomplish these tasks.

Corporate finance is concerned with the capital structure of a corporation, including its funding and management's efforts to increase the company's value. It also includes the tools and analyses used to prioritize and distribute financial resources. The process of identifying, analysing, and accepting or mitigating investment risk is known as risk management. In the banking sector, risk management is seen as "the rational formulation and implementation of a plan to deal with prospective losses" (Tursoy, 2018). Bank regulations are one way of managing bank risks. This paper focuses on risk-weighted capital regulation policies as a way of managing banks risk-taking behaviour.

The banking sector remained resilient to COVID-19 pandemic in 2020, supported by strong capital and liquidity buffers, reforms undertaken since 2015, leveraging on modern innovative financial technologies and business models, repeal of the interest rates capping law, and COVID-19 policy measures. The Core Capital and Total Capital to Total Risk Weighted Assets (TRWA) ratios averaged 16.5% and 18.9% in the year to June 2021, compared to an average of 16.4% and 18.4%, respectively, since December 2016, against the minimum statutory core and total capital requirement of 10.5% and 14.5%, respectively (Central Bank of Kenya [CBK], 2021).

A sufficient amount of capital is required in the banking industry to ensure financial stability, long-term viability, and a smooth flow of corporate activities (Hussein, 2016). The quantity of suitable capital required for a bank is determined by the bank's regulations, size, and economic conditions. As part of risk management, and in accordance with the Basel III framework, an acceptable level of core capital relative to total asset and risk-adjusted asset must be maintained. When banks are better capitalized, their risk-taking incentives are lowered and their loss buffers are enhanced, resulting in greater financial stability.

Prudent capital requirements help banks stay afloat, but they must be evaluated accurately, and the requirements must be proportional to the risk. The 2007-2008

financial crisis has shown that banks are unable to quantify the risks they face (Aiyar et al., 2015). There is a false sense of security that adherence to capital adequacy standards should be adequate to absorb economic shocks. Furthermore, prudential regulations, like most other types of laws, entail costs, thus the benefits of such regulations should be weighed against the costs of implementation.

The first section of this paper presents an overview of Kenya's banking sector. The rest of the paper is organized as follows: Sections 2 and 3 discuss literature review and methodology used, respectively. Section 4 describes data used. The main empirical findings and results are presented in Section 5; while the robustness checks are carried out in Sections 6. Finally, Section 7 concludes the paper and gives some policy implications resulting from the study.

The structure of Kenya's banking sector

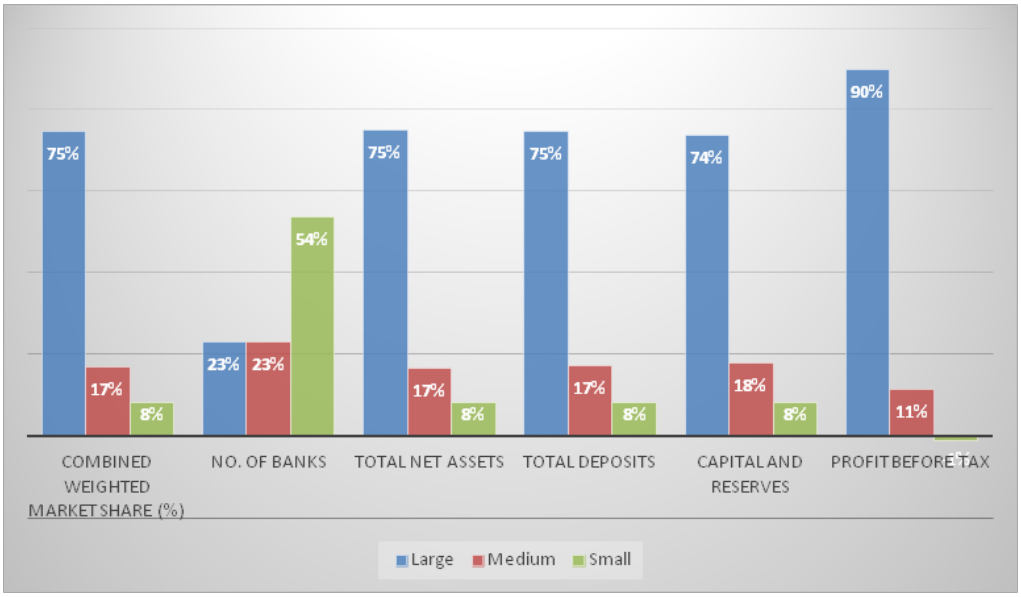
Kenya's banking sector is the most important part of the country's financial system. Kenya's financial sector is getting increasingly intertwined with the domestic and international economy. Banks are linked to telecommunications, product innovations, and distribution channels such as insurance, investment banks, and agents (third-party providers of essential banking services) (CBK, 2015a). The CBK has a principal dictate of price and financial stability of commercial banks.

Even though the stability of Kenya's banking sector has had some significant improvements over the past years, there still remain many challenges (Popiel, 1994). It is faced with interconnected challenges, such as high interest rate spreads, non-performing loans, weak corporate governance practices, low capital bases, among others. Johnson and Upadhyaya (2015) also cite slow conversion of local small privately-owned banks as another challenge in the Kenyan banking sector. In earlier years, most mergers and acquisitions were as a result of bank failures; but in recent years, mergers have been used to create strong capital bases. In a bid to curb high interest rate spreads, a bill capping bank interest rates in Kenya was signed into law in August 2016 to regulate applicable rates to bank loans and deposits. However, it was repealed in 2019 in a move to boost business activity and economic growth. Three major commercial banks in Kenya, namely, Chase Bank, Bank of Dubai, and Empire Bank, recently closed down, indicating that managers did not assess or properly manage bank risks (Gathaiya, 2017). This puts a major test on the reputation of other private banks Upadhyaya, R. (2020).

The Kenyan banking sector consists of the CBK, which served as the regulatory body, 42 financial institutions (41 commercial banks and one mortgage financing company), nine foreign bank representative offices, and 14 microfinance banks as of 31 December 2020. In Kenya, banks are classified mostly according to who owns them. Some banks are locally-owned while others are foreign owned. Forty of the 42 banks were private, with the Kenyan Government owning a majority stake in two of them. Twenty-three of the 40 privately-owned banks were owned by Kenyans (the majority of the shareholding was by Kenyans), whereas 17 were owned by foreigners (CBK, 2020).

Another way to categorize banks is by their size. Kenya's commercial banks are divided into three peer groupings, namely, small, medium, and large. Banks use a weighted composite index for ranking, which includes total assets, total deposits, and shareholder funds. Large banks are rated above 5%, medium banks are rated between 1% and 5%, and small banks are rated below 1%. Figure 1 shows the banking sector market share as of December 2019.

Figure 1: Kenya's commercial banks market share analysis as at December 2019



As shown in Figure 1, the large peer group, consisting of only nine out of the total 39 banks, controls the biggest market share of the banking sector in Kenya. The large peer group has 75% of the market size index, 75% of all the total net assets, and 75% of all the total deposits in the banking sector. This indicates that the banking sector is of medium concentration in terms of the market size index, total net assets, and total deposits. The large peer group also has 74% of the total capital and reserves of the banking sector in Kenya. In terms of profitability, the large peer group accounted for 90% of the total pre-tax profit, while the small peer group proportion of total pre-tax profit was negative one per cent in 2019. This indicates that the banking sector in Kenya is highly concentrated in terms of profitability.

Financial stability in Kenya

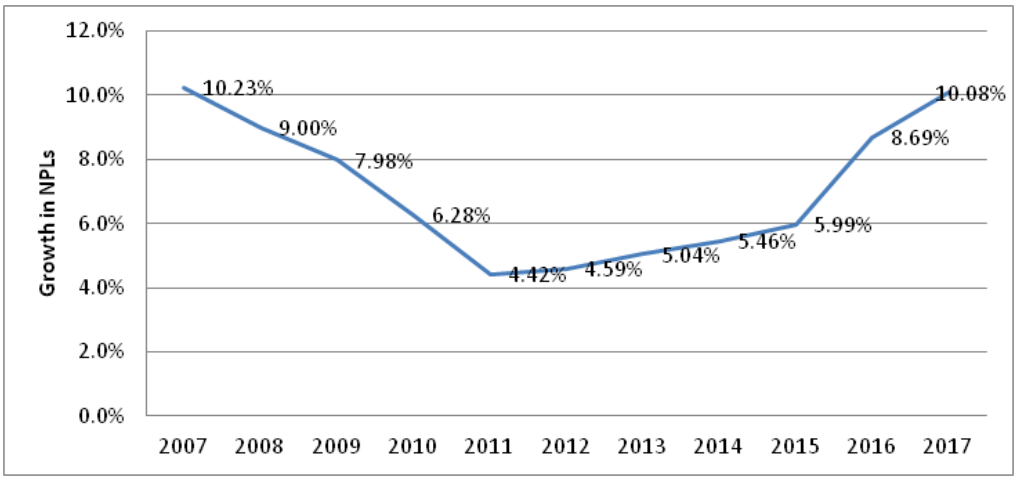
The Kenyan banking industry has grown very rapidly in the past ten years (from 2007 to 2018), which has led to low capital profit margins for some banks and faces financial risks. The country must try to be careful regarding the risks to the financial system and how they affect the economy. According to the CBK (2017), the banking industry

in Kenya generally faces three major risks, leading to a steady decline in bank balance sheets (CBK, 2017). The risks are: credit risk, liquidity risk, and profitability decline.

The main reasons for the serious financial problems of Kenyan commercial banks are directly related to borrowers' credit standards, poor portfolio risk management, or lack of response to fluctuations in economic and competitive conditions (CBK, 2012). Kenyan commercial banks play an important role in mobilizing investment funds by providing loans to many investors. Providing credit is the main activity of the banking industry, and credit is the main asset of commercial banks because it generates most of the operating income. However, the provision of credit exposes commercial banks to the greatest risks (Ghenimi et al., 2017).

The ratio of banks' non-performing loans to assets indicates poor asset quality and financial status. When the financial crisis hits, a high rate of non-performing loans indicates that banks are unhealthy because they have been severely exposed to the source of the problem. Figure 2 display a trend of non-performing loans to total gross loan ratios of commercial banks in Kenya.

Figure 2: Bank non-performing loans to total gross loans (%)



The asset quality, measured by the ratio of non-performing loans to total loans, fell from 9.3% in December 2016 to 11.0% in December 2017, which means that credit risk in 2017 has increased. In December 2016, it was Ksh214.4 billion rising to Ksh264.6 billion in December 2017 (CBK, 2017). Non-performing loans rose sharply from 2013 to 2017. This shows that non-performing loans are a long-standing problem for Kenyan commercial banks. The increase in non-performing loans has led to an increase in the credit risk of the banking industry. If the affected banks fail to achieve their goals or their profits fall sharply, the increase in non-performing loans may be a source of risk. This may eventually lead to bank failures and spread through contagion.

From the perspective of the relationship between bank size and non-performing loans, the ratio of total non-performing loans to total credit of the group's large banks

in 2017 was lower than the industry average (CBK, 2018). In 2017, the total non-performing loan ratio of banks in the small- and medium-sized comparison group was higher than the industry average. The decline in asset quality across the industry in 2017 can be attributed to the slowdown in economic growth. The coverage ratio, measured as a percentage of individual value adjustments to total non-performing loans, fell from 37.6% in December 2016 to 34.5% in December 2017, which means higher risks (CBK, 2018).

Liquidity is also considered to be one of the key indicators of financial stability, because the lack of liquidity in banks due to the interconnection may lead to a systemic crisis in the banking industry (CBK, 2017). The liquidity of a commercial bank shows its ability to provide funds for asset appreciation and perform duties when necessary. For the six months ended December 2014, the average liquidity of the Kenyan banking industry was higher than the 20% regulatory minimum standard that all commercial banks comply with (CBK, 2015b). However, some banks face liquidity problems. For example, on 14 August 2015, Bank of Dubai was placed under bankruptcy management due to capital and liquidity restrictions that prevented it from fulfilling its obligations at maturity (CBK, 2016). The average liquidity ratio in December 2014 was 37.7%, compared with 38.7% in June 2014 and 38.3% in December 2016. This indicates that there may be a decline, leading to liquidity risks.

Profitability is another source of risk for commercial banks in Kenya. Profitability is critical to the sustainability of any bank since it affects the progress of the bank in terms of assets value and it also helps the bank to increase its capital and reserves from the retained earnings (CBK, 2017). At an aggregate level, the industry profits before tax declined by 11.7% with return on assets and return on equity closing March 2017 at 3.6% and 22.8%, respectively.

The profitability of the banking sector has been declining since the year 2012, even though the sector still has positive profits on average. This trend is illustrated in Figure 3.

From Figure 3, we observe that the pre-tax profit of the banking industry fell by 9.6% in December 2017 to Ksh133.2 billion (CBK, 2018). Total revenue fell by 3.1% in 2017 to Ksh486.3 billion, and total expenditure in December 2017 fell by 0.5% to Ksh353.1 billion. Compared with 2016, the decrease in private sector loans, high deposit costs and slower economic growth in 2017 led to a decline in profitability. Profitability weakens the ability of banks to build capital buffers by using retained earnings to buffer shocks. Capital buffers are excess capital held by banks that exceed the minimum required capital (Jokipii & Milne, 2011).

In addition, the return on equity (ROE) and return on assets (ROA) have been continually declining since the end of 2016. ROE reached its lowest level of 19.8% in February 2017, while ROA reached its lowest level of 2.3% in January 2017. In December 2017, the ROA was 2.6%, while in December 2016 it was 3.2%, and the ROE was 20.6%. In December 2016, it was 24.4%. As balance sheet risks increase, the loss of income over time may pose risks to financial stability. It also reduces the accumulation of capital buffers to cushion shocks. As shown in Figure 4, the average

positive profitability is not enjoyed by all the banks. For example, there were huge disparities in profitability among the top and bottom banks in Kenya from the year 2015 to 2018.

Figure 3: Profitability growth rate of the banking sector (%)

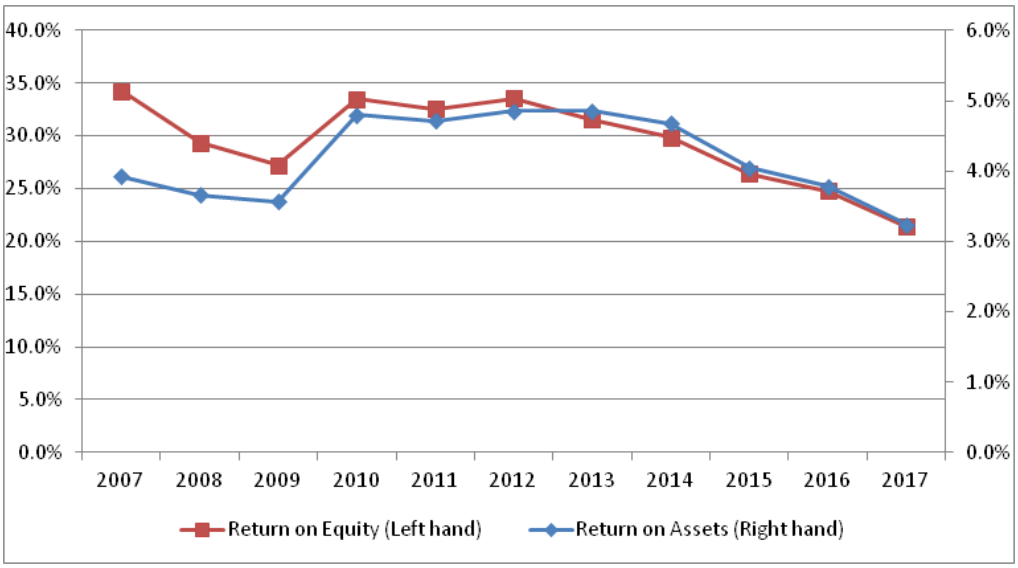
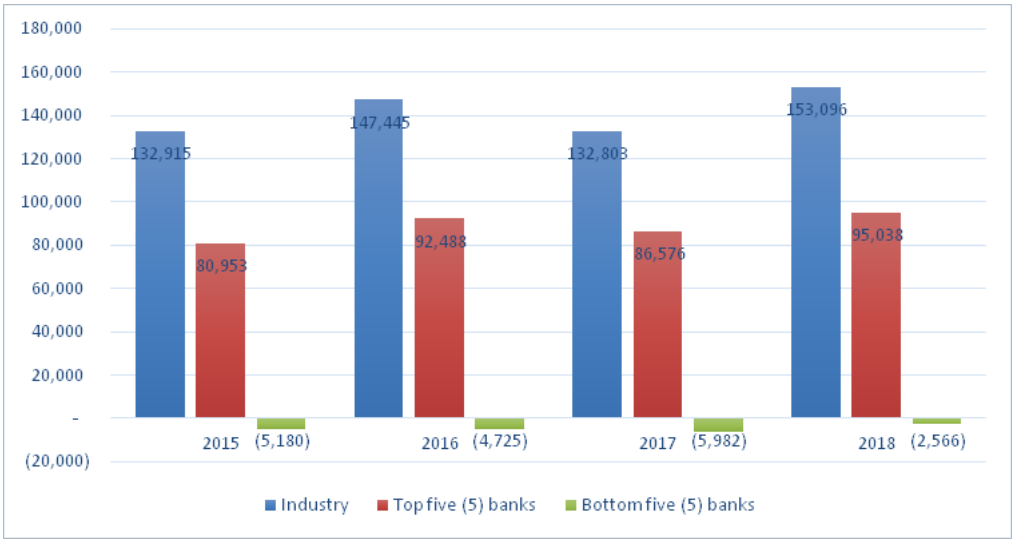


Figure 4: Profits before tax (Ksh. millions) of top and bottom five banks



Despite the strong growth in profitability, the overall performance of the banks remains mixed. The five largest banks are far from the five lowest in terms of profits before tax. Compared with the top five banks, the bottom five banks have negative pre-tax profits, while the top five banks have strong and positive ratios. The banks with

negative profits can affect the other banks through contagion. Declining profitability and/or expanding losses hinder the ability of banks to build up adequate capital reserves and capital buffers through retained earnings.

Prudential capital requirements in Kenya

Prudential capital regulations address the bank's risk of defaulting by creating a relationship between asset risk and minimum capital ratio requirements. The main goal of this framework is to ensure the security and robustness of the banking system (Aiyar et al., 2015). Regulatory capital requirements are designed to improve the stability and flexibility of the banking industry. A more stable banking industry also includes fewer bank failures. Regulatory minimum capital requirements are the legal minimum capital requirements that banks or other financial institutions must have. They show the percentage of bank equity to its risk-weighted assets.

Banking is one of the most regulated sectors in an economy. The regulations range from licensing requirements to continuous supervision, to bank-specific default systems and deposit protection (Beck et al., 2010). The amount of capital an organization owns can be used to measure its financial strength and stability. The external risks between financial institutions, and from them to the real economy, are market failures that justify prudential supervision (De Nicoló et al., 2012). Therefore, regulatory intervention can improve social efficiency. Regarding regulatory capital requirements, the Basel Committee (Basel III) international standards are used by the CBK and set to determine the minimum capital requirements for Kenyan commercial banks. These ratios are subject to review and may change from time to time. The CBK implemented risk-based capital regulation for all commercial banks in 2004. The regulations have been revised several times by the CBK.

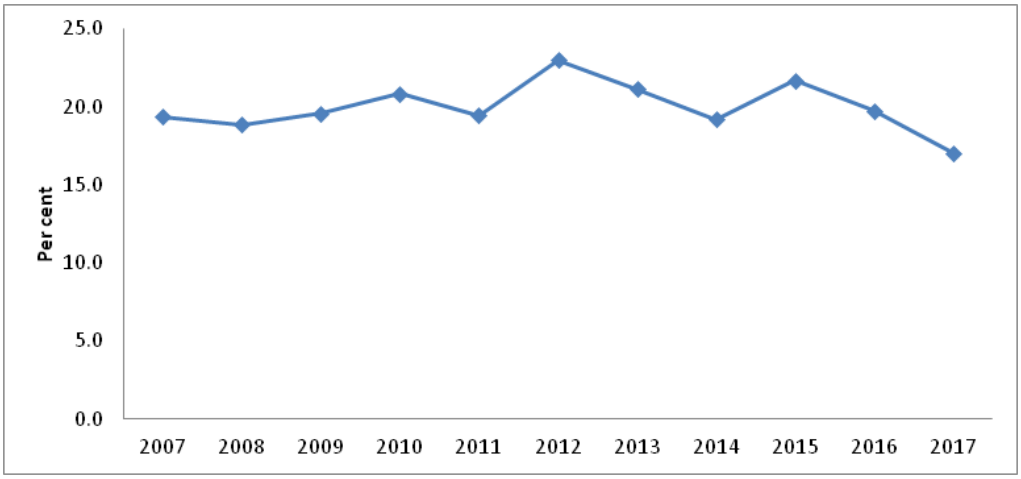
Major regulatory changes were instituted by the CBK from the year 1999, which have helped in stability of the banking sector. The CBK also adopted guidelines that allowed innovations in the banking sector, agent banking, and mobile banking (Johnson & Upadhyaya, 2015). This has helped in increased financial deepening in Kenya. The share of the adults using various forms of formal financial services was 66.7% in 2013, 41.3% in 2009, and 27.4% in 2006 (Johnson & Upadhyaya, 2015).

The CBK revised the capital adequacy ratio guidelines and introduced Basel III requirements in January 2013 to adopt a 2.5% capital retention buffer. However, banking institutions were required to have this capital before 1 January 2015. Therefore, there were two years for banks to build their capital preservation gradually rather than suddenly (CBK, 2014). According to the CBK, the capital buffer is supposed to have high quality capital, which should contain largely common equity, premium reserves, and retained earnings. The CBK requires institutions to hold at least 20% of statutory deposit liabilities, maturity and current liabilities in cash. The regulatory guidelines have been implemented since 1 January 2006, and have maintained the same ratio to this day. Kenya's current regulatory capital requirements are key to financial stability.

The Central Bank of Kenya requires banks to maintain a minimum Total Capital to Risk Weighted Assets Ratio equal to 12% from the year 2006 to 2014 and 14.5% from the year 2015 to date. Some banks have regulatory capital ratios below these limits in some years, while other banks have ratios much higher than these limits. Due to different pressures from regulatory agencies, banks with capital adequacy ratios above and below the regulatory limit may react differently when adjusting the risk-weighted assets in their investment portfolios (Ashraf et al., 2016).

In this study, the use of Total Capital to Total Risk-Weighted Assets Ratio (TCRWAR) as a proxy for prudential capital regulations in its analysis is adopted. Total Capital to Total Risk Weighted Assets was reported at 18.8% in December 2017. This shows a decrease from the previous figure of 19.8% for December 2016. The data reached an all-time high of 23.0% in 2012. Figure 5 shows the trend of the Total capital to risk-weighted assets ratio in Kenya.

Figure 5: Total capital to risk-weighted assets ratio in Kenya (%)



Generally speaking, banks are well-capitalized in meeting the minimum capital requirements, and the capital ratio is still higher than the regulatory minimum requirements. In December 2017, the ratio of total capital to total risk-weighted assets was 18.8%, and the required minimum ratio was 14.5%. However, in the year 2014, two banks in Kenya failed to meet the minimum TCRWAR of 12% due to their increase in loan loss provisions (CBK, 2017). If it spreads to other institutions, it may cause financial instability. The spillover effect of a bank's failure is always likely to spread quickly to the entire economy, and may cause other banks to fail, thereby triggering systemic risks.

A bankrupt bank can attempt to borrow money from other solvent banks to pay its depositors. If the bankrupt bank fails to pay depositors, it will trigger bank panic, and depositors will go to the bank to get their money back. Default may cause losses to depositors and other creditors, disrupt long-term bank–customer credit relationships,

disrupt payment systems, and spread to other banks, financial institutions and markets, and even macroeconomics (Kaufman , 1996). Even though we have deposit insurance (Kenya Deposit Insurance Corporation) to cover depositors from losing their money, the cover is very low in Kenya. The customers are insured up to a maximum deposit of Ksh100,000 (USD 903) only.

2. Theoretical and related literature

Theoretical review

The capital buffer theory

In this theory, bank's goal is to have more capital than suggested. This becomes a capital buffer. Adequate capital buffer regulations aim to decrease the procyclical nature of loans by encouraging creation of countercyclical buffers (Von Thadden, 2004). Capital buffers are excess capital held by banks that exceed the minimum required capital (Jokipii & Milne, 2011). The capital buffer theory states that banks with low capital buffers try to rebuild sufficient capital buffers by borrowing capital, while banks with high capital buffers try to maintain their capital buffers. Extra capital has a tendency to absorb negative shockwaves, thereby reducing probability of adversity (Rime, 2001). As Laeven and Levine (2009) pointed out, when portfolio risks increase, banks will raise funds to maintain their capital buffers, which is obviously related to capital adequacy ratios and bank performance.

Public interest theory of regulation

The public interest theory of regulation is part of welfare economics that aims to protect the public from exploitation. It emphasizes that regulation is supposed to maximize social welfare. It argues that regulation is done after a cost–benefit analysis, which aims to determine if the cost of improving marketing activities exceeds the amount of social welfare added. Regulators are seen as representing the interests of the society in which they operate rather than the private interests of the regulators (Posner, 1974). Regulation is used to address the problems of imperfect competition, unbalanced market processes, lack of markets, and unfavourable market outcomes. By facilitation, maintenance, or imitation of market processes, regulation can improve allocation (den Hertog, 2012). On the other hand, bad regulation can be harmful because it represents capture, which can take the form of erecting barriers to keep existing firms competitive.

Empirical review

Aiyar et al. (2015), in their study, uses a sample of 88 British banks to study the correlation between monetary policy and regulatory capital requirements. The sample includes 48 British banks and 40 foreign subsidiaries. In the research, the panel VAR model is used for analysis. The study concluded that tightening capital requirements or monetary policy will lead to a decrease in credit supply. Credit supply of large banks will obviously respond to regulatory capital requirements changes, but not in monetary policy changes. The credit supply of small banks responds to regulatory capital requirements and monetary policy changes. The findings show that the theoretical agreement is that monetary policy should focus on price stability goals, and that regulatory capital requirements changes are a more effective tool to achieve financial stability goals related to credit supply (Aiyar et al., 2015).

Klomp and de Haan (2014) used sample data of more than 400 banks in 70 developing countries (including Kenya) for the years 2002 to 2008 to examine the impact of bank regulation on bank risks. The study uses a dynamic panel model that takes into consideration the quality of the organization. The systematic GMM method is used to alleviate the possible endogenous problems of bank supervision and regulation. The results indicate that stricter supervision and regulation guidelines reduce risks of the banking industry. Precisely, due to stricter regulatory capital and regulator control, bank risks have been reduced. The results also show that, in the case of higher institutional quality, liquidity supervision and restrictions on certain banking activities also involve bank risks. Effectiveness of supervision and control depends on the specific characteristics of the bank, such as bank size, risk, stock exchange listing, and ownership structure (Klomp & de Haan, 2014).

Gudmundsson et al. (2013) conducted a study to examine the effect of capital requirements on the competition and stability of the banking industry in Kenya from 2000 to 2011. The study used the OLS regression model on the fixed effects panel to estimate a sample of 36 commercial banks effect due to bank capital supervision. The research results show that regulatory Tier 1 capital requirements have a significant non-linear impact on competition. Calculations show that the increase in regulatory core capital first reduces competition to a certain extent, and then significantly intensifies competition. This shows that the benefits of increasing regulatory capital requirements after the banking industry has been integrated have been realized (Gudmundsson et al., 2013). The research results also show that there is a positive correlation, supporting signs that the regulatory capital requirements improve bank performance and financial stability (Gudmundsson et al., 2013).

Mohapatra et al. (2020) provide clues about the risk factors that affect bank stock pricing. They use ten years of data from public and private banks in India. They were able to effectively come up with a model based on conditional information (such as bank profitability, leverage, asset quality, operating profit margin, and loss of asset reserves). They found that bank-specific risk factors affect the price of emerging market bank stocks and thus their returns.

In short, other related studies have concluded that capital requirements have a certain impact on financial stability and bank risks. It can also be clearly seen from various studies that bank-specific characteristics and macroeconomic variables are related to financial stability and bank risks to a certain extent. However, there are research gaps in the reviewed literature. The research of Klomp and de Haan (2014) was conducted in a transnational environment in Kenya. Due to the focus on large-scale macro social units with different characteristics, transnational analysis faces special challenges. The current study uses a detailed country-level analysis of Kenya. Gudmundsen et al. (2013) did not consider bank risks or macroeconomic variables. One of the loopholes in the early studies was that they did not assess the effect of prudent capital requirements on Kenya's systemic risks and financial stability. The study fills this gap by accurately examining how regulatory capital requirements affect the risky behaviour of Kenyan banks. This research has made a useful contribution to the research on regulatory capital requirements. In addition, the research reviewed is not specific to Kenya. It is worth noting that different countries may have different results, which creates a research gap and requires country-specific research for Kenya.

3. Methodology

The methodology used is borrowed from Ashraf et al. (2016), who states that one prudential capital adequacy ratio and a set of two regulatory pressure variables should be used as the main explanatory variables. In the present study, the total capital to risk-weighted assets ratio was used as a proxy for prudential capital regulation. The study employed the difference between actual and target capital ratios as the input variable for prudential capital regulation. The two regulatory pressure variables used in the study are high regulatory pressure (HRP_LTCRWAR) faced by banks having Total Capital to Risk-Weighted Assets Ratio (TCRWAR) lower than the required minimum limits; and low regulatory pressure (LRP_HTCRWAR) faced by banks having Total Capital to Risk-Weighted Assets Ratio (TCRWAR) higher than the required minimum limits. According to the actual level of regulatory capital of each bank, two variables are used to measure regulatory pressure:

$$\text{HRP\_L}TCRWAR = \left(\frac{1}{TCRWAR_i} - \frac{1}{Statutory\ TCRWAR}\right) \quad (1)$$

$$\text{LRP\_H}TCRWAR = \left(\frac{1}{Statutory\ TCRWAR} - \frac{1}{TCRWAR_i}\right) \quad (2)$$

Where: TCRWARi is the actual annual Total Capital to Risk-Weighted Assets Ratio of a bank in a year; and statutory TCRWAR is the minimum annual Total Capital to Risk-Weighted Assets Ratio required by the Central Bank of Kenya in that year.

HRP_LTCRWAR measures the high regulatory pressure faced by banks with a ratio of total capital to risk-weighted assets (TCRWAR) below the required minimum level. Since banks with a ratio of total capital to risk-weighted assets higher than the required minimum limit will not face strong regulatory pressure, all other variables observed by banks, high regulatory pressure, are set to zero. Therefore, for all bank observations where the ratio of total capital to risk-weighted assets is greater than the regulatory limit, the high regulatory pressure variable is zero; when the ratio of total capital to risk-weighted assets is lower than the regulatory limit, its value increases. For total capital and risk, the bank observation with the lowest weighted asset ratio

has the highest value. The higher values of these variables reflect greater regulatory pressure to increase the capital adequacy ratio. High regulatory pressure variables are expected to affect the portfolio risk of bank assets, because banks with lower capital ratios may reduce risk-weighted assets to meet higher risk capital requirements.

LRP_HTCRWAR measures the low-level regulatory pressure faced by banks with a ratio of total capital to risk-weighted assets (TCRWAR) higher than the minimum requirement. Banks with regulatory capital ratios much higher than the minimum capital adequacy ratio are subject to less supervision and have more freedom in choosing risk strategies. For all other bank observations (calculation of low regulation pressure), the low regulation pressure variable is set to zero. Therefore, for all bank observations where the ratio of total capital to risk-weighted assets is below the regulatory limit, the low regulatory pressure variable is zero. When the ratio of total capital to risk-weighted assets exceeds the regulatory limit, its value will increase, and the value of the bank watch with the highest ratio of total capital to risk-weighted assets is the highest. The higher the value of these variables, the less is the regulatory oversight and greater freedom for banks to choose risk strategies. The impact of the "low regulatory pressure" variable on banks' risk appetite is uncertain; since banks with a regulatory capital higher than the minimum requirement are not subject to regulatory pressure, they can adjust portfolio risk to a higher level to offset the expensive cost of equity (i.e., capital buffer theory), or they can establish capital buffers in the following ways to reduce portfolio risk to deal with future uncertainties.

In this study, one dependent variable, Risk-Weighted Assets to Total Assets ratio (RWA_TA), to proxy for bank portfolio risk in two alternative models as adopted from Ashraf et al. (2016), was used. However, we also included bank-specific characteristics and macroeconomic control variables in our analysis. We used two models to analyse how prudential capital regulations policies can effectively curb financial risks in Kenyan banks. Firstly, the Total Capital to Risk-Weighted Assets ratio, a proxy for prudential regulation, was used as the main explanatory variable and its effect examined on the bank risk-taking proxy variable (RWA_TA), after including other control variables in regressions as stated in Equation 2. Secondly, the prudential regulation variable was replaced with a set of two regulatory pressure variables (high regulatory pressure and low regulatory pressure) and their effects examined on the bank risk-taking proxy variable (RWA_TA) as stated in Equation 4.

$$\mathrm{RWA\_TA}_{i,t} = \theta + \alpha \mathrm{RWA\_TA}_{i,t-1} + \lambda TCRWAR_{i,t} + \beta_1 LD_{i,t-1} + \beta_2 LnSIZE_{i,t-1} + \beta_3 LnNPLs_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 ROE_{i,t-1} + \phi_1 GDP_{i,t} + \phi_2 r_{i,t} + \mu_i + \varepsilon_i \quad (3)$$

$$\mathrm{RWA\_TA}_{i,t} = \theta + \alpha \mathrm{RWA\_TA}_{i,t-1} + \lambda_1 \mathrm{HRP\_LTCRWAR} + \lambda_2 \mathrm{LRP\_HTCRWAR} + \beta_1 LD_{i,t-1} + \beta_2 LnSIZE_{i,t-1} + \beta_3 LnNPLs_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 ROE_{i,t-1} + \phi_1 GDP_{i,t} + \phi_2 r_{i,t} + \mu_i + \varepsilon_i \quad (4)$$

Where: RWA_TA is Risk-Weighted Assets to Total Assets ratio which was used as a bank risk-taking proxy; TCRWAR is Total Capital to Risk-Weighted Assets Ratio, which is used as the prudential capital regulations indicator; HRP_LTCRWAR is high regulatory pressure faced by banks having total Capital to Risk-Weighted Assets Ratio lower than the required minimum limits. LRP_HTCRWAR is low regulatory pressure faced by banks having total Capital to Risk-Weighted Assets Ratio higher than the required minimum limits; LD is Loans to deposits ratio; SIZE is a bank's total net assets, which is a proxy for its size; NPLs is non-performing loans; ROA is a return on assets; ROE is return on equity; GDP is gross domestic product growth rate; *r* is real interest rate growth; and εit is the error term. The lagged endogenous variables are included to control for autoregressive tendencies.

The dependent variable is the bank risk-taking proxy represented by Risk-Weighted Assets to Total Assets ratio (RWA_TA) in equations 3 and 4. To account for the dynamic dependent variable, the right-hand side includes one-period lag of dependent risk variable in each equation. Five bank-specific characteristics were used in the study. These are the size of the bank, expressed in terms of the bank's total assets (SIZE); loan-to-deposit ratio (LD); non-performing loans (NPL); return on investment (ROA); and return on equity (ROE). The macroeconomic variables used as control variables are: GDP growth rate and real interest rate growth rate (r).

A robustness test to further support the main results was done using the Non-performing Loans to Gross Loans ratio (NPL_GL) as an alternative proxy of bank risk. Two models were examined for robustness check. Firstly, the Total Capital to Risk-Weighted Assets Ratio, a proxy for prudential regulation, was used as the main explanatory variable in model three as stated in Equation 5. Secondly, the prudential regulation variable was replaced with a set of two regulatory pressure variables in model four as stated in Equation 6.

$$\begin{aligned}\mathrm{NPL\_GL}_{i,t} = \theta + \alpha\mathrm{NPL\_GL}_{i,t-1} + \lambda TCRWAR_{i,t} + \beta_1 LD_{i,t-1} + \ \beta_2 LnSIZE_{i,t-1} + \\ \beta_3 LnNPLs_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 ROE_{i,t-1} + \\ \phi_1 GDP_{i,t} + \phi_2 r_{i,t} + \mu_i + \varepsilon_{it}\end{aligned} \tag{5}$$

$$\begin{aligned}\mathrm{NPL\_GL}_{i,t} = \theta + \alpha\mathrm{NPL\_GL}_{i,t-1} + \lambda_1\mathrm{HRP\_LTCRWAR} + \lambda_2\mathrm{LRP\_HTCRWAR} + \\ \beta_1 LD_{i,t-1} + \beta_2 LnSIZE_{i,t-1} + \beta_3 LnNPLs_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 ROE_{i,t-1} + \\ \phi_1 GDP_{i,t} + \phi_2 r_{i,t} + \mu_i + \varepsilon_{it}\end{aligned} \tag{6}$$

Where: NPL_GL is the Non-performing Loan to Gross Loan ratio which was used as a proxy for bank riskiness. All the other variables are as earlier stated in the equations 1 and 2. The dependent variable is bank-risk proxies represented by the Non-performing Loans to Gross Loans ratio (NPL_GL) in equations 3 and 4. To account for the dynamic dependent variable, the right-hand side includes one-period lag of the dependent risk variable (NPL_GL) in each equation.

4. Data and descriptive analysis on study variables

A balanced panel data of 30 commercial banks in Kenya for ten years from 2011 to 2018 was used in this study. The banks used are presented in Table 1.

Table 1: Banks used in the study

Bank	Ownership Type	Bank size Type
African Banking Corporation Ltd	Local	Tier 3
Bank of Africa (K) Ltd	Foreign	Tier 2
Bank of Baroda (K) Limited	Foreign	Tier 2
Bank of India	Foreign	Tier 2
Barclays Bank of Kenya Ltd	Foreign	Tier 1
CFC Stanbic Bank (K) Ltd	Foreign	Tier 1
Citibank N.A Kenya	Foreign	Tier 2
Commercial Bank of Africa Ltd	Local	Tier 1
Consolidated Bank of Kenya Ltd	Local	Tier 3
Cooperative Bank of Kenya Ltd	Local	Tier 1
Credit Bank Ltd	Local	Tier 3
Development Bank of Kenya Ltd	Local	Tier 3
Diamond Trust Bank (K) Ltd	Local	Tier 1
Equity Bank (Kenya) Ltd	Local	Tier 1
Family Bank Ltd	Local	Tier 2
Guardian Bank Ltd	Local	Tier 3
Habib Bank A.G Zurich	Foreign	Tier 3
I & M Bank Ltd	Local	Tier 2
Kenya Commercial Bank Ltd	Local	Tier 1
M Oriental Commercial Bank Limited	Local	Tier 3
Middle East Bank (K) Limited	Local	Tier 3

continued next page

Table 1 Continued

Bank	Ownership Type	Bank size Type
National Bank of Kenya Ltd	Local	Tier 2
NIC Bank Ltd	Local	Tier 2
Paramount Universal Bank Ltd	Local	Tier 3
Prime Bank Ltd	Local	Tier 2
Sidian Bank Ltd	Local	Tier 3
Spire Bank Ltd	Local	Tier 3
Standard Chartered Bank (K) Ltd	Foreign	Tier 1
Transnational Bank Ltd	Local	Tier 3
Victoria Commercial Bank Ltd	Local	Tier 3

The Central Bank of Kenya categorizes banks in Kenya into three tiers or size (Tier 1, Tier 2, and Tier 3) based on selected key parameters. Tier 1 banks consist of the large banks with a huge customer base. The CBK developed this classification system to distinguish different banks based on market share, asset base, and customer deposits. The weighted index of the first-tier banks is above 5%, the weighted index of the second-tier banks is between 1% and 5%, and the weighted index of the third-tier banks is less than 0%.

The data on balance sheet variables and regulatory capital requirements are from the Central Bank of Kenya. In order to fill in the missing values of the Central Bank of Kenya, some data from the annual financial statements provided on the website of the relevant bank were used. The GDP growth rate and real interest rate growth rate data come from the World Bank database. The data used by the study has the attributes of bank effects, dynamic dependent variables, and endogenous explanatory variables. Each bank has different characteristics, such as loan-to-deposit ratio (LD), size, non-performing loans (NPL), return on assets (ROA), and return on equity (ROE) as fixed effects. The main dependent variable, the ratio of risk-weighted assets to total assets (RWA_TA), has a certain degree of sustainability, because long-term loans and investments are included in the calculation of risk-weighted assets for more than one year. The main explanatory variable, the ratio of total capital to risk-weighted assets (TCRWAR) is an endogenous variable because banks can adjust capital and portfolio risks at the same time. Table 2 shows the average of the endogenous and explanatory variables over eight years (2011 to 2018). The mean, standard deviation, and range coefficients of all explanatory variables and endogenous variables are described.

Table 2: Descriptive statistics of study variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Non-performing Loans to Gross Loans ratio	0.0914	0.1085	0.0013	0.9246
Risk-Weighted Assets to Total Assets ratio	0.7150	0.1649	0.0478	0.9941
Total Capital to Risk-Weighted Assets Ratio (TCRWAR)	0.0933	0.0957	-0.365	0.449
High Regulatory Pressure (HRP)	0.2131	1.9225	-11.4420	20.1304
Low Regulatory Pressure (LRP)	2.7597	1.6519	0	6.5759
Loans to Deposits ratio (LD)	0.8494	0.6454	0.0253	8.724
Bank Size	98,619.44	116,904.7	1,599	621,723
Non-Performing Loans (NPLs)	4,084.838	6,514.08	15	34,182
Return on Assets (ROA)	0.0432	0.2450	-0.1414	3.8
Return on Equity (ROE)	0.1659	0.1963	-1.327	0.494
Gross Domestic Product (GDP) Growth Rate	5.5859	0.5737	4.5632	6.3198
Interest rate (r)	7.6648	3.0529	2.7826	11.5478

Source: Author computation, Study Data, 2019.

The mean value of risk-weighted assets to total assets ratio (0.715) shows that, on average, commercial banks have allocated around 71.4% of total assets to risk-weighted assets. The standard deviation of risk-weighted assets to total assets ratio (0.1649) indicates small variation in commercial banks' investment in risk-weighted assets. The mean value of Non-performing Loans to Gross Loans ratio is 0.0764, indicating that 7.6% of the total gross loans are non-performing. The standard deviation of Non-performing Loans to Gross Loans ratio (0.0914) exhibits almost the same trend as risk-weighted assets to total assets ratio.

The study employed the difference between actual and target capital ratios as the input variable for prudential capital regulations. The data indicate that the average total capital to risk-weighted assets ratio (TCRWAR), which was used as a proxy for prudential capital regulations for the banks, was approximately 9.3, with minimum value of -0.365 and a maximum value of 0.449. The mean value of prudential regulatory capital as measured by total capital to risk-weighted assets ratio (TCRWAR) of 9.3% over the sample period, indicates that, on average, banks maintained regulatory capital (TCRWAR) ratios lower than the set minimum limits of 12% from year 2006 to 2014, and 14.5% from year 2015 to date as required by the Central Bank of Kenya. The minimum value of prudential regulatory capital as measured by total capital to risk-weighted assets ratio of -36.5%, indicates that some banks had the regulatory capital ratios lower than the statutory required ratio. The maximum value of prudential regulatory capital as measured by total capital to risk-weighted assets ratio (TCRWAR) of 44.9%, indicates that some banks had the regulatory capital (TCRWAR) ratios higher than the statutory required ratio.

Two other proxies for prudential capital regulations used in this study are High Regulatory Pressure (due to having the total capital to risk-weighted assets ratio below the required minimum) and Low Regulatory Pressure (due to having the total capital to risk-weighted assets ratio above the required minimum). The mean value of High Regulatory Pressure is 0.2131, while the mean value of Low Regulatory Pressure is 2.60. That is, the mean Low Regulatory Pressure is more than the mean High Regulatory Pressure. This indicates that, on average, more banks have total capital to risk-weighted assets ratio above the required minimum and thus face low regulatory pressure.

The average loan to deposits ratio (LD) is 0.8494, with minimum and maximum ratio of 0.0253 and 8.724, respectively. The data shows that, on average, the commercial banks in Kenya rely on deposits to fund their loans. This is indicated by the average value of 0.8494, which is less than one. The minimum value of 0.0253 indicates that the deposits of some banks are more than the loans given out by the banks, and hence they are not generating optimal return from the interest spread. The maximum value of 8.724 indicates that some banks do borrow from external financing to provide credit to its customers, and therefore bear the risk of not having enough funds to meet possible financial needs in times of crisis.

The data indicate that the average total assets of commercial banks, which was used as a proxy for bank size, was 98,619.44 million, with minimum and maximum values of 1,599 million and 621,723 million, respectively. This shows a big discrepancy in size of different commercial banks in Kenya in terms of their net assets. Loans growth for the complete set of banks has a mean value of 0.3079, with a minimum value of -0.97 and a maximum value of 34.615. The negative minimum growth rate indicates that some banks do have growth rate of their loans decreasing annually. The data indicate that the average non-performing loans (NPLs) of commercial banks were 4,084.838 million, with minimum and maximum values of 15 million and 34,182 million, respectively. This indicates that NPLs is a problem for every bank in Kenya.

The average profitability, proxied by return on assets (ROA) ratio, of the commercial banks in Kenya was 0.0432, with maximum and minimum ROA being 3.8 and -0.1414, respectively. The standard deviation of 0.2445 implies that this indicator has a lower variability. The average return on equity (ROE) ratio of the commercial banks in Kenya was 0.1659, with maximum and minimum ROA being 0.494 and -1.327, respectively. The standard deviation of 0.1963 implies that this indicator has a lower variability. The ratio shows how well a firm's assets are being used to generate profits. The negative minimum values of ROA and ROE indicate that some banks do suffer losses and thus the negative return on assets and equity.

5. Empirical findings

Equations 3 and 4 were separately estimated as model one and two, respectively, using the two-step dynamic system GMM method and the estimation results separately presented in tables 3 and 4. For robustness check, equations 5 and 6 were separately estimated as models three and four, respectively, using the two-step system GMM method, and the results ratio in the two models was used as another proxy for bank riskiness.

The findings indicate that regulatory capital ratio is related to portfolio risks. Banks tend to offset the increase in regulatory capital by reducing asset risk. This shows that banks are more risk-averse. In the context of high economic uncertainty, raising regulatory capital standards forces banks to reduce the credit risk of their asset portfolios and increase their capital adequacy ratios, resulting in an average ratio of total capital to risk-weighted assets higher than legal requirements. Relatively excessive capitalization, loose liquidity, and relatively low non-performing loans enable banks to absorb losses and better manage liquidity crises. Strict regulatory capital requirements effectively force undercapitalized banks to increase their capital levels because they increase the credit risk of their asset portfolios. This shows that regulatory and peer pressures actually force all banks to hold higher than required equity ratios, which leads to excess capital in most banks.

Diagnostic tests

The Wald Chi-squared test

The Wald Chi-squared test is a way to find out if explanatory variables in a model are significant. The Wald Chi-squared test for model one is 2,106.93 with nine degrees of freedom, while model two has a Wald Chi-squared test of 6,978.54 with ten degrees of freedom. The Wald Chi-squared test for model three is 9,543.56 with nine degrees of freedom, while model four has a Wald Chi-squared test of 7,459.99 with ten degrees of freedom. The p-value of the Wald Chi-squared tests for all four models is 0.0000, indicating that the tests are statistically significant at all levels of significance. Therefore, the null hypothesis was rejected, indicating that the coefficients are not simultaneously equal to zero. This indicates that all four models are of good fit.

The first-order and second-order serial correlation of residuals

The consistency of GMM estimates depends on the perturbations in the uncorrelated equations and the effectiveness of the tools. In order to test the consistency of the estimator, the validity of the tool and the assumption of the lack of serial correlation in the error term were tested. The consistency of the estimate depends on the best choice of the tool, and the effectiveness of the tool depends on the lack of serial high-order correlation in the specific component of the error term. Therefore, under the null hypothesis of no serial correlation, the first-order and second-order serial correlations in the first-order difference remainder are tested. The first-order serial correlation test of difference residuals should be significantly negative, and the second-order test should not be significant (Arellano & Bond, 1991; Cameron & Trivedi, 2010).

The results of first-order and second-order serial correlation of residuals are shown in tables 3, 4, 5, and 6. The first-order serial correlations for all the four models are negative and significant at 1% level of significance. The second-order serial correlations for all the four models are insignificant with no evidence of second-order serial correlation. Therefore, the evidence usually indicates the lack of continuous first-order and second-order correlations.

The Sargan test of over-identification conditions

The Sargan test is a restricted over-identification test, which checks the overall effectiveness of the tool by analysing the sample simulation of the instantaneous conditions used in the estimation process. This test has the null hypothesis that the tool is exogenous (Sargan, 1958). The Sargan tests statistics in all the four models show that the GMM model cannot reject the assumption that the over-identification tool is satisfied and is not related to the error term. Thus, the Sargan tests provide no evidence of misspecification.

The system GMM estimation results

Equation 3 was estimated for model one and the results are reported in Table 3. Model one has the dependent variable as risk-weighted assets to total assets ratio (a proxy for bank risk-taking) and the main explanatory variable as Total Capital to Risk Weighted Assets Ratio (a proxy for prudential capital regulations). The coefficient of the lag of dependent risk variables (Lag of Risk-weighted Assets to Total Assets ratio) is positive and significant, suggesting considerable persistence in bank risk-taking. This can be explained by the fact that last year's level of risk will affect the current level of risk.

The results suggest that prudential capital regulations, as proxied by Total Capital to Risk-Weighted Assets Ratio (TCRWAR) has a negative effect on risk-weighted assets to total assets ratio. The coefficient of total capital to risk-weighted assets ratio in model one is -0.622 with a significant p-value of 0.000. The p-value is highly significant,

implying that the total capital to risk-weighted assets ratio decreases risk-weighted assets to total assets ratios of banks. This implies that risk-based capital adequacy requirements are effective ex-ante in reducing bank risk-taking in high risk assets.

Table 3: Model one

Explanatory Variables	Coefficient	Standard Error	Z-Value	P-Value
Risk-Weighted Assets to Total Assets Ratio (Lagged once)	0.298***	0.034	8.790	0.000
Total Capital to Risk-Weighted Assets Ratio	-0.622***	0.126	-4.960	0.000
Loans to deposits ratio (Lagged once)	-0.015**	0.008	-1.950	0.051
Natural Log of Bank Size (Lagged once)	0.009	0.009	0.950	0.340
Natural Log of Non-performing Loans (Lagged once)	-0.010**	0.004	-2.220	0.026
Return on Assets (Lagged once)	0.414	0.844	0.490	0.623
Return on Equity (Lagged once)	0.034	0.074	0.460	0.645
Gross Domestic Product (GDP) growth rate	0.047***	0.008	6.120	0.000
Real interest rate	-0.010***	0.001	-7.490	0.000
Constant	0.361***	0.088	4.100	0.000
Wald Chi-squared test	2,106.93***			0.000
Sargan test	25.5202			0.4897
Arellano-Bond test for the first-order autocorrelation in first differences	-3.2481***			0.0012
Arellano-Bond test for the second-order autocorrelation in first differences	-0.715			0.4746

Source: Author computation, Study Data, 2019.

The negative parameter coefficient of variable total capital and risk-weighted assets in model one shows that the risk-weighted assets to total assets ratio of banks with capital ratios much higher than the minimum limit is lower than that of banks with capital ratios only slightly higher than the minimum limit. That is, the well-capitalized banks tend to invest more in the safer portfolio of assets.

Equation 4 was estimated for model two and the results are reported in Table 4. Model two has the dependent variable as risk-weighted assets to total assets ratio (a proxy for bank risk-taking) and the main explanatory variables as High Regulatory Pressure and Low Regulatory Pressure. The coefficient of the lag of dependent risk variables (Lag of Risk-Weighted Assets to Total Assets ratio) is positive and significant, suggesting considerable persistence in bank riskiness. This can be explained by the fact that last year's level of risk will affect the current level of risk.

Table 4: Model two

Explanatory Variables	Coefficient	Standard Error	Z-Value	P-Value
Risk-Weighted Assets to Total Assets Ratio (Lagged once)	0.335***	0.035	9.680	0.000
High Regulatory Pressure	0.000	0.001	0.580	0.561
Low Regulatory Pressure	-0.009*	0.006	-1.340	0.179
Loans to deposits ratio (Lagged once)	-0.012*	0.008	-1.540	0.124
Natural Log of Bank Size (Lagged once)	0.016*	0.009	1.800	0.071
Natural Log of Non-performing Loans (Lagged once)	-0.010***	0.004	-2.750	0.006
Return on Assets (Lagged once)	0.760	0.913	0.830	0.405
Return on Equity (Lagged once)	-0.006	0.086	-0.070	0.943
Gross Domestic Product (GDP) growth rate	0.056***	0.009	6.600	0.000
Real interest rate	-0.012***	0.001	-8.090	0.000
Constant	0.187**	0.093	2.000	0.046
Wald Chi-squared test	6,978.54***			0.000
Sargan test	25.3422			0.4997
Arellano–Bond test for the first-order autocorrelation in first differences	-3.1114***			0.0019
Arellano–Bond test for the second-order autocorrelation in first differences	0.1705			0.8647

Source: Author computation, Study Data, 2019.

The results of low regulatory pressure variable in model two suggest a strong relationship between regulatory pressure and bank risk-taking. Precisely, the negative and significant coefficient of the low regulatory pressure variable (-0.009) suggests that banks that have their actual capital adequacy ratios above the minimum required regulatory limits have decreased portfolio risk in reaction to risk-based capital requirements. A one percentage increase in low regulatory pressure decreases risk-weighted assets to total assets ratio by 0.9 percentage points ceteris paribus. A probable reason for this decrease in risk-weighted assets by the well-capitalized banks may be the lower credit demand in the economy. Another reason could be a bank's desire to signal a healthier position of the bank to investors. Additionally, the bank may be attempting to build capital buffers in advance to face lower regulatory pressure in the future.

The results suggest that the well-capitalized banks (those facing low regulatory pressure) are more risk-averse and they tend to invest more in the safe portfolio assets. This reduces their Risk-Weighted Assets to Total Assets ratio. The p-value of high regulatory pressure variable is 0.561, which is higher than the statistical significance levels at 1%, 5%, and 10%, indicating weak evidence against the null hypothesis. This

implies that high regulatory pressure has an insignificant effect on Risk-Weighted Assets to Total Assets Ratio.

The other variables included in the model were: gross domestic product (GDP) growth rate; real interest rate; loans to deposits ratio; bank size; non-performing loans; return on assets (ROA); and return on equity (ROE). The coefficients of these variables have the expected sign in the baseline regressions in models one and two as reported in tables 3 and 4. The coefficients of economic growth, as measured by GDP growth rate, are all positive and significant in the two models. These results suggest that economic growth increases banking risk. With improvements in the economy, as measured by GDP growth rate, there is increased borrowing and with it increase in non-performing loans and thus increased risk. Likewise, with improvements in the economy, as measured by GDP growth rate, government borrowing reduces and thus the portfolio of bank's government securities (which have less risk) reduces and bank assets with high risk such as unsecured loans increase.

The coefficients of real interest rates are all negative and significant in the two models. These results suggest that the real interest rate hurts the riskiness of banks. This can be explained by the fact that an increase in real interest rate makes risk-free government securities to be more attractive and the bank assets with high risk such as unsecured loans to be expensive. Therefore, banks invest more in government securities and less in unsecured loans thus reducing the Risk-Weighted Assets to Total Assets Ratio.

Contrary to expectations, the coefficients of loans to deposits ratio is negative in both model one and model two. A higher loan to deposits ratio implies increased loans relative to customer deposits. As loans increase, it would be expected that the risk-weighted assets portfolio would increase. However, the results revealed the opposite, suggesting that the increase in loan to deposits ratio may be due to an increase in the safer type of loans such as commercial borrowing and therefore the negative relationship.

The negative and significant coefficient of the natural log of bank size in model one and model two shows that large banks have less risk-weighted assets to total assets ratio. These results are consistent with Altunbas et al. (2018), who found that large European commercial banks have lower portfolio risk. The estimation results show that the lagged natural log of bank size significantly and positively affects bank's investment in risk-weighted assets. Bigger banks tend to have more capital and thus tend to invest more in the less risky government securities and other less risky assets. This decreases their risk-weighted assets to total assets ratio.

The coefficient of the natural log of non-performing loans is positive and significant in the two models. The results indicate that non-performing loans positively affect bank risk as measured by risk-weighted assets to total assets ratio in the two models. This implies that as the non-performing loans increase, they are removed from the portfolio of risky assets in the risk-weighted assets calculations. This results in a positive effect on the risk-weighted assets to total assets ratio.

The results suggest that profitability, as measured by lagged return on assets (ROA), positively affects banks' risk. In this case, the profitable banks increase their capital

through retained earnings and generate their returns by investing in more risky assets, including unsecured loans. However, this effect is insignificant with p-values of 0.623 and 0.405 in models one and two, respectively. The findings also suggest that return on equity (ROE) does not affect banks risk-taking behaviour. This is indicated by the insignificant p-value of 0.645 in model one and 0.943 in model two.

In summary, the results suggest that well-capitalized banks having capital adequacy ratios above the required regulatory minimum limits have increased assets portfolio risk. These banks are able to engage in more risky lending. But since loans forms the biggest source of bank's profits, the well-capitalized banks ends up getting biggest share of the industry's profits. The findings complement Ashraf et al. (2016), who find that commercial banks in Pakistan have a negative association between capital and bank risk-taking. The findings also support Jokipii and Milne (2011) to the extent that they find a negative association between bank capital and portfolio risk. These findings indicate that risk-based capital regulation is effective in reducing bank risk-taking. Similarly, the findings are in line with those of Klomp and de Haan (2014) who found that regulation had an effect of reducing risks in the banking sector of developing countries, including Kenya. The findings also suggest that bank-specific characteristics affect financial stability. This finding is in line with Githinji (2016), who also concludes that internal factors of commercial banks, such as bank size, affect the financial stability of commercial banks.

6. Robustness tests

To deal with potential endogeneity, robustness tests were conducted using different dependent variables. Equation 5 was estimated for model three and the results reported in Table 3. Model three has the dependent variable as Non-performing Loans to Gross Loans ratio (a proxy for bank riskiness) and the main explanatory variable as Total Capital to Risk-Weighted Assets Ratio (a proxy for prudential capital regulations). The results appear consistent qualitatively with those of model one. The coefficient of lag of the dependent risk variable (Lag of Non-performing Loans to Gross Loans ratio) is positive and significant, suggesting considerable persistence in bank riskiness. This can be explained by the fact that last year's level of risk will affect the current level of risk.

Table 5: Model three

Explanatory Variables	Coefficient	Standard Error	Z-Value	P-Value
Non-performing Loans to Gross Loans ratio (Lagged once)	0.862***	0.043	20.060	0.000
Total Capital to Risk-Weighted Assets Ratio	0.310***	0.023	13.500	0.000
Loans to deposits ratio (Lagged once)	-0.003*	0.003	-1.320	0.187
Natural Log of Bank Size (Lagged once)	0.047***	0.003	13.940	0.000
Natural Log of Non-performing Loans (Lagged once)	-0.019***	0.002	-7.910	0.000
Return on Assets (Lagged once)	-0.666***	0.218	-3.060	0.002
Return on Equity (Lagged once)	-0.138***	0.020	-6.770	0.000
Gross Domestic Product (GDP) growth rate	0.026***	0.001	18.350	0.000
Real interest rate	-0.006***	0.000	-16.960	0.000
Constant	-0.419***	0.034	-12.290	0.000
Wald Chi-squared test	9,543.56***			0.000
Sargan test	26.4282			0.4398
Arellano–Bond test for the first-order autocorrelation in first differences	-2.6184**			0.0088
Arellano–Bond test for the second-order autocorrelation in first differences	0.8657			0.3867

Source: Author computation, Study Data, 2019.

The results suggest that prudential capital regulations, as proxied by Total Capital to Risk-Weighted Assets Ratio (TCRWAR) have a positive effect on non-performing loans to gross loans ratios. The coefficient of total capital to risk-weighted assets ratio is 0.310, suggesting a positive effect on non-performing loans to gross loans ratios. This can be explained by the possibility that when banks feel that they have met the prudential capital regulation requirements, they tend to feel safe and can engage in more risky assets in the form of unsecured loans. The p-value of the coefficient of total capital to risk-weighted assets ratio is 0.000, which is significant at all levels of statistical significance.

Equation 6 was estimated for model four and results reported in Table 6. Model four has the dependent variable as Non-performing Loans to Gross Loans ratio (a proxy for bank risk-taking) and the main explanatory variables as High Regulatory Pressure and Low Regulatory Pressure.

Table 6: Model four

Explanatory Variables	Coefficient	Standard Error	Z-Value	P-Value
Non-performing Loans to Gross Loans ratio (Lagged once)	0.759***	0.033	22.830	0.000
High Regulatory Pressure	-0.012***	0.000	-26.050	0.000
Low Regulatory Pressure	0.010***	0.002	5.490	0.000
Loans to deposits ratio (Lagged once)	-0.004*	0.002	-1.700	0.088
Natural Log of Bank Size (Lagged once)	0.039***	0.004	9.660	0.000
Natural Log of Non-performing Loans (Lagged once)	-0.006**	0.003	-1.990	0.047
Return on Assets (Lagged once)	-0.984***	0.189	-5.210	0.000
Return on Equity (Lagged once)	-0.015	0.014	-1.050	0.293
Gross Domestic Product (GDP) growth rate	0.018***	0.003	5.430	0.000
Real interest rate	-0.006***	0.000	-14.920	0.000
Constant	-0.386***	0.048	-8.040	0.000
Wald Chi-squared test	7459.99***			0.000
Sargan test	22.1600			0.6799
Arellano–Bond test for the first-order autocorrelation in first differences	-2.5901**			0.0096
Arellano–Bond test for the second-order autocorrelation in first differences	1.5408			0.1234

Source: Author computation, Study Data, 2019.

The results appear consistent qualitatively with those of model two. The coefficient of lag of dependent risk variables (Lag of Non-performing Loans to Gross Loans ratio) is positive and significant, suggesting considerable persistence in bank riskiness. This can be explained by the fact that last year's level of risk will affect the current level of risk.

The results of the regulatory pressure, high regulatory pressure and low regulatory pressure variables, in model four shows that there is a strong correlation between regulatory pressure and bank risk. In particular, the positive parameter estimates of variable low regulatory pressure in model four indicate that banks with capital adequacy ratios much higher than the minimum requirements have higher non-performing loans than banks with capital adequacy ratios below the minimum requirements. Similarly, estimates of negative parameters with variable high regulatory pressure indicate that banks with equity ratios far below the minimum requirement have fewer non-performing loans than banks with equity ratios above the minimum requirement. This can be explained by the fact that higher non-performing loans can erode bank capital adequacy ratios. If capital adequacy ratios fall below the required minimum limits, banks will reduce the number of loans they issue due to the high regulatory pressure of meeting the required total capital to risk-weighted assets ratio. This eventually decreases the non-performing loans over time. This suggests that banks having lower capital adequacy ratios reduce the non-performing loan risk.

The coefficients of the control variables have the expected sign in the baseline regressions of models three and four. The coefficients of economic growth, as measured by GDP growth rate, are all positive and significant in the two models. These results suggest that economic growth increases banking risk. With improvements in the economy, as measured by GDP growth rate, there is increased borrowing and with it increase in non-performing loans, thus increased risk.

The coefficients of real interest rates growth are all negative and significant in the two models. These results suggest that the real interest rate has a negative effect on the riskiness of banks. This can be explained by the fact that the increase in real interest rate makes the loans to be expensive making them unaffordable. This reduces the number of total loans and consequently reduces non-performing loans. Also, it may be that when interest rates are high, the banks divert investment to other safer assets such as government securities. This reduces the number of loans granted and consequently also reduces the non-performing loans.

The coefficients of the loans to deposits ratio suggest a negative relation with non-performing loans to gross loans. The significant coefficients of the loans to deposits ratio variable show that banks that have higher deposit ratios have a higher non-performing loan to gross loans ratios. The results suggest that lagged loans to deposits ratio significantly increases banking risk. Higher loans to deposits ratio mean that the bank has more unsecured loans relative to its customer's deposits. Therefore, the increase in unsecured loans increases the ratio of non-performing loans to total loans. These results are consistent with Ashraf et al. (2016), who found that domestic deposits are the main determinant of Pakistani bank loans.

Positive and significant coefficient of the natural log of bank size in models three and four show that large banks have higher non-performing loan ratios. Bigger banks tend to have more capital and can invest more to issue more loans to their customers. This increases their unsecured loans portfolio and consequently also increases their non-performing loans to gross loans ratio. They increase their holdings in riskier assets

to compensate for the costs of holding capital to maximize their returns. This result contradicts Ashraf et al. (2016), who found that large commercial banks in Pakistan have fewer non-performing loans compared to small banks.

The coefficient of the natural log of non-performing loans is negative and significant. The results indicate that non-performing loans negatively affect bank risk as measured by Non-performing Loans to Gross Loans ratio. This finding was surprising and unexpected. The explanation for this inconsistency could be that, when there is an increase in non-performing loans, the banks will tend to avoid the unsecured loans for fear of incurring losses. They invest more in safe government securities and secured loans leading to a decrease in the Non-performing Loans to Gross Loans ratio. This implies that an increase in non-performing loans decreases a bank's risk-taking.

The results suggest that profitability, as measured by lagged return on assets, negatively affects banks' risk. Therefore, the profitable banks increase their capital through retained earnings and generate their returns by investing in the less risky assets. This is shown by the negative coefficient of return on assets in the two models. Thus, the profitable banks are more risk-averse.

The results also suggest that return on equity (ROE) has a negative effect on banks' risk. For banks to offer higher returns to their investors, they need to be more profitable and retain more earnings. This leads them to engage in less risky assets mostly in the form of secured loans or government securities. This has the effect of increasing banking risk by increasing the non-performing loans to gross loans ratio. However, the coefficient of return on equity has an insignificant p-value of 0.293 in model four.

7. Conclusion and policy implications

The main findings indicate that changes in financial regulation provide an impetus for banks to immediately adjust their investment portfolios, especially when facing capital constraints. In order to meet new capital requirements, banks are gradually and steadily adjusting the capital adequacy ratio or credit risk of their asset portfolios. This is consistent with the capital buffer theory. The results also show that, compared with small banks, big banks have different risk appetites. Smaller banks tend to increase their holdings of riskier assets, while larger banks are more risk-averse and hold less risky assets. The willingness to take risks is negatively correlated with profitability; big banks have the highest profits and the lowest portfolio risks, while small banks in the industry have the lowest profits. The results also show that profitable banks increase capital through retained earnings and generate returns by investing in assets with lower credit risk. The bank scale results support the risk aversion attitude of large banks. Large banks with greater market power protect their valuable banking licenses by financing more equity and invest in safer investment portfolios, even if doing so may sacrifice some potential profits.

The macroeconomic variables; real GDP growth rate, and real interest rate also have a significant effect on the assets portfolio of banks. The positive correlation of real GDP growth and risk weighed assets to total assets ratio imply that during periods of economic growth, most banks invest more in risky assets. The banks are confident of the possible returns from risky assets such as unsecured loans. The real interest rate, on the other hand, is negatively correlated to risk weighed assets to total assets ratio. When real interest rates are low, the banks invest more in the risky assets and less in the safe portfolio. This result was not expected since, in Kenya, higher interest rates encourage banks to be willing to invest in risky assets to compensate for the possibility of having very risky borrowers who might default on their loans. However, the reason for this is probably that at low real interest rates, the return on the safe government securities is low, thus banks opt for risky unsecured loans.

This study found that, although the capital adequacy ratio rules are partially effective in forcing banks to make full use of the capital adequacy ratio, the capital adequacy ratio rules have not led to any changes in attitudes towards bankruptcy and portfolio risk. Banks seem to be aware of this, which shows that they hold more excess capital than required. Maintaining a higher than required equity ratio is not only a signal of solvency, but also reflects the bank's belief that keeping equity at a regulatory

level will not necessarily protect them from bankruptcy. However, holding too much capital can adversely affect the profitability of banks, which in turn affects the safety of the entire banking industry and slows down economic growth, especially when banks increase their capital adequacy ratios by reducing the supply of credit to the economy. Therefore, in order to ensure the effectiveness of regulatory capital requirements, the Kenyan Government must address the weaknesses of the institutional environment. In addition, bank capital is a necessary condition for bank stability and solvency, but not a sufficient condition. Vigilant regulators need to ensure that the expected effects of capital requirements on bank risk-taking behaviour can be achieved.

All explanatory variables such as bank size, profitability, economic uncertainty, regulatory and peer pressure, etc., have a significant impact on the bank's equity and credit risk in asset portfolio decisions. However, there are differences in risk appetite among banks of different sizes. This leads to the recommendation that managers of commercial banks in Kenya should be held accountable for the financial soundness of their banks. They should effectively manage credit risk and ensure adequate levels of capital and liquidity to be able to absorb adverse shocks when they occur. As the management ensures that adequate capital is held to absorb any unanticipated losses, the capital ends up playing a regulatory role, hence protecting the banks from breach of capital requirements.

The findings also suggest that smaller undercapitalized banks are more risk-averse than bigger well-capitalized banks. This is comparable to the capital buffer theory. In the capital buffer theory, the bank's goal is to hold more capital than suggested. Adequate capital buffer regulations aim to reduce the procyclical nature of loans by encouraging the creation of countercyclical buffers (Von Thadden, 2004). The capital buffer theory states that banks with low capital buffers try to rebuild sufficient capital buffers by borrowing capital, while banks with high capital buffers try to maintain their capital buffers. Commercial banks with insufficient capital are adjusting their business models to support loans and purchases of government bonds to large corporate borrowers. This, in turn, reduces loans to small-scale and deemed risky borrowers. The policy implication on this is on improving creditworthiness of small borrowers. Thus, information sharing on credit references should be enhanced.

Further analysis showed that low interest rates are good for credit availability since banks will invest more in the risky portfolio which includes unsecured loans. This can be interpreted as being in favour of the Public Interest Theory of Regulation, thus advocate the interest rate capping. However, extreme caution must be exercised on this view since there are some other market driven mechanisms that can bring down interest rates. For example, the government's appetite for borrowing locally should be minimized to coerce banks to lend more to the public. The government should also pursue measures to enhance financial inclusion. Government borrowing through treasury bills, bonds and loans should be distributed to the larger public. Even though there is a new product (M-Akiba) that allows Kenyans to invest small amounts of money in a low-risk, high-return infrastructure bond using their mobile phones, there is lack of awareness and information to Kenyans. The COVID-19 pandemic has

brought economic consequences which are bound to last much longer. This requires the monetary authorities to devise effective policy interventions such as liquidity support, borrower assistance, and monetary easing. This study used a sample of all the banks in Kenya without classifying them into ownership type or bank size. The results may change if we test for different categories of banks, such as foreign owned versus locally owned banks, small or large banks, and so on.

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