CAPITAL ADEQUACY, ASSET QUALITY, EARNINGS AND LIQUIDITY ON OPERATIONAL EFFICIENCY OF COMMERCIAL BANKS IN KENYA

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DOCTOR OF PHILOSOPHY IN
FINANCE

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

2026

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Finance of the Jomo Kenyatta University of Agriculture and Technology

2026

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

This thesis is dedicated to my family that comprises of my husband Nelson, my daughters Karenza, Lowenna and my mother Wanjira. Without their endless love, support, and encouragement, I would never have been able to get this far in my doctoral studies. I love you all and I appreciate everything that you have done for me.

ACKNOWLEDGEMENT

First and foremost, I would like to thank God Almighty for giving me the grace, good health, and ability to write this thesis, and to persevere and complete it satisfactorily. Without His blessings, this achievement would not have been possible. This doctoral thesis is in its current form due to the assistance and encouragement of numerous people. It is a pleasure to express my sincere thanks to all those who helped me with the success of this study and made it an unforgettable experience. It has been a great privilege for me to work under the guidance of Dr. Tabitha Nasieku and Dr. Olanrewaju Isola Fatoki. I am very grateful to them for all the support they provided and for all those hours we spent discussing various aspects of this thesis. Words are insufficient to appreciate them for their instrumental involvement in the design, development, and preparation of this thesis. I am indebted to all the staff of JKUAT for their consistent and dependable support that enabled me to have a conducive environment for scholarly work. I particularly applaud the Department of Economics, Accounting, and Finance lecturers for evaluating my work and giving feedback that helped me improve this thesis and provided guidance for my future research.

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ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey Fuller
ANOVA	Analysis of Variance
ALM	Asset Liability Management
ASEAN	Association of South East Asian Nations
AQ	Asset Quality
BS	Bank Liquidity
BCBS	Basel Committee on Banking Supervision
CA	Capital Adequacy
CAMEL	Capital Adequacy, Asset Quality, Management Efficiency, Earnings Quality, and Liquidity
CAR	Capital Adequacy Ratio
CBK	Central Bank of Kenya
CBN	Central Bank of Nigeria
COVID-19	Coronavirus disease 2019
DEA	Data Envelopment Analysis
DMUs	Decision-making units
DPM	Data Point Modelling
EQ	Earnings Quality
FE	Fixed Effect
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HHI	Herfindahl Hirschman Index
LLC	Levin, Lin, & Chu
M&M	Modigliani and Miller
OE	Operational Efficiency
OS	Ownership Structure
R&D	Research and Development
ROE	Return on Investment
SME	Small and Medium Enterprises

SFA	Stochastic Frontier Analysis
NPAs	Non-Performing Assets
NPLs	Non-Performing Loans
Max	maximum value
Min	minimum value
PP	Phillips-Perron test
QQ	Quantile-Quantile plot
SD	Standard Deviation
TE	Technical Efficiency
TC	Total Cost
VIF	Variance Inflation Factor

DEFINITION OF OPERATIONAL TERMS

Asset Quality refers to the financial health of a bank's loan portfolio. It is measured by the percentage of non-performing loans (NPLs) compared to the total amount of loans issued. (Chen et al., 2009; Ongore, 2013).

Capital adequacy The Basel III definition of Tier one capital includes subordinate capital and debt/equity finances that a company has established. Subordinate debt is uninsured debt that the bank has, that is, the bonds this debt component is senior to equity but junior to the deposits. The assessment is based on an analysis of equity levels that consist of regulatory, economic, and internal capital, as well as information regarding the solvency ratio (Miller, 1995).

Earnings quality Earnings quality indicates the financial health of a bank and in some instances its financial health. Net Interest income is the best indicator of bank earnings quality since it reflects the evolution of the main factors of the banking framework. Net Interest Income is the difference between interest income on assets and interest expenses on liabilities. It is the gross result of financial intermediation (Cebenoyan, 2003).

Operational Efficiency production of maximum output using a given quantity of input or the ability to cost-effectively deliver services and products without compromising on quality (Shawk, 2008; Odunga, 2016).

Liquidity Bank liquidity refers to the ability of a bank to pay for liabilities in the period of maturity. Liquidity challenges arise when banks fail to attain fiscal responsibilities in repaying debt without improper losses occurring (Landskroner & Paroush, 2011).

Stochastic Frontier Analysis parametric technique used to estimate the parameters of the production technologies and those related to the firm's (Badunenko, et al., 2015)

ABSTRACT

The study investigates the capital adequacy, asset quality, earnings quality, liquidity on operational efficiency of commercial banks in Kenya. This was guided by analyzing the effect of capital adequacy, asset quality, earnings quality, bank liquidity and operational efficiency while mark share was used as the moderating variable. Operational efficiency is viewed as a pre-requisite for the financial soundness of any banking institution. In banking literature, empirical review indicated mixed findings on the effect of capital adequacy, asset quality, earnings quality, bank liquidity and market share on the operational efficiency of the respective banks. Thus the issue of agency problems between managers and shareholders, asset liability mismatch and inefficiency remain unclear in Kenyan commercial banks. Thus this study is anchored on theories from agency theory, conventional economic efficiency theory and asset liability management theory. Quantitative research design was embraced as it aligns with the choice of positivism philosophy. Positivism philosophy was used as it allows the researcher to explore measurable and credible results from the financial statements to establish the cordial relationship amongst the variables. A census was applied with the target population being all the 43 banks listed under the Central Bank of Kenya. The study covered a period of 14 years from 2008-2022. The period is appropriate for the research since it incorporates banking sector financial reforms and issues of financial efficiency that shook the Kenyan financial system in 2008. Data was extracted from the verified audited financial statements of the banks available in the Central Bank of Kenya and the official websites of respective commercial banks. The independent variables were capital adequacy, asset quality, earnings quality and liquidity; moderating variable was market structure and dependent variable operational efficiency. In testing Panel regression model, normality, heteroscedasticity and autocorrelation, Shapiro Wilk Test, Variance Inflation Factor (VIF) and Breauch Pagan Test were used. The study used a two-step model of analysis. The first step involved the use of the Stochastic Frontier Analysis approach, where scores were estimated for each of the cross-sections under study. Second, the panel Generalized Method of Moments (GMM), was applied to regress efficiency scores on the regression model. The regression results indicate that capital adequacy demonstrates a substantial positive influence on operational efficiency of banks; however, liquidity has no significant influence on efficiency while asset quality and earnings quality lead to an increase in operational efficiency. Furthermore, the results indicated previous years' earnings are important in determining the current year's operational efficiency. Market structure was found to moderate effect of capital adequacy, earnings quality and liquidity on operational efficiency of banks. This implies that large banks with higher core capital often benefit from economies of scale, allowing them to spread fixed costs over a larger asset base. This can lead to lower average costs per unit of output and greater operational efficiency. Furthermore banks should seek mechanisms to improve these variables to enhance operational efficiency and ensure market readiness.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Banks, which are sometimes seen as the foundation of financial systems, are essential to economic growth because they make it easier for money to move from units with surpluses to those with deficits. Maudos (2017) have pointed out that the success of financial institutions is largely dependent on the efficiency of banks. However the aftermath of Kenya's financial sector liberalization in the early 1990s, the banking sector experience market power dynamics, for instance collapse of certain banks, which reduced the ultimate efficiency of operations among the respective banks. Therefore, efficiency is influenced by a myriad of factors, both internal to individual banks and external within the institutional environment they operate. Restoy (2023), identifies unique challenges in Kenya, including capital deterioration, non-performing loans, inflation, and limited fiscal resources, all of which necessitate focused efforts to enhance operational efficiency of the banks.

Efficient banking systems are pivotal for enhancing financial stability and providing high-quality services at minimal cost (Manta et al., 2026). For instance, efficient banking systems contribute to financial stability by effectively allocating capital, managing risks, and providing liquidity to the economy (Vrotslavskyy, 2024). Banks act as intermediaries between savers and borrowers, ensuring that funds are channeled to productive uses while mitigating systemic risks. Efficient banking systems help reduces transaction cost for both individuals and businesses. Streamlined processes, automated services, and effective risk management practices enable banks to offer services at competitive rates, benefiting customers and promoting economic growth. Efficient banking systems help reduces transaction cost for both individuals and businesses (Zaremba, et al., 2025). Streamlined processes, automated services, and effective risk management practices enable banks to offer services at competitive rates, benefiting customers and promoting economic growth. A well-functioning banking system enhances access to credit for businesses and individuals, fostering

entrepreneurship, investment, and consumption. By efficiently assessing creditworthiness and managing loan portfolios, banks can extend credit to a broader range of borrowers, including small and medium-sized enterprises (SMEs) and underserved populations (Karigi et al., 2021). Additionally, efficient banking systems are often at the forefront of innovation and technology adoption (Zhou and Liao, 2024). By investing in digital infrastructure, online banking platforms, and fintech solutions, banks can improve service delivery, enhance customer experience, and expand financial inclusion (Liang et al., 2024). Finally, efficient banking systems adhere to strict regulatory standards and compliance requirements. By maintaining transparent and accountable practices, banks can build trust with regulators, investors, and customers, thereby enhancing the stability and integrity of the financial system.

Odunga (2016) define operational efficiency as producing more outputs with fixed inputs or minimizing inputs while maintaining outputs. This definition of operational efficiency is centered on the idea of maximizing output while keeping input constant or minimizing input while maintaining output levels. For instance, this concept refers to increasing the efficiency of a process or system by generating greater output using the same amount of input resources. For example, a bank might implement improvements in production techniques or technology to enhance profits without increasing capital or labor required. Additionally, this aspect of operational efficiency involves reducing input requirements without compromising the quantity or quality of outputs (Shawk, 2008). It focuses on optimizing resource utilization to achieve the desired level of output with minimal input. This could involve streamlining processes, eliminating waste, or enhancing resource allocation strategies. In other words, efficient banks excel at resource utilization, maximizing productivity, and redirecting saved costs toward value-adding opportunities.

Olarewaju (2016) emphasize, a bank's success hinges on its ability to effectively transform inputs into desired outputs. However, efficiency extends beyond mere cost minimization. Factors such as asset quality, earnings quality, liquidity, and capital adequacy, as highlighted by Lotto (2019) and Odunga et al. (2013), significantly

influence a bank's ability to manage resources effectively and deliver high-quality services.

Shawk (2008) characterize operational efficiency as the enhancement of processes, personnel, and technology to provide services and goods efficiently in terms of cost while upholding quality, stressing the importance of a comprehensive viewpoint. This multifaceted understanding underscores that concentrating solely on financial indicators is inadequate. Rather, banks should embrace holistic approaches that tackle operational procedures, the nurturing of human resources, and technological progressions—all while upholding service standards and customer contentment. The definition of operational efficiency presented by Shawk (2008) further underscores the intricate interplay of various factors within an organization. By emphasizing the optimization of processes, people, and technology, the authors suggest a comprehensive approach that extends beyond mere financial metrics. This perspective is crucial in the banking sector, where operational efficiency directly impacts the bottom line and customer experience. The notion that operational efficiency should not solely revolve around financial metrics is significant. While profitability is undoubtedly important, focusing exclusively on financial indicators may overlook other critical aspects of organizational effectiveness (Olarewaju, 2016).

Furthermore, the emphasis on a holistic approach highlights the interconnectedness of different facets of banking operations. Operational processes, human resources, and technological infrastructure are not isolated elements but rather integral components of a unified system (Dogan, 2026). Neglecting any one of these aspects could hinder overall efficiency and effectiveness. By optimizing processes, investing in human capital, and leveraging technology, banks can enhance their operational efficiency while simultaneously meeting customer needs and maintaining service quality (Ngware, 2025). This holistic perspective is essential for sustainable success in today's dynamic financial landscape.

Banks operate within a complex web of laws and regulations that govern their activities (CBK, 2013). Compliance with these legal requirements is essential for maintaining trust and stability in the financial system. Regulations may cover areas such as capital

adequacy, risk management, consumer protection, and anti-money laundering measures. Banks engage in numerous contractual relationships with customers, partners, and other stakeholders (CBK, 2024). The terms and conditions of these contracts impact the efficiency of banking operations, influencing aspects such as loan agreements, deposit contracts, and vendor relationships. Additionally, sound accounting practices are fundamental for accurate financial reporting and decision-making within banks. Transparent and reliable accounting standards ensure that stakeholders have access to timely and relevant information about the bank's financial health and performance. Banks are typically chartered and regulated by governmental authorities or regulatory bodies (BCBS, 2019). Chartering rules outline the requirements for establishing and operating a bank, including capitalization requirements, organizational structure, and permissible activities. Governments enact various regulations to safeguard the stability and integrity of the banking system. These regulations may include measures to prevent financial crises, ensure fair competition, and protect consumers' interests. Furthermore, banks operate within dynamic market environments characterized by factors such as interest rates, competition, and technological advancements. Understanding and adapting to these market conditions is essential for optimizing operational efficiency and maintaining competitiveness. Variations in these characteristics among political jurisdictions may result in discrepancies in the effectiveness of banks within those jurisdictions.

The operational landscape can exert significant influence on both the external and internal mechanisms governing the conduct of bank managers. Internally, regulatory frameworks may be shaped or tempered by considerations such as organizational structure, ownership dynamics, capitalization, governance structures, and managerial remuneration practices. Externally, factors such as market conditions, regulatory requirements, and competitive pressures can influence how banks operate and how managers are held accountable for their actions. For example, changes in regulations or market trends may necessitate adjustments in managerial behavior to ensure compliance and maintain competitiveness. Internally, the structure and dynamics of the organization play a crucial role in shaping managerial conduct. This includes aspects such as the organizational form (e.g., whether it's a traditional bank, an online-

only bank, or a credit union), ownership structure (e.g., publicly traded or privately held), and capital structure (e.g., the mix of equity and debt financing). Moreover, governing boards play a pivotal role in setting policies and overseeing managerial decisions, while managerial compensation schemes can incentivize or disincentive certain behaviors. For instance, performance-based compensation may motivate managers to maximize short-term profits, while long-term incentive plans may encourage a more sustainable approach.

Globally, the concept of operational efficiency is still under researched and the related knowledge also limited. Banks are facing challenges in maintaining stable financial performance and operational efficiency amid the dynamics of increasing competition. Financial technology (FinTech) has also transformed the financial industry significantly altering how financial services are delivered (Arnaut & Becirovic, 2023). Efficient banks are better positioned to allocate resources, minimize operational costs, and offer innovative services, contributing to long-term stability (Baduneneko, 2021; Lee, 2021). Badunenko (2021) highlighted that efficient resource allocation boosts bank profitability and mitigates systemic risks critical to understanding efficiency in the study. Similarly Lee (2021) analyzed cost-reduction strategies in banks of varying sizes, providing a framework of evaluating efficiency across different bank categories. In a globally banking structure, inefficiencies can escalate quickly and have varying effects for different bank sizes (Abdo, 2022).

In Africa, there are a few studies that have been undertaken on the factors which affect bank efficiency. These studies include Lotto and Papavassiliou (2019), Nakane & Weintraub (2005), Bandarayake & Probhath (2013), Ayadi & Arbak (2013). Despite the importance of bank operation on economic and financial system, few studies have been conducted in Kenya on capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency of the banks.

In Kenya, Odunga (2013) has shown that the relationship between capital adequacy and operational efficiency emphasizes the significance of efficient operations for banks. However since then the banking sector in Kenya has evolved. The policy shock in the form of the Banking (Amendment) Act in 2016 introduced 4-percentage points

above the Central Bank of Kenya lending rate to banks. This reduced profitability due to lower interest rate margin. Kenya's National Treasury (2015) also proposed in the Finance Bill to increase fivefold the minimum core capital for banks from KES 1 billion to 5 billion over three years. This further affected the efficiency of the banks to operate in Kenya taking into consideration the cost of operation which had increased fivefold. Therefore, understanding and enhancing operational efficiency is essential for banks to bolster their capital adequacy ratios and ensure resilience in the face of financial risks.

1.1.1 International Perspective of Operational Efficiency of Commercial Banks

As banking sector policies change, the banks have been forced to consider factors that affect the efficiency of the banks to reduce inefficiencies and bankruptcy across banks. The financial sector reform in 1992 shifted the banking system policy atmosphere and impacted the operation of commercial banks (Alber, 2019). Operational efficiency is viewed as the ability of a bank to reduce operating costs through combination of people, processes and technology. Banks operate efficiently by channeling savings from deposits mobilized towards companies with high expected social and economic returns.

The success of commercial banks is determined by the level of operational efficiency. Global research has been conducted on exploring factors such as capital adequacy, asset quality, and earnings quality on the operational efficiency of banks. Wang and Lu (2014) on Tawain's banks show clear differences in efficiency between focusing on growth and profit prioritization. Similarly, Allen and Rai (1996) found input efficiencies were more prevalent than output inefficiencies in 15 countries. As research on the complexities of operational efficiency in commercial banks progresses, it has become more clear that elements like capital adequacy are important. Comprehending these variables is imperative in managing the intricacies of the banking industry and enhancing the operational efficiency of commercial banks.

A global study has illuminated these banks' operational efficiency by focusing on factors including capital adequacy, earnings quality, and asset quality. Research

conducted in Sri Lanka by Bandaranayake and Jayasinghe (2014) indicates that capital adequacy, asset quality, and earnings quality are some of the major variables influencing banks' operating efficiency. Hamid, Fatimah, Asid, and Sulaiman (2018) researched the effect of earnings quality management on bank efficiency in five ASEAN countries and discovered that an increase in earnings quality management practices reduces bank efficiency. Although, the influence of these factors is important, in exploring operational efficiency the resources that banks put in and the outputs that come out are essentially important in determining the optimum level of operational efficiency of these banks.

Moreover, recent research delves deeper into the intricate relationship between capital adequacy and operational efficiency in banking institutions. Margaritis and Psillaki (2007) found that while leverage initially enhances efficiency at low to mid-level stages, it turns negative at higher leverage levels. Additionally, Aleksandrina and Pancheva (2019) explored the impact of global economic and financial crises on bank efficiency, revealing how these crises can reverberate through the real economy and affect the operational efficiency of banks. As evidenced by studies from diverse contexts such as Sri Lanka, and China, and during global economic crises, the relationship between inputs such as capital adequacy and outputs like efficiency is complex and multifaceted. Understanding these dynamics is essential for banks to optimize their operations and navigate challenges in an ever-evolving financial landscape. These findings underscore the importance of a nuanced understanding of factors influencing bank efficiency, ranging from capital adequacy dynamics to broader economic contexts. Such insights are invaluable for banks seeking to bolster their operational resilience and adaptability in the face of varying market conditions and economic challenges.

Further research on operational efficiency indicates a complex interplay of factors with mixed findings on a global scale. Recent research delves into the impact of earnings quality on the operational efficiency of these banks. Hamid, Fatimah, Asid, and Sulaiman (2018) found an increase in earnings quality management practices reduces the bank efficiency of five ASEAN countries. Additionally, Kunt (1989) and Whalen

(1991) indicate the detrimental consequences of high non-performing loans, leading to bankruptcy. Supporting this notion, Hassan and Sanchez (2007) suggest that high levels of non-performing loans reflect a deteriorating portfolio quality, which in turn reduces bank efficiency. Raheman and Nasr (2007) research in Pakistan firms further contributed to this discussion by linking asset turnover with current future earning changes, indicating a complex interplay between operational efficiency and asset quality.

The influence of liquidity on the operational efficiency of banks indicates a multifaceted approach. The last two decades evidenced a global surge of events leading to multiple economic downtowns. This led to questions regarding the proper governance and controls on institutions that affect the economy and introduced the need for regulation of banking institutions. Post the financial crises of 2007-2008, the Basel Committee on Banking Supervision (BCBS) introduced several macro-prudential regulations. One of the key components of this was liquidity ratio. The liquidity ratio focuses on liquidity risk and stipulates that banks maintain sufficient liquidity holding to fulfill their thirty day obligation if crises circumstances arose. This regulation plays a fundamental role in preventing bank failures and promoting resilience and stability of the sector. Insufficient liquidity increases the risk of a bank's insolvency, while excessive liquidity enforces redundant costs resulting in an inefficient banking system. Lotto (2019) indicates that bank liquidity and capital adequacy have a positive relationship with bank operational efficiency. This suggest that capital adequacy and liquidity, not only strengthen financial stability by providing a larger capital cushion and bank required liquidity level, but also improve bank operating efficiency by reducing moral hazard between shareholders and debt-holders.

1.1.2 African Perspective on Operational Efficiency of Commercial Banks in Africa

Commercial banks play a critical role in mobilizing savings, allocating credit, and supporting economic growth, as shareholder funds channeled into the financial system are transferred from surplus units to deficit units to stimulate investment and development (Siddique, 2021; Syed & Aidyngul, 2020). However, this intermediation

process exposes banks to multiple risks- particularly credit, default, and liquidity risks- which undermine their profitability and operational stability (Abusharbeh, 2022; Shaheen et al., 2024). Although banks aim to facilitate capital flow, support GDP growth, create employment, and maximize shareholder wealth (Alfadli & Rjoub, 2020), their performance is frequently threatened by risk exposures, political interference (Rizvi, 2018), non-performing loans, high core capital requirement, therefore financial institutions must also monitor factors that could destabilize the broader economy to avoid losses.

Banks in emerging economies face a wide spectrum of risks-including credit, non-performing loans, liquidity, that collectively threaten institutional stability (Addou et al., 2024; Demir & Danisman, 2021). Given that such factors are inherent in banking operations, their effective management is essential to enhance operational efficiency of this institutions, especially in fragile economic environments across Africa. A study on capital adequacy and bank performance in Ghana was carried out by Doku, Kpekpena, and Boateng (2019), and the results showed a favorable correlation between the two variables. On the other hand, Anarfo (2015) conducted a study on the relationship between capital adequacy and bank performance in Sub-Saharan Africa. The research indicated return on equity, return on asset, and net interest margin all showed a negative relationship between the two variables. Alhassan, Coleman, and Andoh (2014) focused on asset quality during the crisis period in Ghanaian banks, identifying an increase in non-performing loans, along with other factors such as loan growth, market structure, inflation, real exchange rate, and GDP growth, as significant predictors of asset quality. Furthermore, Swamy (2015) investigated the modeling of bank asset quality and profitability and concluded that, whilst asset size had no discernible impact, investment activities and capital adequacy had a major impact on bank profitability. Empirical evidence suggest that bank specific factors are a major contributor to inefficiencies in bank operations, in extreme cases, institutional failure (Sharma 2024; Siddique, 2022).

Research on the impact of several independent variables on the operational efficiency of African banks sheds light on the dynamics of banking operations throughout the

continent. In a study on the capital adequacy, corporate governance, and financial performance of Uganda's commercial banks, Madrara (2012) found a strong positive correlation between capital adequacy and financial performance, corporate governance and financial performance, and corporate governance and capital adequacy. After accounting for factors like the financial market and taxation, Al-Kayed, Zain, and Duasa (2014) examined the impact of capital adequacy on the performance of Islamic banks in 19 different countries and discovered a strong positive correlation between the two variables. Additionally, Osayameh (1986), Orji (1989), and Omolumo (1993) emphasized the detrimental consequences of loan default for banks, highlighting the necessity of loan repayment to avoid losses. Lawal, Oluoch, and Muturi's (2018) study on the relationship between asset quality and operational efficiency of Nigerian commercial banks found that asset quality had a significant and positive impact on banks' operational efficiency ratio of banks. Mixed findings are found in African operational efficiency studies when it comes to the impact of liquidity, asset quality, earnings quality, and capital adequacy.

Bank-specific factors play a crucial role in determining operational efficiency within financial institutions. Operational efficiency refers to the ability of a bank to minimize costs, optimize processes, and maximize output while maintaining quality standards. Some of the key bank-specific factors and their impact on operational efficiency: first, the technology infrastructure of a bank, including its core banking systems, digital platforms, and data analytics capabilities, greatly influences operational efficiency. Banks with modern and robust technology systems can automate routine tasks, streamline processes, reduce errors, and improve overall productivity. The organizational structure of a bank, including its hierarchy, division of responsibilities, and communication channels, can impact operational efficiency. A flat organizational structure with clear lines of communication and decision-making authority often facilitates faster decision-making and more agile responses to customer needs. Effective risk management practices are essential for maintaining operational efficiency. Banks that implement robust risk assessment frameworks, compliance procedures, and internal controls can minimize the likelihood of operational

disruptions such as fraud, errors, or regulatory non-compliance, thereby enhancing efficiency.

The skills, expertise, and motivation of bank employees significantly contribute to operational efficiency. Banks that invest in training and development programs, foster a culture of innovation and collaboration, and provide incentives for high performance are more likely to achieve greater operational efficiency. The complexity and diversity of a bank's product and service offerings can impact operational efficiency. While offering a broad range of products can attract customers and generate revenue, managing a complex product mix may require additional resources and increase operational risks. Banks need to strike a balance between product diversification and operational efficiency.

The size and efficiency of a bank's branch network and distribution channels influence operational costs and customer accessibility. Banks that optimize their branch footprint, leverage digital channels effectively, and adopt innovative distribution strategies can improve efficiency by reducing overhead costs and enhancing customer convenience. Building and maintaining strong customer relationships is essential for operational efficiency. Banks that leverage customer data and analytics to personalize services, anticipate needs, and provide seamless experiences can enhance customer satisfaction and loyalty, ultimately driving efficiency through higher retention rates and cross-selling opportunities. Therefore, bank-specific factors such as technology infrastructure, organizational structure, risk management practices, human capital, product mix, distribution channels, regulatory compliance, and customer relationship management all play integral roles in determining operational efficiency. By strategically managing these factors, banks can optimize their operations, improve performance, and remain competitive in the dynamic financial services industry.

Generally, the firm-specific characteristics and operational efficiency are summarized as follows: First, in terms of size and scale. The size of a bank can significantly affect its operational efficiency. Larger banks often benefit from economies of scale, allowing them to spread fixed costs over a larger asset base. This can lead to lower average costs per unit of output and greater operational efficiency. However,

excessively large banks may also face challenges related to complexity and bureaucracy, which can hinder efficiency. Secondly, the capital structure of a bank, including its mix of equity and debt, can impact operational efficiency. Banks with higher levels of equity capital may be better positioned to absorb losses and withstand financial shocks, thereby enhancing their overall stability and efficiency. Conversely, excessive leverage can increase financial risk and undermine efficiency. Thirdly, the adoption of advanced technology and innovation plays a crucial role in improving the operational efficiency of commercial banks. Investments in digital banking platforms, automation, artificial intelligence, and data analytics can streamline processes, reduce costs, enhance customer experiences, and increase operational efficiency. Banks that are slow to embrace technological advancements may find themselves at a competitive disadvantage.

Additionally, the effectiveness of bank management and strategic decision-making can have a significant impact on operational efficiency. Strong leadership, prudent risk management practices, and clear strategic direction are essential for optimizing resource allocation, managing costs, and maximizing operational efficiency. Conversely, poor management decisions, inadequate risk controls, and strategic missteps can lead to inefficiencies and undermine bank performance. Finally, a bank's operating efficiency may be impacted by the configuration of its branch network and distribution channels. Although they may have greater running expenses, banks with a large branch network gain more market share and client accessibility.

1.1.3 Kenyan Perspective of Operational Efficiency of Commercial Banks

The commercial banks deal with liquid asset of citizens and ensure stability and economic growth. Kenya is one of the important East African countries with a population of about 53 million people (KNBS, 2025). Banks in Kenya and the financial services have been identified as a success pillar to achieving 2030 Vision making Kenya a middle income economy by providing macro-economic stability for long term development. The policy framework of Kenya combines socialistic and capitalistic features with a GDP growth of 4.6 percent (KNBS, 2026). However, the last couple of decades in Kenya have witnessed continuous change in regulation, technology and

competition in all sectors including financial service industry. This has led to several banks in the lower tiers exiting the market or being placed under receivership. For instance, Chase Bank was put under receivership due to liquidity issues. Similarly, Imperial Bank faced closure by the Central Bank of Kenya, attributed to poor portfolio management and insider lending. Dubai Bank of Kenya also fell under statutory management for a year due to liquidity and capital deficiencies, with the Kenya Deposit Insurance Corporation (KDIC) appointed as the receiver manager (CBK, 2016).

Similarly challenges such as rising cost ratio and declining profitability, increased core capital, non-performing loans also affecting the efficiency of the respective banks (Miencha, 2013). To enhance the efficiency of the commercial banks, it is therefore important to review bank specific factors that affect operational efficiency of commercial banks in Kenya. In Kenya a few studies on performance of commercial banks can be cited. Mathuva (2009), researched on capital adequacy ratio and the performance of commercial banks in Kenya. Findings from the study indicate that bank profitability is positively related with the core capital ratio and risk-based capital. The study also indicates that bank profitability is negatively related to equity capital ratio and CIR. The research further indicates that non-risk weighted capital adequacy is negatively related with the profitability of a bank while there is a positive relationship between the risk-adjusted capital adequacy measure and profitability of banks. Unlike this previous study, the progress research is going to be hinged on all factors affecting efficiency of banks including liquidity, asset quality, earnings which were not present in the current research with moderating impact of market size on the Kenyan banks.

Similarly, Ongore (2013), studied the determinants of financial performance of commercial banks in Kenya. The findings suggested that bank performance, was widely driven by board efficiency and sound management decisions. The study used liquidity, capital adequacy, and asset quality and management efficiency but failed to address the challenge of operational efficiency of the banks. Further Miencha et al., (2016), analyzed the financial intermediation efficiency with specific target to

technical efficiency of sampled commercial banks. The findings indicate that degree of technical efficiency was indicating inefficiency in the sector. They explained that the banking sector could be producing at an inefficient scale, below the production possibility frontier, rather than producing along the production frontier. When producing below the production frontier, it indicates high levels of inefficiencies due to misallocation of resources.

Since the focus of this study is based on commercial banks listed from the Central Bank of Kenya, CBK is the main regulatory body in charge of regulating the banking industry and guaranteeing that laws are followed. The Banking Act, which establishes the legal framework for bank licensing, regulation, and supervision, is the main piece of legislation controlling banks in Kenya. The Microfinance Act, which governs microfinance organizations, and other financial laws that deal with matters like consumer protection and anti-money laundering are examples of other pertinent legislation. By establishing the guidelines for acceptable bank operations, the Central Bank of Kenya regulates bank operations.

The minimal capital needed for any bank to operate is also specified by the Central Bank of Kenya. These regulations are in place to safeguard depositor money and to guarantee the stability and viability of the banking industry. The CBK reviews and modifies the minimum capital requirements regularly to account for shifts in the banking industry's laws and the state of the economy. Banks must have enough capital as it protects them against unforeseen losses and contributes to the preservation of public trust in the financial system. Higher capitalization banks are thought to be safer by investors and depositors since they can withstand financial shocks. The CBK's particular minimum capital requirements may change based on the bank's size, complexity, and risk profile. Banks that fail to meet these requirements may face regulatory sanctions or restrictions on their operations until they can increase their capital to the required level. Therefore, the minimum capital requirements established by the Central Bank of Kenya play a critical role in promoting the stability and soundness of the banking sector, which is essential for the functioning of the economy.

The banking sector in Kenya is regulated and licensed by the Central Bank of Kenya (CBK) under the provisions of the Banking Act. This regulation ensures that banks adhere to certain standards and guidelines, including prudential guidelines aimed at maintaining financial stability and protecting depositors' funds. As of December 2013, the ownership structure of commercial banks in Kenya was reported to be diverse. According to the supervision report of the CBK, out of the 44 commercial banks, 30 were domestically owned, while 14 were foreign-owned. This indicates a mix of local and international participation in the Kenyan banking sector. Domestic banks are those that are owned and operated by Kenyan entities, while foreign banks are those that are owned by entities based outside Kenya. Both types of banks contribute to the financial system in different ways, with domestic banks often having a better understanding of local market dynamics and foreign banks bringing in expertise and capital from global markets.

The banking sector plays a crucial role in driving economic growth and development in Kenya. Banks provide essential services such as loans, savings, and investment opportunities, which are vital for businesses to expand, individuals to invest, and the government to finance public projects. Like any other sector, the banking industry in Kenya faces various challenges, including regulatory compliance, competition, cybersecurity risks, and economic volatility. However, there are also opportunities for innovation, expansion into underserved markets, and leveraging technology to enhance financial inclusion and efficiency.

According to the CBK, Commercial banks are classified into three different groups, classification based on customer deposits, weight composite index for net assets, capital and reserves, number of loan accounts, and number of deposit accounts. This categorization involves grouping commercial banks according to the amount of customer deposits they hold. Customer deposits are a significant source of funding for banks and play a crucial role in their operations. Banks with higher levels of customer deposits may have more stability and liquidity compared to those with lower levels of deposits. The weight composite index for net assets, capital, and reserves involves assessing commercial banks based on a composite index that considers factors such as

net assets, capital, and reserves. Net assets reflect the total value of a bank's assets minus its liabilities, while capital and reserves represent the financial cushion available to absorb losses. The number of loan accounts and the number of deposit accounts classification categorizes commercial banks based on the number of loan accounts and deposit accounts they manage. Loan accounts represent the number of loans extended by the bank to borrowers, while deposit accounts indicate the number of accounts held by customers for depositing funds. Banks with a higher number of loan accounts may indicate a more active lending activity, while a higher number of deposit accounts may suggest a larger customer base and deposit-taking capability. A bank is proportional to its share of the sector and the total scores add up to 100%. Banks scoring over 5% are classified as large, 1-5% score are medium banks while a score below 1% is a small bank. As of 2014, we had 6 large, 16 medium, and 21 small banks.

According to CBK (2012) annual report the total number of assets increased by 15.8% from Ksh 1,873.8 billion in June 2011 to 2,195 billion in June 2012. The growth is expected to continue due to the technological changes that are experienced by the banks at the moment. The total asset size of the banks as of December 2011 was Ksh 2,020.8 billion which was an increment from Ksh 457 billion in the year 2002 an increase that is three times more in 10 years. This has contributed to increased financial development, increase in asset quality, and ownership that lead to higher efficiency of banks in Kenya.

The distribution of market structure between the tiers was 49.90%, 41.70 %, and 8.40% from the descending peer groups respectively (Central Bank of Kenya, 2014). The 49.9 percent in the top tier indicates that nearly half of the market share or market structure is concentrated in the top tier. These entities likely represent the largest and most dominant players in the market, potentially including major banks or financial institutions with significant assets and market presence. The 41.7 in the middle tier suggests that a substantial portion of the market structure is distributed among entities in the middle tier. These may include smaller banks, credit unions, or other financial institutions that have a moderate level of market share but are not as dominant as those in the top tier. The 8.4 percent in the bottom tier indicates that a relatively small

proportion of the market structure is held by entities in the bottom tier. These could be smaller financial institutions, microfinance institutions, or other niche players in the market that have a limited market share compared to the larger players in the top and middle tiers

The banking sector in Kenya is vibrant, competitive, and dynamic and has enjoyed robust and sustained growth over the period 2000 to 2014 (Kamau & Were, 2013). In terms of asset holding, foreign banks were found to account for about 34% of the assets in banks as of 2013 (Wanjagi, 2018). This presence of foreign banks can bring several benefits to the local banking sector, including access to international expertise, technology, and capital, which can contribute to overall growth and innovation. Additionally, competition from foreign banks can drive local banks to improve their services and products, ultimately benefiting customers. However, there may also be challenges associated with the dominance of foreign banks, such as potential risks related to capital flight or a decrease in market share for domestic banks.

1.2 Statement of the Problem

The banking sector has encountered various hurdles in its pursuit of boosting operational efficiency. In Kenya, a range of challenges has emerged, including a notable increase in non-performing loans, declining asset quality, wide interest rate spreads, heavy reliance on small deposits, lack of clear separation between ownership and control, and the scale of banks (Kiemo, 2015; Osborne, Fuertes & Milne, 2015). Policymakers are still struggling with formulation of best policy options to enhance operational efficiency of financial institutions.

The focus on operational efficiency which is the main problem statement is important for bank survival since service organization offer intangible products to the public with overhead cost constituting the highest operational cost (Olaweraju, 2016). This therefore indicates the need for commercial banks to use the least input to produce more output and thus enhance the operational efficiency of the respective banks. For instance, Okuda, Poleng, and Aiba (2014) investigated determinants of operational efficiency and total productivity factor in Cambodian banks, finding a decline in

productivity. However, Lawal, Oluoch, and Muturi (2018) examined the impact of asset quality on operational efficiency in Kenyan banks, revealing a positive significant effect. Similarly, Wu (2019) and Njagi (2017) explored the relationship between capital adequacy and profitability or firm efficiency, reporting a positive correlation. Yet, Kuria (2013) and AbuTawahina and Helles (2015) investigated the effect of capital adequacy on financial performance, yielding inconclusive results. There's a diversity of findings regarding the influence of capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency.

Banks have had fluctuating capital adequacy where some are over performing while others are underperforming. The variance affects operational efficiency but we do not have any empirical literature regarding this effect in Kenya. Ding and Sickles (2018), for instance, examined the impact of capital adequacy and portfolio risk on frontier efficiency in U.S. banks using the Stochastic Frontier Analysis approach, suggesting that more efficient banks tended to increase capital holdings and assume greater credit risk while reducing risk-weighted assets.

The period 2008-2022, experienced market perturbations of 2015 and 2010, the legislative enactment of the Banking Amendment Act 2016—bringing about the interest rate cap aimed at maintaining financial stability and protecting depositors funds which still do not show clearly the effect of bank specific factors on the operational efficiency of commercial banks in Kenya. The period therefore provides an important step to analyze operational efficiency of the banks and set up policies to regulate and reform the entire sector in Kenya. Although Kenyan banks have reported resilience and good performance, some have been put under receivership, raising questions on their performance and operational efficiency.

The banking sector has further experienced several reform policies in the last two decades, including increase of minimum core capital, targeted at efficiency and capital adequacy of the respective banks. Banks have also experienced a decrease in asset quality which tends to coincide with higher levels of non-performing loans relative to gross net assets (Kariuki, 2016). Aguenaou, Lahrech, and Bounakaya (2017) highlight that the loan loss ratio, asset quality have a negative correlation with the efficiency

ratio. The third quarter of 2018 witnessed deterioration in asset quality among Kenya's listed commercial banks, as evidenced by a surge in non-performing loans, particularly in the retail, manufacturing, and real estate sectors. CBK report (2025), indicates the sector was profitable but recorded high credit and operational risks. Central Bank of Kenya (CBK) further indicated a significant decline in the banking sector's return on assets, dropping to a negative 2.0% in 2018 from a negative 0.9% in 2017. Customer deposits saw a 5.3% increase, reaching approximately 41.0 billion shillings in 2018 from 38.9 billion shillings. Additionally, customer loans and advances rose by 3.1% from 42.8 billion shillings in 2017 to about 44.2 billion shillings in 2018. Despite this, the banks' asset size increased from about 67.60 billion Kenyan shillings to approximately 70.75 billion in 2018 (CBK, 2018). Enhancing efficiency remains a challenge for financial institutions, although, heightened focus on operational efficiency would yield improved performance. This study therefore aims to investigate the curvilinear relationship between capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency in Kenyan banks. The market share will also be introduced as a moderating variable, employing a two-stage method involving Stochastic Frontier Analysis and multiple regression analysis to estimate scores and regress them against the aforementioned factors.

1.3 Objectives of the Study

In carrying out the study, the objectives were categorized into general objective and the specific objectives.

1.3.1 General Objective

The general objective of this study was to determine the effect of capital adequacy, asset quality, earnings quality, bank liquidity on the operational efficiency of commercial banks in Kenya.

1.3.2 Specific Objectives

i. To determine the effect of capital adequacy on the operational efficiency of commercial banks in Kenya

ii. To assess the effect of asset quality on the operational efficiency of commercial banks in Kenya
iii. To establish the effect of earnings quality on the operational efficiency of commercial banks in Kenya
iv. To examine the effect of bank liquidity on the operational efficiency of commercial banks in Kenya
v. To determine the moderating effect of market share on operational efficiency of commercial banks in Kenya.

1.4 Research Hypothesis

H_{01}: Capital adequacy has no significant effect on the operational efficiency of banks in Kenya

H_{02}: Asset quality has no significant effect on the operational efficiency of banks in Kenya

H_{03}: Earning quality has no significant effect on the operational efficiency of banks in Kenya

H_{04}: Liquidity has no significant effect on the operational efficiency of banks in Kenya

H_{05}: Market share has no significant moderating effect on capital adequacy, asset quality, earnings quality, liquidity and operational efficiency of commercial banks in Kenya

1.5 Significance of the Study

The motivation for this research study can be drawn from the dearth and limited studies in this research more specifically in Kenya. The research unveils benefits of operational efficiency in Kenyans banking sector. Limited literature have led to the significant effect of bank specific factors to improve the operational efficiency of the banks. Efficiency in banking operations is widely recognized as a key element in

modern public policy concerning a nation's economic advancement. Analyzing the empirical factors influencing operational efficiency and their associated cost functions is pivotal for shaping future policy adjustments. This research holds significance for following stakeholders. In regard to theoretical contribution, the study is highly important to the following stakeholders: investors in terms of information asymmetry from agency theory that may enhance efficiency among the banks and investor related to needs of investors. It's likely to reduce agency cost and other operation cost that usually affect the efficiency of the banks.

This is quite evident for banks that have non-performing loans. Operational efficiency will greatly improve through monitoring of capital adequacy, asset quality, earnings quality and liquidity of the respective banks. Improvements in operational efficiency in financial institutions are quite vital for providing a more appropriate financial system for asset allocation in the financial service industry. With capital adequacy, and bank liquidity bank managers would be able to decide on the best way to finance the banks in order to increase the value of the banks. For instance, the asset liability management theory used in this study will enhance how to avoid a mismatch between assets and liabilities reducing the risks of liquidity to impact positively for investments of investors.

Additionally, Kenya Revenue Authority (KRA) will benefit by identifying banks that operate more efficiently, potentially leading to adjustments in taxation levels for regulatory bodies. Additionally, such insights allow the Nairobi Securities Exchange to accurately assess and value the shares of these particular banks. By conducting rigorous empirical studies, policymakers can identify areas for improvement and implement targeted interventions to enhance overall efficiency in the banking sector. Additionally, from a policy perspective, identifying banks that operate more efficiently can have significant implications. Policymakers can use this information to design incentives or regulations that promote efficiency and discourage wasteful practices. For instance, adjusting taxation levels based on a bank's efficiency could encourage banks to streamline their operations and improve performance.

Furthermore, the ability to accurately assess the efficiency of banks has implications for investors and financial markets. Stock exchanges, like the Nairobi Securities Exchange, mentioned in the original passage, rely on accurate information to price shares effectively. Banks that are perceived as more efficient may attract greater investor interest, leading to higher valuations and improved access to capital.

Secondly, the concept of capital adequacy may not be new. However, much work carried out is based on its relationship to bank performance. This research will act as an eye-opener to future researchers whose scope is not just limited to capital adequacy, but a new concept of measuring firm performance known as operational efficiency. Furthermore, earnings quality, asset quality, and liquidity will add to the body of knowledge on different variables related to operational efficiency which can be used in the banking industry. The research could also benefit investors who can be able to access the more efficient banks and decide when to invest in such financial institutions.

1.6 Scope of the Study

The study focuses on capital adequacy, asset quality, earnings quality, liquidity and how it has influenced operational efficiency of commercial banks in Kenya. This study has taken a specific focus on the concept of operational efficiency with a view to examine how to improve it in the banking sector. The study population concentrated on the entirety of the 43 commercial banks operating within the Kenyan landscape. Encompassing a temporal span of 14 years, from 2008 to 2022, as delineated in the Central Bank of Kenya report of 2023, this investigative period was strategically selected to encapsulate recent financial regulatory reforms within the banking sector and to address concerns pertaining to financial efficacy. Furthermore, it sought to account for pivotal occurrences such as the market perturbations of 2015 and 2010, the legislative enactment of the Banking Amendment Act 2016—bringing about the interest rate cap—and the legal ramifications ensuing from the COVID-19 Pandemic. Noteworthy phenomena including a discernible escalation in interest rates, stringent monetary policies, fiscal consolidation efforts, sluggish credit uptake, and instances of tightened lending standards by banks were all factored into the study. Moreover, stress

within the financial framework was compounded by factors such as constricted cash flows and defaults on corporate loans.

There are specific factors that affect the operational efficiency of the banks. It extension covers, capital adequacy, liquidity, earnings quality, asset quality and the concept of operational efficiency of banks. The study drew its theoretical foundations from asset and liability management, agency and stakeholders. The theories were found relevant in view of reduction in asset liability mismatch, reduction in information asymmetry and stakeholders' interest in Kenyan banks. Thus, the study focuses on multiple factors that could impede efficient bank operation as well as its contextual constraints.

1.7 Limitations of the Study

There limitations for this research that include conceptual, empirical and theoretical that were encountered in the course of this research study. The study used market share as moderating variable for this study. The study provides useful findings in terms of the relationship between the variables, other moderating variables would still have been used but due to the scope of this research, this moderator was considered appropriate for the research.

The unavailability of data for some of the commercial banks was also a big challenge that impacted on the research. Some of the banks did not have data dated back to 2008 which had a ripple effect in terms of reliability and led to incomplete data sets for this research.

The study period was only limited between 2008 and 2022, which was more than a decade long term review. Although, it did not account for trend analysis within the research, and the finding could not be generalized for certain economic conditions.

The study focused on only the commercial banks listed in the Central Bank of Kenya, excluding other companies. This indicates that the research is only relevant to commercial banks, which helped investors, and shareholders within this market to

make profound financial decisions. However, it means that the findings were generalized for financial institutions, limiting the larger applicability of this research.

Moreover, the research was limited to only the Kenyan context reviewing commercial banks in the country, marking the study relevant to only Kenyan market. Geographical analysis allows for specific analysis of local context but limits the external application of the findings. Results obtained from this study may not be appropriate for other markets with different market conditions.

Furthermore, the study concentrated on operational efficiency of the banks using Stochastic Frontier Analysis Approach (SFA), thereby excluding other parametric frontier functions like the Data Envelopment Analysis (DEA). This study entailed a detailed analysis on the efficiency of banks where SFA was suitable model to be used though this meant the findings were only relevant to commercial banks. This specification was necessary for banks though it narrowed its usage in other different industries.

The limitations collectively influenced the results of this study. Data unavailability among other external factors led to biasness on the research, leading to skewness in the datasets where data for certain banks was not found. The scope limitation indicated that the findings could not be generalizable, making it difficult to isolate intrinsic effect of bank factor on efficiency of the specified banks. Moreover the narrow scope of commercial banks in Kenya restricts the broader usage of the findings in other different industries rather than banks. The specific focus on SFA reduce bank errors but limited results to banks only indicating that the approach was only relevant to commercial banks in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

A literature review was done to provide more clarity on certain concepts of the research study. The chapter comprises both a theoretical and empirical review of the literature on capital adequacy, asset quality, earnings quality, bank liquidity, and operational efficiency of banks. This chapter explores the theories underpinning the study and key relations between variables. The literature review disclosed several research gaps outlined along conceptual, contextual, methodological, and theoretical gaps. Finally, a conceptual framework is extracted showing the relationship of variables conceptualized by the study.

2.2 Theoretical Framework

This section reviews three theories that explain the operational efficiency of banks and how they relate to capital adequacy, asset quality, earnings quality, and liduidity. Conventional Economic Efficiency theory relates to operational efficiency, liquidity, and market structure. On the other hand, Agency theory relates to the market share and asset quality. Lastly, the Asset Liability Management Structure theory relates to earnings quality and asset quality and how it affects the operational efficiency of banks. All the theories give more clarity on the conceptual framework designed with Agency theory being the main theory that touches on most variables.

2.2.1 Conventional Economic Efficiency Theory

The theory was put forth by the neoclassical school of economics, whose foundations were laid by Adam Smith (1776) and later contested by economists such as Vilfredo Pareto (1906), Aly (1990), Alfred Marshall (1890), Kenneth Arrow (1951), Paul Samuelson (1947) and Gerald Debreu (1959). Conventional Economic Efficiency Theory postulates that companies should strive to derive maximum output using the lowest possible cost per unit produced. The theory indicates that optimal production

can be derived through economies of scale, and a wide range is gained by more costs associated with overusing the current existing system. Zerbe (2001) indicates that the maximum level of operational efficiency is attained through the production of output in which all economies of scale are taking advantage of such levels of efficiency. Moreover, increasing the capacity of currently existing systems would further increase the optimum production efficiency levels (Zerbe, 2001). The theory is based on the assumptions of perfect market, agent rationality, lack of competition and flexibility in prices, resulting in both allocative efficiency and production efficiency criteria.

The allocative efficiency indicates that high completion levels between banks impede them from deriving huge profits by increasing selling prices to almost irrational levels above marginal cost. Maximum allocation is achieved when a business produces optimal output through a combination of goods and services in order to derive the benefit to the business as a whole (Aly et. al, 1990). The theory is based on the fact that businesses are finite and thus can only be utilized in a certain period, the outcome being that using a material once would involve an opportunity cost thus preventing the business from using the same material for another objective. Conventional Economic Efficiency Theory distinguishes between several dimensions of efficiency. Allocative efficiency is derived only when no other patterns of resources can deliver a better outcome in regard to the welfare of the parties involved. Such results represent the highest allocative efficiency levels known as Pareto efficiency (Isik and Kabir, 2002). The theory forms a basis for understanding various factors that affect the operational efficiency of banks. Allocative efficiency is quite important for this study in the essence that banks operate at efficient levels, then all bank products have to be optimally priced. This in turn reduces competition in the market in terms of market size in banks, which is our moderating variable, as well as reducing interest rates.

Production efficiency arises when banks utilize all the resources optimally, producing more output using the least input (Miller et al. 1996). Based on recognition of the main principles in this theory, managers can find different methods to make various components of their business more efficient (Quinzi & Sujaya, 1993). Different researchers have employed this theory of conventional economic efficiency to measure

efficiency in banking systems (Sathye, 2001; Said, 2012). Differences in the economic efficiency of banks can be tested using this framework. A bank that is more technically efficient actually produces more output from the same quantities of measurable input than other banks. Differences in economic levels among banks may be caused by differences in technical efficiency. Such differences arise from the value of actual profit functions of banks at a certain output and input prices and quantities of given fixed inputs; specified using competitive markets for inputs and outputs (Isik & Kabir, 2002). The bank with higher profits is more efficient although within a given range of prices (Mullineaux, 1978).

Proponents of this theory argue that transaction costs, property rights, and institutional quality have a significant effect on economic efficiency (Ronald 1937, 1960; Dauglass North (1990), and Oliver Williamson (1985). Modern economist argue that efficient resource allocation depends highly on a functional legal system, proper governance structures, property rights and enforcement of contracts. Similarly some researchers have criticized this theory like Joseph Stiglitz (1975), George Akerlof (1970), Michael Spence (1973), challenged this information by indicating information asymmetry creates moral hazard, inefficiencies in market, adverse selection which prevents markets from achieving Pareto-efficiency optimal outcomes.

2.2.2 Cost minimization Theory

Cost minimization theory originates from the neoclassical theory of firms, which was developed by Alfred Marshall (1890), Paul Samuelson (1947), and John Hicks (1939). The theory is founded on the idea that firms aim to produce a certain level of output while minimizing the cost of production. This theory is based on the principle that firms operate in competitive markets where they face various input prices and technological constraints (Evanoff, 1998). To maximize profits, firms need to find the most efficient way to produce goods and services by minimizing their costs. The theory is based on the following assumptions, perfect information on input prices, competitive markets, and possible adjustment in input mix subject to changes in factor prices.

There are several key strategies linked with cost minimization theory: first, firms can substitute between different inputs (e.g., labor and capital) to minimize costs. For example, if the price of labor increases relative to capital, a firm may choose to substitute labor with capital to reduce costs (Marshall 1890). Secondly, Firms can achieve economies of scale by increasing their level of output, which allows them to spread their fixed costs over a larger production volume until a certain point (Hicks, 1939). This can lead to lower average costs per unit of output. Thirdly, investing in research and development (R&D) and adopting new technologies can help firms reduce costs by improving production processes and increasing efficiency. Fourthly, cost minimization theory often involves analyzing various cost curves, such as the total cost curve, average cost curve, and marginal cost curve. These curves illustrate the relationship between the level of output and the corresponding costs faced by the firm (Samuelson, 1947).

Modern researchers criticize the theory, it often assumes outputs are fixed and inputs should be reduced, however Ghertescu et al. (2024) indicates that by slashing operational, staffing in banks damages its ability to generate revenue or cross-sell products. The argument is that when interest margins are squeezed, a bank might intentionally increase costs (e.g investing in advisory teams, premium wealth management, or complex financial product creation) to boost fee-based, non-interest income. A conventional cost model would penalize these banks as inefficient, whereas a profit efficiency model reveals that the added expenditures generate far greater matching returns (Siameti et al., 2024). Manta et al. (2026) further criticizes the theory by indicating that extra liquidity, physical branch safety nets, more staff are essential for creating systemic stability under uncertainty. The researcher argues under conditions of systemic uncertainty, economic shocks, and geopolitical disruptions these ultra-lean banks lack the operational buffer to absorb defaults or sudden funding freezes. Modern economist argues that banking efficiency not as a static input-to-cost ratio, but as a strategic capability where temporary “inefficient” operational redundancies are required for long term survival and risk mitigation.

Therefore, the cost minimization theory provides a framework for understanding how banks can improve efficiency by minimizing costs and optimizing resource utilization. By adopting cost-effective strategies and investing in innovation, banks can enhance their competitiveness, profitability, and ability to meet the evolving needs of customers and stakeholders.

2.2.3 Theory of Financial Intermediation

The theory of financial intermediation was propagated by Mises (1912). The theory focuses on the role of intermediaries, such as banks, in the financial system (Allen and Santomero, 1997). These intermediaries play a crucial role in channeling funds from savers to borrowers, thereby facilitating economic activity and growth. One aspect of this theory relates to operational efficiency, which refers to how effectively financial intermediaries manage their operations to achieve their objectives. The theory heavily relies on the baseline microeconomic violation of the Modigliani-Miller theorem, which states that in perfect and complete capital markets, financial structures do not affect real economic outcomes.

The theory draws heavily from Gurley and Shaw (1990) regarding transaction costs indicating intermediaries can more easily be diversified than individuals. Modigliani and Miller (1958) indicate that in perfect market, capital adequacy and intermediation are not relevant, thus presence of financial intermediaries demonstrates imperfections in markets. Regarding the theory of financial intermediation in relation to operational efficiency, the following factors come into play. Diamond (1984) further expanded the framework by stating that financial intermediaries often engage in risk transformation, wherein they take on certain types of risks (such as liquidity risk or credit risk) from savers and transform them into different types of risks (such as interest rate risk or default risk) that are more manageable for borrowers. Operational efficiency plays a vital role in managing these risks effectively while minimizing costs. Financial intermediaries can achieve economies of scale and scope by efficiently managing their operations.

Financial intermediaries often possess better information about borrowers than individual savers do. This information advantage allows intermediaries to assess creditworthiness more accurately and mitigate adverse selection and moral hazard problems. Operational efficiency in gathering, analyzing, and utilizing information is critical for maintaining this information advantage. Financial intermediaries reduce transaction costs by pooling funds from multiple savers and providing a convenient platform for borrowers to access capital. Operational efficiency is crucial for minimizing these transaction costs, which can include administrative expenses, processing fees, and regulatory compliance costs. Additionally, financial intermediaries provide liquidity by offering deposit accounts that allow savers to easily access their funds while simultaneously lending to borrowers for longer durations. Operational efficiency is vital for managing liquidity effectively, ensuring that intermediaries have sufficient funds to meet withdrawal demands while maintaining profitable lending activities.

Thus, financial intermediaries are subject to various regulatory requirements aimed at safeguarding financial stability and protecting consumers. Operational efficiency is essential for complying with these regulations while minimizing associated costs and disruptions to business operations. Generally, operational efficiency is a critical component of the theory of financial intermediation, as it enables intermediaries to fulfill their functions effectively while minimizing costs and risks. By efficiently managing their operations, intermediaries can enhance their competitiveness, attract funds from savers, and allocate capital to productive uses, thereby contributing to overall economic growth and development.

Proponents of the financial intermediation theory indicate that a bank that is well functioning and non-bank are the most important mechanisms for allocating capital and hence promote economic growth. Fama (1980) indicated that the theory of financial intermediation is necessary in perfect efficient markets. Freixas and Rochet (2008) argue that banks are quite unique due to their special ability to create money inside, transform maturities, and provided insurance markets that are liquid indicating their critical role in macro economy.

Recent critiques of Intermediation theory in modern banking argue that the classical paradigm that depicts banks primarily as passive qualitative middlemen filtering asymmetric information is completely flawed and structurally obsolete. The traditional theory suffers from information cost paradox since introduction of technology, lowering transaction and search costs does not reduce the need for financial intermediaries. Allen & Santomero (1997) argue that despite all the factors financial intermediation has expanded. Scholars further indicate that banking centers rely heavily on financial engineering, risk management, and participation costs rather than simple brokerage. Banks create value not by hiding information, but by actively creating markets for complex derivatives and transferring risks to entities best equipped to absorb it (Scholtens et al., 2000). Stiglitz (2009), further criticizes it on the base of intermediaries solving certain information related challenges, indicating that banks possess market power which allows them to get some funds from borrowers, and the reliance on collateral-based lending proves wealth inequality by excluding productive but asset-poor financial institutions.

The vertical/ horizontal disintegration lies in the rise of digital platforms and decentralized ledgers that decouple the classic balance-sheet reliance intermediary model. Modern tech innovations allow specialized non-bank financial institutions to strip away classic banking tasks (Hoffmann et al., 2020). Large digital tech firms and payment networks can interject themselves between the consumer and the financial provider. This vertical and horizontal disintegration leaves traditional banks acting as upstream utility providers of maturity transformation, rather than the primary relationship holders envisioned by classical theory (Hoffman et al., 2020).

Central bank researchers and post-Keynesian economists critique target traditional loanable funds framework inherent in intermediation models. Traditional theory assumes that banks must first collect deposits before they can extend credit. The researchers argue that commercial banks do not passively intermediate pre-existing savings. Instead, when a bank grants a loan it simultaneously creates a new deposit out of endogenous money creation. The shift is that the primary constraint on bank lending is not deposit availability, but rather capital requirements, risk appetite, and profitable

credit demand. Thus, treating banks as pure "intermediaries" misinterprets their monetary role as credit creators.

Despite these criticisms, the theory provides a strong foundation for understanding the link between capital adequacy, asset quality, and operational efficiency of banks. It explains how through efficient allocation of core capital through intermediaries influence operational efficiency of banks. It predicts that improved operational efficiency reduces cost of operation, reduces information asymmetry costs, and maximum income. Consequently, it offers a useful framework for interpreting the relationship between operational efficiency and capital adequacy, asset quality while recognizing the moderating effect of market size on commercial banks in Kenya.

2.2.4 Agency Cost Theory

The agency theory was propounded by Mitnick (1973) and propagated by Jensen and Meckling (1976). The theory asserts that agency problems occur when shareholders and managers have different goals and objectives. Such conflicts occur more when the managers of the firm have a lot of cash at their disposal. Managers often use the excess cash to implement projects that are not important, and this reduces the banks' value (Weston & Brigham, 1990). Jensen and Meckling (1976) indicated that there are two different types of conflicts between shareholders and managers, debt holders and shareholders. Conflicts between managers and shareholders occur when managers have an appetite to consume while putting no effort into profit maximization for the banks. This actually occurs because managers are forced to bear the entire profit maximization cost while not receiving the whole profit. Brush (2000) observed that agency theory is based on the principle that the objective of the management is to achieve their individual interests instead of shareholders' interests and that managers' personal interest encourages waste and effectiveness. By increasing the debt level, this cost of agency on managerial discretion can actually be mitigated. However, increasing the levels of debt leads to another agency cost between debtholders and shareholders in which conflicts arise because of shareholders' desire to invest in projects that have zero returns. Returns received by debtholders are normally fixed. Therefore, if an investment earns a good return above its debt value, shareholders

should receive most of such gains, however, if it fails debtholders are expected to bear the entire cost as shareholders are only limited to the amount in which they have invested. Fernando (2015) argued that the high risk-taking behavior of managers at the bank leads to poor loan quality, hence shareholders should exert appropriate measures to monitor the actions of the managers and implement suitable control devices to minimize possible agency conflicts.

According to Easterwood (2011), agency theory suggests different mechanisms aimed at resolving the conflict between shareholders and managers that include external control mechanisms such as takeovers. The potential for conflict between shareholders and managers may also be minimized by the use of internal control mechanisms like non-executive directors' monitoring and executive share ownership incentives. The advocates of agency theory postulate that control mechanisms are mandatory for directing dishonest managerial actions.

A critique of the Agency Cost Theory is based on the fact that the analytical focus on how to resolve conflict between the shareholders in the firm is too narrow, and the shareholders are not the ones who invest in the firm (Donaldson, 1990). Additionally, Hill (1990) has argued that even in situations of very specific assets, where the possibility of unscrupulousness is very high, there are people who will give precedence to collaboration and trust and will not initiate opportunistic behavior. This theory relates to asset quality and market structure as managers try to balance the performing and non-performing loans while shareholders try to control the actions of managers so as not to get into excess risk that would make the bank suffer severe losses. The theory is important as it talks about conflict of interest between managers and shareholders which directly relates to the moderating variable on market structure. Managers and shareholders may have conflicts as the managers try to increase their salaries while shareholders want to increase their wealth.

Efficient banks are those that effectively mitigate agency problems and ensure that management acts in the best interests of shareholders and creditors by maintaining high asset quality (Osamor et al., 2018). In the context of a bank, shareholders seek to maximize their returns, while management may have different objectives, such as job

security or personal gain, which may not always align perfectly with shareholder interests. Creditors, on the other hand, are primarily concerned with the bank's ability to repay its debts. These conflicting interests can lead to agency problems, where management may prioritize its own interests over those of shareholders and creditors. According to Panda et al, (2017), maintaining asset quality is crucial in this context because it serves as a common ground that aligns the interests of shareholders, management, and creditors. High asset quality indicates that the bank's investments are sound, and its risk exposure is minimized, which benefits all stakeholders. For shareholders, this involves preserving the value of their investment and maximizing returns. Creditors benefit from increased security of their loans, reducing the risk of default. Additionally, for management, it strengthens the bank's reputation and ensures long-term viability, which can translate into personal advantages such as job security and performance-based bonuses. Efficient banks are those that effectively mitigate agency problems by implementing mechanisms that align the interests of stakeholders and ensure that management acts in the best interests of shareholders and creditors. These mechanisms may include robust corporate governance structures, incentive systems that tie management compensation to performance metrics such as asset quality and profitability, and transparent communication with stakeholders. Maintaining high asset quality is crucial not only for financial stability but also for building trust and confidence among stakeholders. By aligning the interests of shareholders, management, and creditors, banks can reduce agency costs and enhance their overall efficiency and effectiveness.

The theory is found relevant to the study since it addresses quality information among financial institutions aimed at improving capital adequacy and operational efficiency. The theory is relevant as it maximizes asset quality and core capital with an aim of reducing operational cost and achieves optimum level of operational efficiency. Mihaiu et al (2010), compelled government and banks to streamline processes through revenue from assets and capital and redistribute the loans and advances based on the principle of optimum efficiency performance.

2.2.5 The Bertrand Competition Market Structure Theory

The Betrand Competition Market Structure theory is rooted in the neoclassical school of microeconomics, whose foundations were laid by Bertrand (1989) in reviewing Cournot research on competition in quantities, which was based on mathematical theory and research on the mathematical principles in wealth theory. According to Bertrand, firms face a total cost curve for producing their good and could not choose the price for their respective goods. The theory indicates that banks sets the lowest prices get all the customers, and if the banks set the same price for products, then they both split the market evenly. It is found on the assumption of profit maximization, perfect information, homogenous goods, and similar price-setting and unlimited production. The conditions indicate that simultaneous price setting eliminates economic profits, forcing firms to achieve operational and productive efficiency to survive, as any firm with higher marginal costs is immediately driven out of this market.

Bertrand's 1983 theory draws heavily from critique of the Cournot (1983) model, indicating that firms compete based on price rather than quantity, leading to the "Bertrand paradox." Economist Edgeworth (1897) expanded this framework through introduction of capacity constraints, indicating that when banks cannot meet total market demand using the marginal cost, prices increase higher rather than settling at stable equilibrium. The theory was strengthened further by Nash (1950) through the provision of setting price equal to marginal cost which a dominant strategy used in the current market. Kreps and Scheinkman (1983) contributed significantly by including capacity choices in the framework, indicating that banks first choose capacity and then compete on price dynamics, the equilibrium reverts to the Cournot outcome, indicating Bertrand competition is the ultimate baseline for analyzing price power and discipline in banking institutions.

The theory distinguishes between different dimensions of efficiency, more specifically operational performance. Allocative efficiency is achieved since price equals marginal cost (P=MC), indicating that consumers pay for the cost of producing final unit. Efficiency is indicated by market structure, since banks cannot change a premium over

marginal cost, only while reviewing accounting profits is through minimizing cost of production, optimizing supply chains, and eliminating banking slack. While Betrand theory eliminates excess operational costs used to fund Research & development, proponents argue that constant threat of marginal cost spurs escape competition innovations.

Proponents of the Betrand Competition theory argue that constant price competition remain the most effective way for driving operational efficiency and maximizing bank market size. Freidman (1982) further purports that threat of Betrand-style competition disciplines banks maintaining lean operation and minimizing costs. Clark (1941) advanced the concept by viewing Betrand model as the theoretical extreme that ensures financial institutions cannot extract monopoly extent through reductions in operations. Moreover, Hayek (1945), further compounds that decentralized price competition is an information process that forces banks to seek further cost reduction methods and technological advancements to maintain market position.

Economists from the school of thoughts have criticized this theory. Chamberlin (1933) and Robinson (1933) challenged the homogeneous goods assumption, indicating that through the theory of Monopolistic competition banks can differentiate their products to escape the Betrand paradox, indicating that prices can go higher than marginal cost. Stiglitz (1989) critique the perfect information assumption, indicating that the real world price of one price-does not necessary hold, indicating that banks with operational inefficiencies hide behind information frictions. Max (1867) further indicates that high price competition forces banks to drive down operational cost by suppressing workers' wages, intensifying labor, extending work hours, thus creating a systemic exploitation.

Understanding the market structure for banks is essential for policymakers, regulators, investors, and consumers to assess competition, risk, and efficiency within the banking industry (Karlsson et al., 2021). Different market structures can have varying implications for pricing, product quality, financial stability, and overall economic welfare. In the banking industry, various theories of the market structure provide insights into the organization, behaviour, and competitiveness of banks within the

market. Some prominent theories include perfect competition, monopolistic competition, oligopoly, duopoly, Bertrand competition, Stackelberg competition, and contestable market.

The Bertrand Competition market structure theory focuses on price competition among firms selling homogeneous products. In a banking context, banks compete by offering the lowest interest rates on loans or the highest interest rates on deposits, assuming all other aspects of the products are the same. Finally, under the contestable market theory, even in markets with few firms, if there are low barriers to entry and exit, the market behaves competitively. In banking, if it's easy for new banks to enter the market or for existing banks to leave, competition may still be strong despite a small number of players.

For this research, the Betrand Competition Market Structure theory provides the theoretical foundation for explaining market structure and influence it has on capital adequacy, asset quality, earnings, liquidity and operational efficiency. It indicates that higher price competition forces banks to minimize marginal cost, increase internal processes and reduce X-inefficiency to maintain market size and optimum levels of operational efficiency.

2.2.6 Assets Liability Management Theory

Asset Liability Management Structure theory is a structural framework rooted in the portfolio theory, financial intermediation theory and risk management. Proponent of the theory include Martin Leibowitz (1987), a prominent figure in Asset Liability Management (ALM), has contributed significantly to the field over four decades through various publications. The concept initially focused on aligning assets with liabilities to ensure each inflow corresponds to a specific cash outflow (Ronald, 2013). ALM theory offers an effective framework for mitigating risks associated with asset/liability discrepancies, particularly concerning interest rates and liquidity, commonly encountered by banks. From another perspective, Asset Liability Modeling, proposed by Klein (1971) and Monti (1972), operates within a neoclassical banking model, treating banks' balance sheets with assets including central bank reserves,

loans, bonds, and interbank loans, and liabilities including deposits, equity, and regulatory reserves. Managing ALM involves aligning various assets and liabilities based on maturity levels through hedging or securitization.

ALM is described as a risk management strategy aimed at maximizing returns while ensuring assets exceed liabilities (Sudanarao, 2017). The theoretical foundations revolved through the contributions of key several academic proponents. Pyle (1971) and Jaffee (1974), pioneered the application of Markowit'z Portfolio theory to banks. They modelled banks as risk-averse portfolio managers balancing expected returns against costs and risk of liabilities. To enhance this further Ho and Saunders (1981), developed the bank interest margin model that conceptualizes ALM as a dynamic hedging process where banks as the risk averse intermediaries adjust the balance sheet structures to hedge against interest rate shocks.

The Financial Accounting Standards Board defines assets as potential future benefits and liabilities as future sacrifices expecting economic returns (Sodhi, 2005). ALM leverages assets and liabilities to enhance bank profitability while managing liquidity and meeting regulatory standards (Ong, 1998). In the banking sector, liabilities encompass customer accounts while assets include mortgages and loans. ALM addresses interest rate fluctuations and risk management, particularly highlighted after the banking crises of the 1980s, driving investors towards institutions offering stable earnings (Giarla, 1991).

Propositions on balance sheet structuring include Besis (2015), indicates that bank must utilize both on-balance sheet matching and off-balance sheet derivatives in order to structurally hedge against macroeconomic shocks. To prevent bank runs and structural solvency, banks must hold a proportion of their assets in highly liquid-low yielding securities to cushion against liability withdrawals (Diamond & Dybvig, 1983).

While ALM theory posit a framework for balance sheet optimization, recent empirical evidence indicate that banks mostly deviate from theoretical propositions leading to systemic fragilities. ALM theory indicates that financial institutions should minimize

equity against interest rate risk. However, empirical evidence indicate that prolonged low-interest rate force banks to violate this assumption to maintain profitability. Claessens et al. (2018) indicates that low rate reduce profits, pushing financial institutions to aim for yields by increasing their asset portfolios, thus structurally exposing them to interest rate risk. This interrogates the theory by indicating that risk return trade-off often supersede the structural hedging proposition.

ALM structure is deeply intertwined with operational efficiency of banks. Effective ALM requires sophisticated internal systems, such as Funds Transfer Pricing Mechanisms, to determine the cost of operations in different banks. Kabi et al (2022) indicates that banks with robust ALM structures exhibit better operational efficiency duet to funds transfer pricing which allows for exact allocation of capital costs and liquidity, reducing misallocation and mispricing. Therefore, poor ALM structures force banks into costly, reactive operational measures which reduce the operational efficiency of the respective banks.

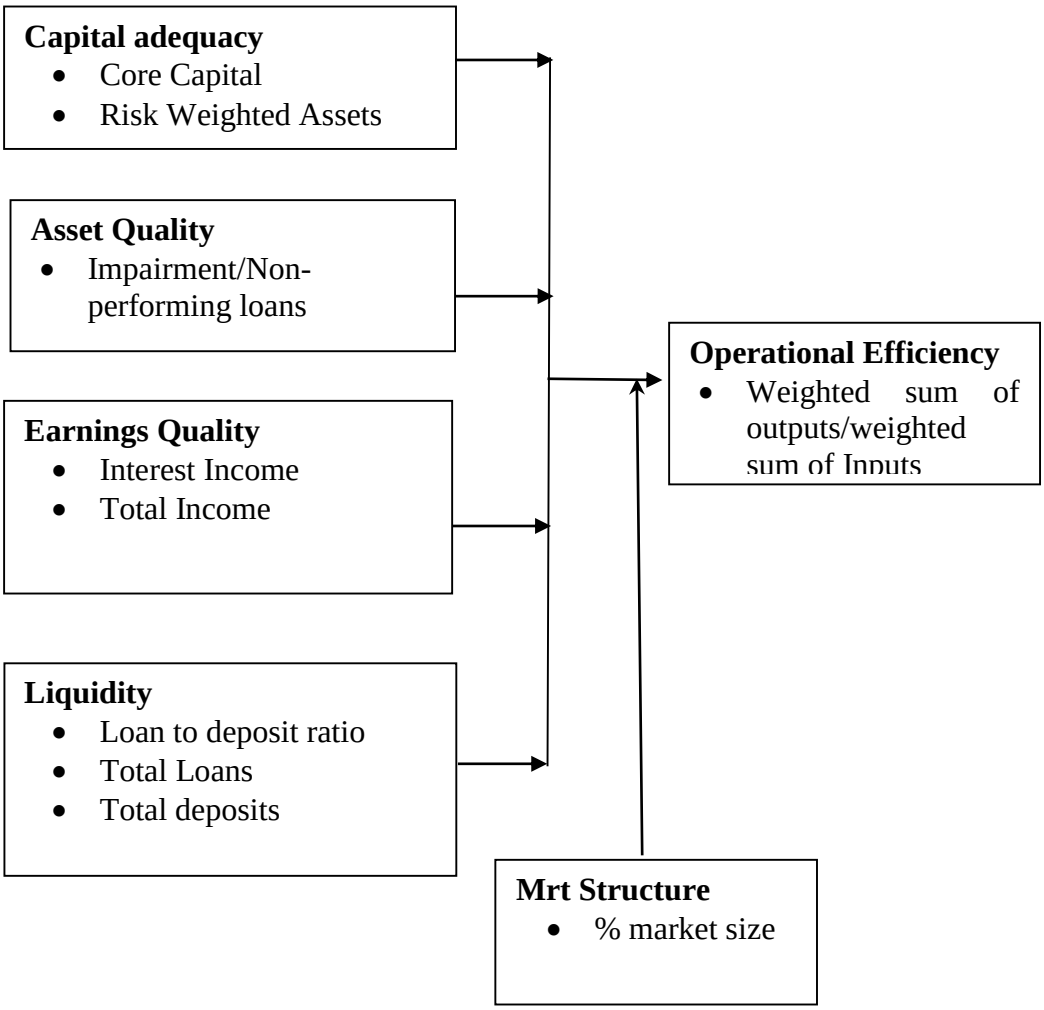
Empirical findings show that banks are flush with abundant cheap liabilities, and loan officers tend to originate riskier loans, thus degrading asset quality (Acharya and Navqi 2012). ALM through asset quality is an effective mechanism of liquidity constraints solution effect. Zakrajšek (2018), further indicates that banks with a positive maturity gap between repricing assets slower than liabilities tend to experience significant declines in earnings quality when interest rate rise.

Dynamic balance sheet management within ALM involves decision-making to control risks related to credit, interest rates, contingency, and liquidity positions. ALM relies heavily on information systems for data collection and analysis, ensuring efficient operations across bank branches (Sudanarao, 2017). A well-integrated banking system, according to Lina (2014), requires a comprehensive ALM desk covering all operational factors strategically rather than tactically. This theory directly impacts bank asset and earnings quality, ultimately influencing operational efficiency. For research purposes, ALM's relevance lies in its necessity for banks to efficiently manage asset and liability structures to avoid discrepancies. It underscores the

importance of ALM committees for overseeing liquidity and interest rate risk management.

2.3 Conceptual Framework

According to Kombo and Tromp (2009), a concept is a generalized idea or abstract. Myers (2013) describes it as a diagrammatical representation of the relation between certain variables under investigation. Ngumi (2013) indicates that it is a different set of ideas and principles from a relevant research study that assists researchers in understanding the current situation under study. A conceptual framework is defined as a set of networks of interlinked concepts that are brought together to provide a comprehensive understanding of a phenomenon. In other words, it is a visually written product that explains graphically or in a narrative form, the main things to be studied (factors, concepts, variables, and relationships among them) (Miles & Heberman, 1994). The conceptual framework shows the association between capital adequacy, asset quality, earnings quality, and liquidity on the efficiency of banks. The efficiency of banks is the independent variable that was measured using operational efficiency by use of different input and output variables. The SFA model would be applied using the following outputs: total loans and other earning assets and bank input as labor, capital, and deposits. The moderating variable is market structure measured using the total assets that each bank depicts.



Independent Variable **Moderating Variable** **Dependent Variable**

Figure 2.1: Conceptual Framework

2.3.1 Capital Adequacy

Capital adequacy is defined as the level of capital that a commercial bank requires to allow them to endure risks such as operational, credit, or market risks that are prone in order to absorb the possible losses and protect firm debtors. Capital is one of the important components that influence the operational efficiency of banks. Capital represents the amount of finances available to support the bank's operating cost. Bank's capital acts as a buffer in cases where their adverse situations within the firm.

Capital is determined by Core capital over risk-weighted assets. Basel II accord indicates that a bank should hold a minimum tier I capital of 8% which is the ratio of core capital to risk-weighted asset. Moreover, banks should have a minimum tier 2 capital of 12% which is the ratio of tier plus asset revaluations and term debt to risk-weighted asset, and a minimum of tier 3 is 12% being the ratio of tier 1 plus tier 2 plus short-term debt to risk-weighted assets. Tier 1 in banks is known as regulatory capital while tiers 2 and 3 are termed as supplementary capital (Greuning & Bratanovic, 2009).

2.3.2 Asset Quality

The concept of asset quality involves the evaluation of assets in a bank that are used in credit risk and generally linked to general operation. Asset quality is an important factor for bank management that includes bank asset evaluation to facilitate the level of measurement and size of credit risk that is associated with bank operation. It directly relates to the banks' balance sheet left-hand side and is focused on loan quality which provides bank earnings quality. The most vital asset that requires a determination on the level of asset quality are loans that can be non-performing assets when borrowers default on the repayment requirement.

Asset quality has been used by several researchers as a proxy for non-performing loans (Mintarti, 2009; Damayanti & Chaniago, 2014; Pratiwi, 2014; Ahmad, 2015; Haryanto, 2016; Thalib, 2016). Asset quality indicates current assets quality that are used in different bank assets contained in the cash flow and balance sheet. Asset quality directly relates to the level of credit risk that is encountered by several banks due to massive lending and funds investment in current existing portfolios. Asset quality can be measured in terms of the number of non-performing loans.

2.3.3 Earnings Quality

Earnings quality is a measure of how reliable a company's earnings quality is for assessing a company's current and future performance. To measure the earnings quality of bank indicators such as net interest income, fee income, and operating

expenses are used from a bank financial statement. The indicators are the core income and expense factors of a bank and are determined by essential factors such as profit margins, asset and client base size, capitalization, and cost efficiency. The long-term feasibility of a bank greatly lies in its ability to generate adequate earnings quality to protect and thus enhance reward and capital to all its shareholders.

2.3.4 Bank Liquidity

Bank liquidity refers to the ability of a bank to pay for liabilities in the period of maturity. Liquidity challenges arise when banks fail to attain fiscal responsibilities in repaying debt without improper losses occurring (Landskroner & Paroush, 2011). Basel Committee indicates that the vulnerability of a bank due to liquidity problems arises when financial institution are involved in short-term repayments of mature long-term loans. Higher liquidity occurs in situations where the banks are able to meet all untimely withdrawals from the depositors. The gap between liabilities and the resources of banks are referred to as the liquidity gap. Liquidity is measured using the ratio of liquid assets to total assets.

2.3.5 Market Structure

A moderation effect is a causal model that indicates when or for whom an independent variable strongly or weakly causes a dependent variable. A moderator modifies the strength or direction either positive or negative of a causal relationship. The moderation effect is commonly termed as the interaction term in which the strength or direction of an independent variable effect on the dependent variable depends on the level or the value of other independent variable. Therefore moderation effect is a special case of an interaction effect, a causal interaction effect, which requires a design behind the data. Thus, a moderation effect is certainly an interaction effect. The study adopted market structure to control for differences in market size among the different banks. This was informed by data that indicate market structure has potential to influence operational efficiency of banks (Sanfiz, 2025).

2.3.6 Operational Efficiency

Operational efficiency is described as the ability of a bank to efficiently deliver services and products with minimal cost without compromising on quality. It can also be described as the influence of having the right personnel, technology, and processes that combine to enhance productivity and business operational value while minimizing operational costs to desired levels (Shawk, 2008). The effect of such an influence is that resources previously spared can be used in new, high-valued initiatives that bring more profit to the bank. Relatively banks that are more cost-efficient tend to have better operational performance and maintain better levels of output compared to other banks (Mills & Schumann, 1985).

Banks need to operate more efficiently by directing savings toward investments with higher expected returns. According to Said (2012), operations management has been considered a secondary concern since it was not as critical as profitability (Said, 2012). The relationship between capital adequacy and the operating efficiency of banks was evidenced by a study done by Odunga (2013). Its findings were that total capital ratio and liquid assets over short-term liabilities were positively and significantly affecting the bank's level of operating efficiency. Olarewaju and Obalade (2015) evaluated the factors that determine operational efficiency in deposit-making money banks in Nigeria from the period 2004 to 2013. Ratio analysis was used on a sample of six banks in which data was derived from the bank's financial statements that are listed on the Nigeria Stock Exchange. The data included personnel expenses, interest expenses, total loans, deposits from customers, and total investment. The results indicated that total loans and total deposits had a negative relationship with the operational efficiency of banks.

The link between capital adequacy and operational efficiency as advanced by Mendoza, Ramos, Sepulveda, and Fuentealba (2019) indicated that the level of short-term debt, leverage, and monitoring by external investors act as effective methods of control that influence operational efficiency in Chilean companies. Efficiency can be measured in two ways using either the parametric or non-parametric approach. According to Mandl (2008), parametric frontier functions require an assumption of a

certain type of correlation between inputs and outputs. However, a non-parametric approach has little or no cause and effect. In other words, the assumption about the population having a specific distinctive structure is almost not in existence. For instance, the Stochastic Frontier Approach (SFA) is a non-parametric and distinctive approach for estimating productive efficiency. The parametric method such as SFA uses econometric methodologies to estimate parametric functions. The most important advantage of this method is that it overcomes certain defects of the Deterministic Frontier production function, including data sensitivity and error, and lack of stability and thus it is considered as an ideal method. Moreover, the method has a strong orientation policy, and it can also be used to calculate the efficiency effects of different policies.

Vardar (2013) researched the efficiency and stock performance of banks in Eastern and Central Europe to investigate if efficiency scores are correctly priced in bank stocks. Changes in the level of efficiency scores of banks are regressed against stock price, obtained from the Stochastic Frontier Approach model by applying the fixed effect regression equation. Findings revealed that efficiency changes had a positive and significant effect on stock returns, but a negative effect was found between the cost of efficiency changes and stock returns. The researcher would have incorporated more input and output variables to expand the horizon, and this would greatly assist in attaining a more precise finding on the link between cost and profit efficiency scores as well as whether the scores are priced correctly.

Thus, efficiency is determined by the technology that a firm uses in production. The technology of a bank can be shown using production frontiers, profit functions, cost functions, or distance functions. A bank is technically efficient if it has both inputs and output on a production frontier. Besides, banks are said to be technically inefficient if it has both input and output below the frontier. The technically efficient banks use existing technology to produce the maximum amount of output given a certain quantity of inputs. This research embarked on determining the relationship between capital adequacy and operational efficiency on liquidity, earnings quality, and asset quality.

2.4 Empirical Literature Review

This section represents empirical studies on the operational efficiency of banks and how it relates to capital adequacy, asset quality, earnings quality, and liquidity. Market structure is also used to moderate the effect of these bank specific factors on operational efficiency.

2.4.1 Capital Adequacy and Operational Efficiency

Capital adequacy and the effect it has on the operational efficiency of banks has elucidated serious debate in the banking industry. Adequate capitalization allows banks to absorb losses without jeopardizing their financial stability. This enables them to engage in riskier activities, such as lending, while still maintaining prudent risk management practices. Efficient banks not only maintain sufficient capital but also effectively allocate it to mitigate risks and optimize returns. Well-capitalized banks have a competitive advantage in the market as they can attract deposits, lend more, and expand their operations with confidence (Pradhan et al., 2017). Moreover, efficient banks can achieve economies of scale and scope, reducing their cost of operations and enhancing profitability. This competitive advantage allows them to thrive in a highly competitive banking landscape. Compliance with capital adequacy regulations is essential for banks to operate legally and maintain the trust of depositors and investors (Sentero, 2013).

Banks that meet or exceed regulatory capital requirements demonstrate sound financial health, which can enhance their reputation and attract more customers. Additionally, efficient banks can meet these regulatory requirements without significantly impacting their profitability, ensuring long-term sustainability. The relationship between capital adequacy and efficiency is further emphasized when considering risk-adjusted returns. Efficient banks not only generate higher returns but also manage risks effectively, resulting in superior risk-adjusted returns (Olalekan and Adeyinka, 2013). Adequate capitalization supports this by providing a buffer against unexpected losses, allowing banks to maintain stable earnings and shareholder value.

Capital adequacy and bank efficiency are interconnected factors that contribute to the overall performance and stability of banks. While capital adequacy ensures financial resilience, efficiency enables banks to maximize profitability and competitiveness. A balance between the two is essential for banks to thrive in a dynamic and challenging banking environment.

Ongore (2013) indicates that capital creates a buffer against bank losses and therefore banks need to hold more capital to minimize the chances of bankruptcy cases. Capital as a Buffer refers to the funds that a bank holds as a cushion against unexpected losses. These losses could arise from various sources, such as bad loans, market volatility, or economic downturns. By holding sufficient capital, banks can absorb these losses without jeopardizing their solvency. On the other hand, Bankruptcy occurs when a bank's liabilities exceed its assets, leading to insolvency. Insufficient capital increases the risk of bankruptcy because the bank may not have enough resources to cover its losses. Therefore, holding an adequate amount of capital is crucial for minimizing the risk of bankruptcy. The assertion that banks need to hold more capital implies that the current level of capital might not be sufficient to effectively mitigate the risks they face. Increasing the amount of capital held by banks can enhance their resilience to adverse events and reduce the probability of bankruptcy. Banking regulators impose capital requirements to ensure that banks maintain a sufficient buffer against losses. These requirements dictate the minimum amount of capital that banks must hold relative to their risk-weighted assets. Banks that fail to meet these requirements may face regulatory sanctions or even closure. Thus, Ongore (2013) indication underscores the importance of capital adequacy in banking and the need for banks to maintain robust capital buffers to safeguard against potential losses and bankruptcy. This aligns with the broader principles of prudential regulation aimed at promoting the stability and soundness of the financial system.

According to Estrada and Osorio (2004), capital adequacy requirement influences the operational efficiency of banks since they act as fixed inputs during the production process. By continuously allowing regulatory cost components to determine efficiency levels, directly considers the regulatory burden borne by financial institutions and thus

assists in understanding hidden costs that are quite difficult to understand in practice. Additionally, by recognizing the impact of capital adequacy requirements on operational efficiency, we gain insight into the true cost of regulation on financial institutions. This understanding is important for policymakers, regulators, and banks themselves in managing resources effectively and ensuring a balance between regulatory compliance and operational performance. Furthermore, tighter capital regulations are required to safeguard against unintended adverse effects on banks and efficient capital allocation of all resources.

Yener, Carbo, Gardener, and Molyneux (2007) researched the relationship between capital, risk, and operational efficiency for a large bank sample in Europe from 1992 and 2000. The findings indicate that a negative correlation existed between capital adequacy and operational efficiency. The finding of a negative correlation suggests that as banks allocate more capital to ensure safety and regulatory compliance, their operational efficiency may suffer. Additionally, regulatory requirements often dictate the minimum levels of capital banks must hold to safeguard against financial risks. If higher capital adequacy is associated with lower operational efficiency, it might indicate challenges for banks in meeting regulatory requirements without compromising their operational performance. Therefore, the findings of the study suggest an important trade-off that banks must navigate between capital adequacy and operational efficiency, highlighting the complex relationship between risk management, regulatory compliance, and profitability in the banking sector.

Odunga, Nyangweso, Carter, and Mwarumba (2013) conducted a study examining the capital adequacy, credit risk, and operational efficiency of banking institutions in Kenya. Their findings revealed a positive correlation between capital adequacy and operational efficiency. The positive correlation they discovered between capital adequacy and operational efficiency suggests that as banks maintain higher levels of capital, they are likely to operate more efficiently. This finding has significant implications for the banking sector and regulatory authorities. Capital adequacy is a crucial aspect of banking regulation aimed at ensuring the stability and resilience of financial institutions. The positive relationship with operational efficiency indicates

that adequate capital not only serves as a buffer against financial distress but also enhances the overall effectiveness and productivity of banks. One possible explanation for this positive correlation is that well-capitalized banks have more resources to invest in technology, staff training, and process optimization, leading to smoother operations and higher efficiency levels. Additionally, higher capital levels may instill greater confidence among depositors and investors, thereby attracting more business opportunities and reducing funding costs for banks. From a regulatory perspective, this research underscores the importance of maintaining stringent capital adequacy requirements to promote a healthy and efficient banking system. By ensuring that banks have sufficient capital to absorb losses and support their operations, regulators can mitigate the risks of financial instability and enhance the overall resilience of the banking sector. Therefore, the findings of this study highlight the critical role of capital adequacy in driving operational efficiency within banking institutions, emphasizing the need for both banks and regulators to prioritize capital management strategies to achieve sustainable performance and stability in the financial system.

Pradhan and Shrestha (2017) conducted a study examining how capital adequacy and operational efficiency affect the financial performance of commercial banks in Nepal. Their findings revealed that factors such as loan loss provision to total loan, core capital ratio, risk-weighted ratio, and total capital ratio were associated with a detrimental effect on the financial performance of Nepalese commercial banks. This indicates that higher levels of capital might not necessarily translate into improved financial performance. This finding could prompt banks to reevaluate their capital allocation strategies and consider optimizing capital utilization to enhance profitability. While the study doesn't delve into specific efficiency metrics, it implies that factors related to bank operating efficiency may also influence financial performance. Efficiencies in operations, such as cost management, resource allocation, and productivity, could play a crucial role in determining the profitability and sustainability of banks. Banks may need to focus on streamlining their operations and improving efficiency to mitigate the negative impact on financial performance highlighted in the study. This finding underscores the importance of effective credit risk management practices. Banks need to carefully assess credit risk, establish

adequate provisions for potential loan losses, and implement strategies to minimize non-performing loans. Improving asset quality and credit risk assessment processes could help mitigate the adverse effects of loan loss provisioning on financial performance.

Rizal (2016) conducted a study examining the relationship between capital adequacy ratio, non-performing loans, operational efficiency ratio, and return on assets in Sharia banks in Indonesia from 2012 to 2015. The results of the study revealed that the capital adequacy ratio did not have a noteworthy impact on return on assets. Conversely, non-performing loans and operational efficiency exhibited a statistically significant negative influence on the return on assets of Sharia banks. Despite its importance in measuring a bank's financial health and ability to absorb potential losses, the study found that the capital adequacy ratio did not significantly affect the return on assets for Sharia banks in Indonesia during the specified period. This suggests that factors other than capital adequacy might have played a more dominant role in determining the profitability of these banks. The findings of Rizal's study shed light on the factors influencing the profitability of Sharia banks in Indonesia. While the capital adequacy ratio did not emerge as a significant determinant, the study highlights the critical roles of managing non-performing loans and improving operational efficiency in enhancing the financial performance of Sharia banks. These findings could potentially inform strategic decisions and policies aimed at strengthening the financial stability and profitability of Sharia banks in Indonesia.

Hussein (2013) conducted a study examining operational efficiency within 17 Islamic banks in Sudan spanning the years 1990 to 2000, employing the Stochastic Frontier Analysis (SFA) methodology. The research outcomes revealed a correlation between increased capital adequacy ratio and elevated operational efficiency costs. Moreover, the findings implied that foreign banks outperformed state-owned banks in terms of efficiency. The study suggests that a higher capital adequacy ratio is associated with increased operational efficiency costs. This finding implies that while maintaining sufficient capital reserves is crucial for financial stability and regulatory compliance, it may also result in higher operational costs for Islamic banks in Sudan. Further

exploration into the specific mechanisms through which capital adequacy influences operational efficiency could provide valuable insights for bank management and regulators. Another notable finding is that foreign banks demonstrated greater operational efficiency compared to state-owned banks. This observation could be attributed to various factors such as differences in management practices, access to resources, technology adoption, and regulatory environments. Understanding the specific strategies and practices that contribute to the efficiency of foreign banks could offer valuable lessons for improving the performance of state-owned banks and enhancing the overall competitiveness of the banking sector in Sudan. Fundamentally, the research sheds light on important dynamics within the Islamic banking sector in Sudan, highlighting the interplay between capital adequacy, operational efficiency, and ownership structure. Further research building upon these findings could contribute to the development of more effective policies and strategies aimed at fostering a robust and efficient banking system in the country.

Ding and Sickles (2018) conducted research examining the relationship between capital adequacy, portfolio risk, and frontier efficiency in U.S. banks spanning from 2001 to 2016. Their findings indicated that banks with higher efficiency levels are capable of boosting their capital reserves while simultaneously assuming greater credit risk. The study employed Stochastic Frontier Analysis (SFA) to construct a frontier representing the cost of banks' efficiency levels, serving as a proxy for their overall performance. One of the key findings of the study suggests that more efficient banks have the ability to enhance their capital reserves while also taking on increased credit risk. This finding is significant as it challenges conventional notions that increasing capital reserves necessarily comes at the expense of assuming higher levels of risk. Instead, it implies that efficient banks are better equipped to manage and mitigate the additional risks associated with expanding their credit activities. The utilization of Stochastic Frontier Analysis (SFA) in the study is noteworthy. SFA is a powerful econometric technique commonly used to measure and assess the efficiency of production processes. In this context, SFA was applied to construct a frontier representing the cost of banks' efficiency levels. By using efficiency as a proxy for

bank performance, the study provides insights into how variations in efficiency levels among banks influence their ability to manage capital and risk effectively.

In an empirical analysis utilizing a sample of commercial banks in Kenya, Odunga (2016) investigated the determinants of bank operating efficiency. The study discerned bank capital adequacy as a paramount factor significantly impacting operational efficiency. Odunga (2016) asserted that augmenting their capital reserves is imperative for banks in mitigating operational costs effectively. Furthermore, Odunga's (2016) research on the determinants of bank liquidity corroborated the pivotal role of capital adequacy in shaping liquidity dynamics. The findings from Odunga's (2016) research regarding the determinants of bank operating efficiency and liquidity in Kenyan commercial banks hold significant implications for both financial institutions and regulatory authorities. Firstly, the identification of bank capital adequacy as a pivotal factor affecting both operating efficiency and liquidity underscores the fundamental importance of a robust capital base in ensuring the stability and sustainability of banking operations. Banks with adequate capital reserves are better positioned to absorb losses, manage risks, and maintain operational continuity even during adverse economic conditions. This underscores the importance of prudent capital management practices for banks in safeguarding their financial health and resilience. From a regulatory perspective, the research findings underscore the importance of regulatory frameworks that promote sound capitalization levels and liquidity management practices among banks. Regulatory authorities should emphasize the implementation of robust capital adequacy standards such as Basel III to ensure that banks maintain adequate capital buffers relative to their risk exposures. Additionally, regulatory stress testing and liquidity risk management guidelines can help banks assess their resilience to adverse scenarios and take proactive measures to enhance their risk management frameworks.

Siddik and Kabiraj (2019) conducted a study examining the influence of capital adequacy on the operational efficiency of banks in Bangladesh. They utilized panel data from 23 commercial banks in Bangladesh spanning the years 2013 to 2017 for their analysis. The findings revealed a notable and positive correlation between capital

adequacy ratios and the operational efficiency of banks. Additionally, the findings suggested that meeting minimum capital requirements prompts banks to reassess their internal operational policies, including aspects such as corporate governance, risk assessment methodologies, credit evaluation procedures, recruitment of skilled personnel, and enhancement of internal control mechanisms.

Odekina (2019) conducted a study examining the impact of capital adequacy, credit risk, and operating efficiency on the performance of commercial banks in Nigeria. Secondary panel data from the Central Bank of Nigeria (CBN) and Annual Bank Reports were utilized for the analysis. The study employed the panel random effect regression method to analyze the data. The findings revealed a noteworthy positive relationship between capital adequacy and the financial performance of the banks. The results of the analysis revealed a significant positive effect of capital adequacy on the financial performance of commercial banks in Nigeria. This suggests that maintaining sufficient capital reserves is vital for enhancing the overall performance and stability of banks.

Margaritis and Psillaki (2007), researched on effect of capital adequacy on firm efficiency of 12,240 New Zealand firms using a quantile regression, the results indicated that efficiency on firm leverage is positive and has a non-monotonic effect. However, Tian and Zeitun (2007) researched on effect of capital adequacy on the corporate performance of firms in Jordan which indicated that capital adequacy had a negative effect on performance. Llorrens (2019) investigated capital adequacy, productivity, and bank restructuring of banks in Spanish from 1998-2007. The researcher discovered that increasing hybrid capital weight is considered a leveraging process with the capital regulations since there is an increase in debt-like instruments in unison with the level of capital. Furthermore, evidence suggests that savings banks experienced higher growth rates during the pre-crisis period, targeting a proportion of high debt-like instruments in their regulatory capital. This phenomenon explains why the capital of these banks could not absorb losses during the crisis

Empirical evidence reveals a disparity between capital adequacy and operational efficiency. While many researchers typically use financial performance as the

dependent variable, this study opts for operational efficiency due to its ability to encompass various input and output factors, thus providing impartial findings. Moreover, operational efficiency considers the error term, which is often overlooked when using performance as the dependent variable.

2.4.2 Asset Quality and Operational Efficiency

Asset quality and operational efficiency are two crucial factors that determine the stability, profitability, and sustainability of banks. Asset quality refers to the health and performance of a bank's loan portfolio and other assets. It indicates the likelihood of those assets generating income as well as the risk of default or non-performance (Kadioglu and Ocal, 2017). Key indicators of asset quality include non-performing Loans (NPLs), which are loans that are in default or close to default. High levels of NPLs indicate poor asset quality. Loan Loss Provision-the amount set aside by the bank to cover potential losses from bad loans. High asset quality is essential for banks to maintain investor confidence, attract deposits, and borrow funds at favorable rates. Poor asset quality can lead to financial instability and even bankruptcy.

Various researchers have investigated the relationship between asset quality and operational efficiency. Justin, Michael, Vasanthi, and Selvaraju (2006) explored how non-performing assets affect the operational efficiency of Central Co-operative banks in India. They found that non-performing assets have a significant impact on operational efficiency, which in turn affects the liquidity, profitability, and solvency ratios of cooperative banks. To enhance and elevate the quality of Indian Cooperative banks, prudential regulations regarding income and asset recognition were implemented during the period spanning 1996-1997. The study conducted by Justin, et al., (2006) focuses on Central cooperative banks in India and their non-performing assets (NPAs). NPAs are loans or advances where the borrower has failed to make interest or principal payments for a specified period, indicating a potential risk of default. The findings suggest that NPAs have a direct impact on the operational efficiency of these banks. When NPAs increase, it indicates a higher level of credit risk and potential losses for the bank. This can lead to various operational challenges such as increased provisioning for bad debts, higher administrative costs related to

managing distressed loans, and a decrease in the overall efficiency of banking operations. Furthermore, high levels of NPAs can also affect the liquidity, profitability, and solvency ratios of banks, which are critical indicators of their financial health and stability. The study highlights the significant impact of asset quality, particularly NPAs, on the operational efficiency and overall performance of Cooperative banks in India. It underscores the importance of implementing effective regulatory measures to address asset quality concerns and maintain the stability and resilience of the banking sector.

Cheruiyot (2015), researched the asset quality effects on banks' profitability in Kenya using all 43 banks' audited financial reports. The researcher discovered that there is a strong positive correlation between asset quality and the profitability of banks in Kenya. This is because when the non-performing asset to net asset ratio is lower, it means that the association between asset quality and bank profitability is positive and significant. In a similar study Dimitris (2008), indicated that there exists a positive correlation between bank profitability and operational efficiency. This indicates that big banks have larger operational efficiency compared to less profitable banks. There is no strong evidence that links large banks that are profitable to operational efficiency as compared to small profit-making banks (Myron & Blac, 1983). Delis and Papanikolaou (2009), and Kalluru and Bhat (2009), researched determinants of bank efficiency and discovered that there is a positive cordial relationship between banks' efficiency and level of profitability.

From a managerial accounting perspective, there exists a discernible and positive relationship between the quality of assets held by a bank and its operational performance. This association stems from the imperative that banks facing a shortfall in asset quality are compelled to navigate increased losses arising from non-performing loans and must allocate additional resources towards the management and recovery of such assets (Abata, 2010). As banks designate loans for collection, they inevitably incur supplementary operational expenses, attributed primarily to non-value-added activities involved in overseeing the collection process. These activities encompass a spectrum of tasks, including but not limited to the routine monitoring of

debtors' financial positions, the valuation and protection of collateral assets, the restructuring of amortization schedules, the negotiation of contractual terms, and the computation of withholding liabilities (Khalid, 2012).

The costs incurred extend beyond purely financial considerations and encapsulate broader strategic imperatives. These encompass the necessity of fostering and preserving trust among stakeholders, including both management and the public, ensuring the ongoing safety and integrity of the institution, mitigating the risk of adverse ratings due to external contingencies, addressing potential deposit withdrawals resulting from diminished depositor confidence, continually monitoring the quality of loan portfolios, and proactively addressing issues that may arise from neglecting other operational dimensions once concerns related to asset quality have captured the attention of senior management (Khalid, 2012).

Achou and Tenguh (2008) highlighted a negative correlation between non-performing loans (NPL) and banks' profitability. They emphasized the critical importance of banks implementing prudent credit risk management to protect their assets and safeguard the interests of investors. Likewise, Aboagye and Otieku (2010) argued that in order for banks to sustain their operations, they must generate sufficient income from lending and fiduciary services to offset operational and financing expenses, as well as reinvest retained earnings to support future endeavors. This approach, they suggested, not only ensures survival but also fosters growth and profitability for banks. The discussion presented here underscores the significance of effective credit risk management in maintaining banks' financial health and ensuring the satisfaction of stakeholders. By minimizing non-performing loans and maximizing profitability through sound lending practices and prudent financial management, banks can sustain their operations and foster long-term growth. This emphasizes the imperative for financial institutions to prioritize risk mitigation strategies and prudent investment decisions to maintain their stability and competitiveness in the market.

According to Alhassan, Coleman, and Andoh (2014), non-performing loans, market structure, loan growth, inflation, bank market structure, real exchange rate, and GDP growth are significant factors that determine the asset quality of Ghanian banks. These

findings are particularly important for bank managers and regulators in emerging economies. Swamy (2017) researched asset quality determinants and profitability using a panel data model from 1997 to 2009. Priority sector credit was found insignificant in affecting non-performing assets. Bad debts are found to be more industry-dependence performance measures than most different sectors of the economy. Public sector banks indicated that they can better contain bad debts and performance while private sector banks indicated they are quite established in bad debt containment since they had better risk management processes which definitely allowed them to end quite well while having lower levels of non-performing assets.

Kariuki, Muturi, and Ngugi (2016), researched asset quality and intermediation efficiency using credit cooperative societies and deposit-taking saving banks in Kenya. DEA was used when generating efficiency scores in the first stage. To minimize heavy reliance on the efficiency scores, corrected biased efficiency scores were generated and regressed against asset quality. Firm size, diversification, and profitability were included as control measures. The findings indicated a strong positive relationship between asset quality and intermediation efficiency.

2.4.3 Earnings Quality and Operational Efficiency

The earning quality and operational efficiency of banks are critical factors that determine their overall performance and sustainability. Banks that maintain a balance between earning quality and operational efficiency are better positioned to deliver sustainable returns to shareholders, provide value to customers, and withstand economic challenges. Continuous monitoring and optimization of these factors are essential for long-term success in the banking industry. The long-term sustainability of a bank depends to a great extent on its ability to generate earnings quality to protect and enhance capital holdings and shareholders' rewards. Losses lead to capital reduction and liquidity in a bank which leads to reduced operational efficiency.

Earnings qualities are used as indicators of the financial well-being of a bank. Researchers have tried to discover the relationship between earnings quality and operational efficiency and have shown mixed results, Cebenoyan (2003), researched

operational efficiency and value relevance of earnings quality using stochastic frontier methodology. The findings indicated a significant relationship between firms' relative operational efficiency and earnings quality persistence.

In a study conducted by Michael, Vasanthi, and Selvaraju (2006), the impact of non-performing assets on the operational efficiency of Co-operative banks in India during the period of 1996-1997 was investigated. They discovered that non-performing assets within the loan portfolio had a direct effect on the operational efficiency of these banks, consequently influencing their liquidity, profitability, and solvency ratios. The findings of their study suggest that the presence of NPAs in the loan portfolio had a significant effect on the operational efficiency of cooperative banks. Operational efficiency is crucial for banks as it directly influences various key financial metrics such as liquidity, profitability, and solvency ratios. NPAs tie up funds that could otherwise be used for lending or investment activities. When a bank has a high level of NPAs, it may face liquidity challenges as a significant portion of its assets is not generating income. This condition could lead to difficulties in meeting short-term obligations or managing day-to-day operations. NPAs can directly impact a bank's profitability. When loans become non-performing, banks may need to set aside provisions to cover potential losses. This reduces the profits available for distribution to shareholders or for reinvestment in the business. Moreover, the resources expended on recovering or writing off NPAs can further erode profitability. The study suggests that managing non-performing assets is crucial for cooperative banks to maintain operational efficiency and ensure financial stability. Strategies such as proactive risk management, effective loan monitoring, and timely resolution of NPAs are essential for mitigating the adverse effects of NPAs on cooperative banks' performance.

Abusharba, Triyuwono, Ismail, and Rahman (2013) conducted a study on the factors influencing the capital adequacy ratio of Islamic banks in Indonesia. They found that depositors' funds and operational efficiency did not have a significant impact on the capital adequacy of these banks. The findings suggested that Islamic banks in Indonesia possessed surplus funds to fulfill their obligations and safeguard the interests of their capital owners. The study's findings are noteworthy as they indicate that factors

such as depositors' funds and operational efficiency do not significantly affect the capital adequacy of Islamic banks in Indonesia. These findings suggest that traditional metrics used in conventional banking may not fully apply to Islamic banking institutions. Moreover, the finding of excessive funds in Islamic banks suggests a potential area for further investigation. While having surplus funds may indicate financial resilience, it could also raise questions about the optimal allocation of capital and potential opportunities for greater efficiency or profitability. The study underscores the importance of tailored research into the performance and determinants of capital adequacy in Islamic banking, considering the unique principles and practices that distinguish it from conventional banking.

Aguenaou, Lahrech, and Bounakaya (2017) analyzed the efficiency of banks as performance measurement in Moroccan with the use of the CAMEL framework from 2004 to 2014. The efficiency ratio was proxied as the dependent variable while the camel variables (capital adequacy, asset quality, management efficiency, earnings quality performance, and liquidity) as the independent variables. The results of the study indicated that earnings quality performance among the other indicators had a positive significant effect on bank efficiency. The researcher would have increased the number of banks so as to get a more comprehensive finding.

Ardekani (2012) investigated the association between acquisition, earnings quality management, and firm performance in Malaysia from 2004 to 2010. The findings indicated that earnings quality management had a negative effect on the financial performance of firms. However, Lee (2006) used a sample of non-financial institutions from 1998 to 2001 to investigate the association between earnings quality management and the performance of firms and discovered that management earnings quality has a positive link with a firm’s performance and growth. The results show that firms with higher performance reported increased earnings quality. Wu, Ting, Lu,Nourani, and Kweh (2016) researched the effect of earnings quality management on the performance of ASEAN banks from 2007 to 2014. According to the regression model, loan loss provisions were negatively correlated to bank performance. Therefore, policymakers need to promote a multidimensional perspective so as to keep an eye on

loan loss provision of the banks over the years in order to increase the net income and the return on assets.

Assessing the financial well-being of a corporation hinges significantly on the quality of its earnings, which pertains to how accurately reported earnings mirror the true income of the company. According to Li (2014), this aspect is pivotal for accurately gauging a company's worth. Huynh (2018) scrutinized the correlation between earnings quality and financial performance by examining data from 2012 to 2015, focusing on 194 firm-years of Vietnamese publicly listed companies featured in the Forbes Vietnam list. Emphasizing the significance of earnings quality, Huynh (2018) highlights its substantial impact on financial performance. Discussions on earnings quality are crucial in the realm of financial analysis and corporate governance. By understanding and prioritizing earnings quality, stakeholders can make more informed decisions, mitigate risks, and contribute to the overall integrity and stability of financial markets.

Al-Hadad and Al-Own (2017) found that earnings quality has a detrimental effect on performance. The findings of their study underscore significant implications for various stakeholders seeking to enhance the standard of financial reporting within the banking sector. This statement highlights a key finding from the study conducted by Al-Hadad and Al-Own in 2017, which suggests that lower earnings quality is associated with poorer performance outcomes. The negative impact of earnings quality on performance is a critical insight for stakeholders within the banking industry, including regulators, investors, and management teams. Understanding the relationship between earnings quality and performance is crucial for making informed decisions about financial reporting practices and performance evaluation strategies. Poor earnings quality can erode investor confidence, affect stock prices, and even lead to regulatory scrutiny. Thus, efforts to improve financial reporting standards and practices within the banking sector can yield positive outcomes for various stakeholders by enhancing transparency, reliability, and trust in financial information. This underscores the importance of ongoing research and initiatives aimed at

enhancing earnings quality and overall financial performance within the banking industry.

Research conducted by Liu Wang and Kenneth Yung (2011) delved into the impact of company ownership on earnings management within a company. Unlike the traditional belief that state ownership leads to corporate inefficiency, this study discovered that State-Owned companies in China exhibited lower levels of revenue manipulation compared to private companies. Further analysis suggests that government protection of state enterprises may have contributed significantly to alleviating managerial pressure to manipulate company-specific information. Additionally, the research indicates that the distinction in earnings quality between State-Owned and private companies is less definitive due to the market-driven nature of the economy. This research sheds light on the complex interplay between ownership structure, government intervention, and corporate behavior in the context of earnings management, offering insights that challenge conventional theories and provide valuable implications for both academia and practice.

2.4.4 Bank Liquidity and Operational Efficiency

Bank liquidity is one of the most fundamental factors that measure the banks capacity to honor its short term obligations when they fall due. On its effects on efficiency, Hamid and Khurram (2017) established that liquidity, ownership, capital adequacy and bank size ratios were the main determinants of overall technical efficiency for commercial banks. Besides, Tesfay (2016) indicated that liquidity and deposits have a positive correlation with efficiency in banks. Moreover, Dell'Atti (2015) indicates a positive association between liquidity and efficiency while Sing and Malik (2018) indicates a positive relationship between bank liquidity and efficiency. However, while various authors on liquidity and efficiency indicate a positive relationship, Sufian and Habibullah (2014) found out that bank liquidity, proxied by a ratio of loans to total assets, consistently exhibited a negative relationship with bank efficiency levels.

A few studies in Kenya have addressed the issue of bank liquidity and operational efficiency of commercial banks in Kenya. Ratemo and Ndede (2021) researched on

liquidity risk and financial performance of commercial banks in Kenya. The findings indicated money supply moderates the relationship between banks. While, Odunga and Nyangweso (2020) found liquidity proxy by interbank ratio was insignificant in explaining operational efficiency. Musyoki and Kallui (2026), research on the relationship between liquidity and operational efficiency of commercial banks in Kenya. The findings indicated that explanatory variables, ROA, current ratio and price to earnings ratio indicated a positive relationship with explanatory variables. Financial institutions need to adopt strategic measures to favour liquidity for commercial banks and thus enhance their operational efficiency.

A few studies have found mixed and inconclusive results on bank liquidity and operational efficiency of commercial banks in Kenya. Abuga et al. (2023) research on liquidity capacity and financial performance of commercial bank in Kenya, findings indicated that net stable funding and liquidity coverage exert a positive impact on the financial performance of commercial banks in Kenya. Matunda et al. (2024) research on liquidity management and financial performance of commercial banks in Kenya indicate an increase in capital adequacy increases return on assets, while a rise in non-performing loans negatively impacts ROA. Thus effective liquidity management is essential in optimizing financial performance, particularly in balancing liquid assets to meet regulatory requirements and operational demands.

2.4.5 Market Structure and Operational Efficiency

Market structure drives the conduct and performance of commercial banks in the sector. The market structure indicates the degree of oligopolistic competition in an economy. Market structure was used to indicate the moderation effect on capital adequacy, asset quality, earnings quality, liquidity and operational efficiency of commercial banks in Kenya. The tendency to use capital is also great due to a large number of companies that need funds to support their operations. The greater the market structure, the higher the amount of assets that are held, and more debt can thus be used as a source of corporate funding. The banking sector in Kenya has undergone several challenges in the recent past. It is quite important to look at which business models banks need to adapt in order to continue in operation.

The effect of market structure on operational efficiency has not yet received much attention in the literature, in Kenya there is no research that has analyzed effect of market structure on efficiency of banks. Phan et al. (2018), from MENA region indicated that market structure has controversial effects on the efficiency of the banking system. The Queit Life Hypothesis (QLS) reveals a positive connection between banking specificities hypothesis (BSH) implies that more competition is detrimental to efficiency. Sanfiz (2025), indicates that concentration influences efficiency positively and market power negatively; in terms of interaction between both variables, bank efficiency increases, in line with the bank specific hypothesis. Naceur (2003), examined how a bank's characteristics, financial structure and macroeconomic indicators affect net interest margin and profitability for Tunisian commercial banks between 1980-2000. The results indicate net interest margin is negatively and significantly influenced by market concentration, but is insignificant with return on assets.

Market structure plays a significant role in determining the relationship between market structure and operational efficiency. Bhawa (2015), indicated that a market structure had a negative insignificant effect on capital adequacy while liquidity had a positive significant effect on capital adequacy. According to Yudiaatmaja (2016), market structure had a positive significant effect on capital adequacy. Demsetz and Strahan (1997) further indicated that diversification had a significant positive relationship with the bank asset size, the larger the bank deposits, the higher the loan requisite for customers. The market structure was measured by natural logarithm on total assets. Curi (2015) and Berger (2010) indicated that a nonlinear relationship existed between market structure and business performance levels.

The effect of the size of the bank on operational efficiency is still debatable. McAllister and McManus (1993) indicated that large banks had the size advantage and more chances to diversify their risk component as compared to small banks. However, large banks had lower-cost opportunities and therefore made more profits (Goddard, 2004). Besides, Vallascas and Keasey (2012) argued that large banks tend to be more motivated to make riskier investments. Hence, large banks tend to be less effective

than smaller banks. Sreesha (2014) researched the effect of market structure and operational efficiency on banks' financial performance. The results indicated that there existed a significant effect of asset size, NPA, and operational efficiency on internal performance as measured by the return on assets.

Large banks have a big role to play as compared to small banks since large banks have enough capacity to mobilize resources such as material, human resources, and level of technology to improve operating efficiency (Hughes, 2001). Although, Berger, Hasan, and Zhou (2009), Athanasoglou, Panayiotis, and Brissimis (2008), Feng and Sertlists (2010), Wheelock and Wilson (2009), and Hassan and Marton (2003) indicated a significant positive correlation between market structure and operational efficiency, some studies such as Bonin, Hassan, and Watchet (2005), Berger, Hanweck and Humprey (1987), Noulas, Ray and Miller (1990), and Mester (1992) discovered that larger banks were less efficient in evolving economies. Some researchers argued that operating costs decrease as the size of the bank increases until a certain point and afterwards operating costs increase as the size of the bank increases. This indicates that operating efficiency increases as market structure increases, but banks become less efficient at a certain point.

Lu et al. (2007) utilized concentration ratios and the Herfindahl–Hirschman index to analyze shifts in market organization and profitability among Chinese commercial banks, encompassing four state-owned commercial banks, ten joint stock commercial banks, and all foreign banks operating in China. Their findings indicated that market structure seemed to impact the performance of Chinese commercial banks, with foreign banks exerting marginal effects on the Chinese banking sector. The authors employed concentration ratios and the Herfindahl–Hirschman indexes, which are commonly used metrics in assessing market structure and competition within an industry. The tools allow for quantitative analysis, providing insights into the level of concentration and competitiveness within the Chinese banking sector. By including four state-owned commercial banks, ten joint stock commercial banks, and all foreign banks operating in China, the study aimed to capture a comprehensive view of the Chinese banking industry. This diverse sample likely provided a nuanced

understanding of how different types of banks contribute to market dynamics. The study suggests that market structure influences the performance of Chinese commercial banks. This finding underscores the importance of understanding the competitive landscape and regulatory environment in shaping banks' profitability and operational efficiency. The marginal effects of foreign banks on the Chinese banking industry imply that while they play a role, their influence may be limited compared to other factors affecting market structure and performance. This could be due to regulatory restrictions, market entry barriers, or other factors that constrain the operations of foreign banks within China. In their study, Lu et al., (2007) employed return on assets (ROA) and return on equity (ROE) to gauge performance. However, these basic ratios have limitations as they only allow comparison between two dimensions of activity—numerator and denominator—within a single indicator. Given the intricate nature of banks, which involve various physical and financial inputs and outputs, such simplistic measures may not capture the full complexity. Additionally, banks operate in a dynamic environment with multiple dimensions—both physical and financial. Their activities span various functions, including lending, investment, asset management, and customer services. Consequently, evaluating their performance requires consideration of a broader range of factors beyond what can be captured by simple ratios like ROA and ROE. Therefore, there is a need for more comprehensive performance evaluation methods that account for the intricate nature of banking operations. While ROA and ROE offer valuable insights, researchers and practitioners should supplement them with additional metrics and analytical tools to gain a holistic understanding of bank performance.

Fu and Heffernan (2009) conducted research examining the impact of reform on both market structure and performance within China. Employing the stochastic frontier approach, they divided their dataset into two distinct periods (1985–1992 and 1993–2002) corresponding to different stages of banking reform. Their findings indicated that during the initial stage, the relative market power hypothesis was most applicable in describing the dynamics of the Chinese banking sector. However, during the latter stage, the results provided support for the relatively efficient structure hypothesis. The study conducted focuses on understanding how reform efforts influence both the

structure and performance of the banking sector in China. This is a significant area of research given the transformative nature of China's economy and the pivotal role of the banking industry within it. The researchers utilized the stochastic frontier approach, a statistical method commonly employed in efficiency analysis, to examine the relationship between reform and banking sector dynamics. By dividing their dataset into two distinct periods, they were able to capture the evolving nature of reforms over time. The study divided its observations into two key periods, namely 1985–1992 and 1993–2002, corresponding to different phases of banking reform in China. This specific period allows for a nuanced analysis of how reforms impacted the banking sector across different stages of development. The shift from the relative market power hypothesis to the relative efficient structure hypothesis suggests a maturation or optimization of the banking sector in response to reforms. This has implications for policymakers and industry stakeholders seeking to understand the long-term effects of reform efforts on market competition and efficiency.

Khalil and Azhar (2017) conducted a study examining the impact of market structure and operational efficiency on the performance of Islamic banks in Pakistan. The research revealed that market structure had a positive and significant influence on bank profitability. However, they found that asset management had a negative relationship with bank profitability, suggesting that banks with more effective asset management tended to have lower profitability. The study suggests that the competitive environment in which Islamic banks operate plays a crucial role in determining their profitability. A more favorable market structure, characterized by healthy competition and market dynamics, can enhance the profitability of Islamic banks. This finding underscores the importance of regulatory policies and market conditions in fostering a conducive environment for banking operations. The study sheds light on the interplay between market structure, operational efficiency, and bank profitability in the context of Islamic banking. Understanding these dynamics is crucial for policymakers, regulators, and banking practitioners to devise effective strategies for enhancing the performance and stability of Islamic banking institutions.

A study by Giokas (2008), on banks in Greece found that there is a positive correlation between bank profitability; size of the branches, and their operational efficiency and within the branch characteristics variables, more profitable and large branches had higher operating efficiency.

2.5 Critique of Existing Literature

Different researchers have discussed the relationship between capital adequacy, asset quality, earnings quality, and liquidity but used only one or two of the variables. For instance, Yener, Carbo, Gardener, and Molyneux (2007) researched the relationship between capital, risk, and operational efficiency for a large sample of European banks between the period of 1992 and 2000. However, Odunga, Nyangweso, Carter, and Mwarumba (2013) researched credit risk, capital adequacy, and operating efficiency of commercial banks in Kenya. Ukhriyawati, Ratnawati, and Riyadi (2017) also researched the influence of asset structure, capital adequacy, risk management, and good corporate governance on the financial performance of banks. This researcher did not employ all the factors affecting the operational efficiency of banks i.e. under capital adequacy minimum amount of capital (core capital) is a critical factor in determining the operational efficiency of the banks. Banks that have more reserves are able to withstand any losses and challenges. Similarly the ratio of non-performing loans to total loans determines the sustainability of the banks. A reduction in non-performing loans leads to an improvement in the operational efficiency of the banks. The Earnings quality and ownership structure determine the performance for this banks. Higher earnings quality and robust management that includes board directors leads to improved performance for these banks. The researcher therefore decided to embark on research on capital adequacy, asset quality, earnings quality, and liquidity linking it to the operational efficiency of banks in Kenya.

Additionally, there is a lack of consistency in the methodological approaches employed in previous studies. For instance, Kariuki, Muturi, and Ngugi (2016) investigated the asset quality and intermediation efficiency of deposit-taking savings and credit cooperative societies in Kenya using Data Envelopment Analysis (DEA). Meanwhile, Kao (2018) examined the relationship between ownership structure and

efficiency in the banking industries of China and Vietnam, employing a two-stage stochastic frontier analysis (SFA). In contrast, Margaritis and Psillaki (2007) focused on capital adequacy and firm efficiency in New Zealand firms, utilizing a quantile regression model. While the DEA method may reveal inconsistencies in the error terms employed in research, the SFA model addresses this issue, rendering it more robust for such analyses. The discussion contrasts DEA and SFA methodologies, noting that while DEA may have limitations regarding the handling of error terms, SFA is considered more robust in this regard. This comparison adds depth to the discussion by highlighting the advantages of one method over another in certain contexts.

Most research has also shown mixed results regarding the relationship between capital adequacy, asset quality, earnings quality, liquidity, and operational efficiency of banks. Rizal (2016) researched on capital adequacy ratio, non-performing loans, and operational efficiency ratio to return on assets of Indonesian Sharia banks. The findings indicated that the capital adequacy ratio had no significant effect on the return on assets while non-performing loans and operational efficiency had a negative and significant effect on to return on assets of Sharia banks. However, Hussein (2013) further researched operational efficiency in 17 Sudanese (Islamic) banks and discovered that a higher capital adequacy ratio leads to higher costs of operational efficiency. Tian and Zeitun (2007) researched the effect of capital adequacy on the corporate performance of firms in Jordan and discovered that capital adequacy had a negative effect on performance. However, Margaritis and Psillaki (2007), also researched capital adequacy and firm efficiency of New Zealand firms, and the results indicated that efficiency on firm leverage is positive. Casu, Girardone, and Molyneux (2004), Sanchez, Hassan, and Barkus (2013), Delis and Papanikolaou (2009), and Kalluru and Bhat (2009), also researched factors influencing bank efficiency and discovered that there is a positive association between profitability and efficiency of banks.

2.6 Research Gap

Based on the above literature, the researcher discovered that some studies have been done on capital adequacy, asset quality, earnings quality, and liduidity but relating it

to financial performance. However, no in-depth study has been done in Kenya relating capital adequacy, asset quality, earnings quality, liquidity, and efficiency. Mwarumba (2013) researched credit risk, capital adequacy, and operating efficiency of commercial banks in Kenya. However, the researcher concentrated on two variables checking on the unidirectional relationship among the variables. Lawal, Oluoch, and Muturi (2018) also researched on effect of asset quality on the operational efficiency of deposit money banks in Nigeria. The researcher used the CAMEL framework linking it to operational efficiency but limited the research to only Nigeria. Ukhriyawati, Ratnawati, and Riyadi (2017) researched the influence of asset structure, capital adequacy, risk management, and good corporate governance on the financial performance of banks. The results indicated that capital adequacy among other variables was negatively correlated to earnings quality although it positively correlated to free cash flow but negatively influenced financial performance. The researcher should have increased the number of years to about a 14-year period in order to get a more comprehensive finding. Furthermore, the researcher would have used other variables such as earnings quality management and corporate social responsibility to find out their impact on the financial performance of the banks in Indonesia.

Furthermore, most research has used different methodological approaches such as financial ratios and DEA model, but few have concentrated on SFA model. Kariuki, Muturi, and Ngugi (2016), researched asset quality and intermediation efficiency of deposit-taking saving and credit co-operative societies in Kenya using a Data Envelopment Analysis (DEA). Bokpin (2013) researched ownership structure, corporate governance, and bank efficiency in the banking industry in Ghana using accounting data and stochastic frontiers (SFA) of estimated translog and profit functions. Nasieku, Kosimbei, and Obwogi (2013), examined the intermediation efficiency and productivity of Kenyan commercial banks during the year 2001-2011 using DEA. Despite the pieces of literature on operational efficiency in the local context, there is still scarce literature that empirically analyzes the capital adequacy, asset quality, earnings quality, bank liquidity, and operational efficiency of banks in Kenya using the SFA Approach. The researcher therefore decided to embark on

research relating to capital adequacy, asset quality, earnings quality, bank liquidity, and operational efficiency using the Stochastic Frontier Approach (SFA).

2.7 Summary of Literature

This chapter identified and discussed both the empirical review and theoretical framework of capital adequacy, asset quality, earnings quality, bank liquidity, and efficiency of banks in Kenya. The chapter further explains the conceptual framework which clarifies the purpose of the research in Kenya. Finally, a critique of the research and study gap is clearly illustrated by the researcher.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter addresses the methodologies employed in the study to achieve the research objectives. Section 3.2 of the study delineates the research philosophy, while section 3.3 expounds upon the research design. The target population is explained in section 3.4, followed by a discussion on the sampling technique in section 3.5. Section 3.6 outlines the procedures for data collection, while section 3.7 elucidates the processing and analysis of the collected data. Lastly, section 3.8 pertains to the diagnostic tests that were conducted.

3.2 Research Philosophy

This research adopted the positivism research philosophy. According to Saunders, Lewis, and Thornhill (2007), the concept of research philosophy encompasses beliefs about various systems and assumptions regarding how knowledge is developed. This study adopts a positivist approach, which posits that the researcher and the subject matter are independent entities with no mutual influence (Guba & Lincoln, 1994). Positivism provides a theoretical framework from which substantial hypotheses can be formulated and tested through empirical investigation (Aosa, 1992). The choice of a positivist approach for the research discussed suggests a preference for objectivity and empirical validation. Positivism assumes a clear distinction between the researcher and the researched phenomena, emphasizing the need for rigorous testing and verification of hypotheses through observable evidence. This approach aligns with the belief that scientific inquiry should be grounded in empirical observation and measurement.

According to Neuman (2013), positivism research indicates that there is an objective reality that can be expressed numerically based on certain explanations and predictive power. Understandably, knowledge from this view is applicable only if it is based on values of reasons and facts, produced from information collected through direct observations and experience, evaluated using quantitative techniques, and subjected to

statistical assessment to explain causal relationships as conceptualized (Saunders, 2009). Positivism philosophy advocates for collecting data resulting from the observable reality that contributes to developing a hypothesis, therefore aligning with the quantitative research design for this study. This approach enabled the researcher to investigate the credible and measurable results from financial statements in order to establish a relationship between capital adequacy, earnings quality, asset quality, and liquidity on the efficiency of banks in Kenya. The selection criteria of positivism philosophy was based on investigating the cause and effect relationship among capital adequacy, asset quality, earning quality and liquidity on operational efficiency of the banks.

3.3 Research Design

A research design is the process an investigator follows right from the inception to the completion of the study (Cooper & Schindler, 2011; Kothari, 2011). According to Selltiz, Wrightsman, and Cook (1965), research design is described as the set of conditions for gathering and analyzing data which are arranged and geared towards integrating its relevance, for research. The methods for research design are quantitative, quantitative, descriptive research design, and correlational research design among others. Through quantitative research design, the relationship between the dependent and the independent variables is explained (Kothari, 2004).

The quantitative research design is considered appropriate since the emphasis is on examining the possible relationship between capital adequacy, earnings quality, asset quality, liquidity, and efficiency of banks in Kenya. Quantitative research design is a scientific approach that explains a phenomenon by collecting data numerically that was analyzed using mathematical methods. The research choice on the type of research design was longitudinal based on the repeatedly data collection from similar banks from 2008-2022, covering 16-year period.

3.4 Population of the Study

According to Cooper and Schindler (2011), a population is an entire component of a group that is used to base our conclusions. The target population comprised all 43 commercial banks as per Central Bank of Kenya (2022). The research covered a period of 14 years from 2008-2022. The CBK is the main licensing institution of commercial banks in Kenya and was therefore used for deriving the bank related information. Specifically, the study focused on four factors affecting efficiency of banks-capital adequacy, asset quality, earnings quality and liquidity- together with moderating variable (market share) and independent variable operational efficiency. The data collected was secondary in nature with panel data derived from the respective bank websites and Central Bank of Kenya website.

3.5 Sampling Technique

The sample frame represents a list of all elements found in a population from which the sample can be drawn (Mugenda & Mugenda, 2012). It comprises a group of objects in which the researcher wants to generalize findings. The sample frame was all licensed commercial banks found in Kenya during the period 2012-2022 from the Central Bank of Kenya. A census was applied in this study with the target population being all banks licensed and listed under the Central Bank of Kenya-where the variables capital adequacy, asset quality, earnings quality and liquidity were extracted.

The method was considered appropriate based on the data availability and the nature of business carried out by the respective banks. Census method minimized the risk of bias by ensuring all available banks were analyzed to enhance accuracy in developing efficiency of the respective banks. The sampling further ensured efficiency and comprehensiveness on achieving the study objectives and hypothesis.

3.6 Data Collection Procedure

The study involves collection of secondary data for a period of 14 years from 2008-2022 using verified audited financial statements obtained from the Central Bank of Kenya and the websites of the respective banks. The period suits the purpose of the

research as it incorporates recent financial reforms in the banking sector and incorporates financial efficiency issues that shook the Kenyan financial system in 2008, market shocks of 2015 and 2010, and the Banking Amendment Act 2016 that introduced the interest rate cap. The data collection form was used to extract data from the audited financial statements. Data was collected using a data collection sheet. The data collection form was convenient since it assisted the researcher in easily extracting data from the financial statements and quickly coding and editing to assist in data processing and analysis (Saunders, 2009). Data obtained was then compared from both the audited financial statements and from the Central Bank of Kenya to check on the accuracy. The data collected was then keyed into STATA Software.

3.7 Determining Operational Efficiency Model

Economic analyses aimed at determining productivity and efficiency are predicated upon four essential components: Decision-making units (DMUs), outputs, inputs, and a formalized production function delineating the mathematical relationship between inputs and outputs. Within the domain of research funding organizations, funded projects serve as the primary DMUs. These projects, influenced significantly by financial disbursements, particularly the magnitude of grant allocations, as well as the intellectual rigor embedded within project proposals (Falzagic, 2005), yield research outcomes spanning scholarly articles, publications, conference presentations, and doctoral theses. The evaluation of project proposals entails a rigorous assessment of intellectual capital, conducted by reviewers during the pre-evaluation phase.

From a data analysis standpoint, when conducting a productivity and efficiency assessment, there's a departure from the traditional method of statistical regression in that the primary focus isn't on prediction. Instead, the objective isn't to predict the average research output of a Decision-Making Unit (DMU); rather, it's to ascertain the highest anticipated research outputs of the DMU given specific inputs (Archibald & Feldman, 2008). This process involves transforming a set of research inputs or production factors into a corresponding set of research outputs. The collection of maximum anticipated research outputs for a given set of research inputs defines what's known as the production function or production frontier. Technical efficiency (TE)

delineates "the correspondence between observed production and an ideal or potential production" (Greene, 2008, p. 100), which represents the highest achievable output for a given input as depicted by the estimated production function. Productivity, on the other hand, is characterized as "the ratio of output y (what we produce) over input x (the resource we use: Productivity = y/x)" (Färe, Grosskopf, & Margaritis, 2008).

SFA presents several advantages over the strong arguments favoring DEA. Firstly, SFA acknowledges the presence of random measurement errors, recognizing that the research output of DMUs which can fluctuate due to various chance factors. Secondly, SFA emphasizes the importance of understanding the factors influencing measured values for productivity and efficiency. Unlike DEA's two-stage procedure involving regression on predictors, SFA integrates this consideration within a single process. Thirdly, by incorporating multi-level models, SFA allows for the hierarchical modeling of performance data. Fourthly, SFA enables the testing of different production functions to determine the best fit for the data, thereby easing the challenge of explicitly defining a functional connection. Additionally, SFA supports the estimation of more complex models than DEA, including panel data and various multilevel and latent class models. (References: Johnson & Kuosmanen, 2012; Ramalho, Ramalho, & Henriques, 2010; Ehlers, 2011; Parmeter, 2014).

The superiority of Stochastic Frontier Analysis (SFA) over Data Envelopment Analysis (DEA) in terms of benefits led to the measurement of bank operational efficiency using SFA. Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are both widely used techniques in measuring efficiency, particularly in the banking sector. Each method has its strengths and weaknesses. In summary, SFA assumes that observed inefficiencies in a production process are due to random factors or noise, and it attempts to estimate the maximum feasible level of output given the inputs and the existing technology. It allows for the separation of random noise from inefficiency, providing a clearer picture of true efficiency levels. On the other hand, DEA is a non-parametric method that does not require specific functional forms for the production process. It compares the efficiency of different units (in this case, banks) by creating a frontier of best practices based on the observed data points.

However, DEA does not explicitly account for random variations or noise in the data, which can lead to less precise efficiency estimates.

Given the advantages of SFA, such as its ability to explicitly model random noise and its flexibility in handling different sources of inefficiency, it may be preferred over DEA in certain contexts, particularly when the underlying assumptions of SFA are considered appropriate for the analysis at hand. Therefore, the decision to use SFA for measuring bank operational efficiency suggests a preference for a method that can provide more robust estimates, potentially offering deeper insights into the factors affecting bank performance.

Battese and Coelli (2005), formulated a stochastic frontier approach that specified the use of panel data. The simultaneous equation approach had a major advantage over the first approach in that it is based on a two-stage procedure that examines the exogenous roles of variables while explaining the operational efficiency of banks. Wang (2007) similarly estimated stochastic frontiers and predicted the level of firm efficiencies then regress the predicted efficiencies on different firm variables in an effort to identify reasons for differences in certain predicted efficiencies among the industries. In line with Wang (2007), the study decided to use a similar approach.

In econometrics, Data Envelopment Analysis (DEA) stands as the predominant approach for examining Technical Efficiency (TE). Its application extends significantly to research domains such as higher education, as evidenced by the works of Abbott & Doucouliagos (2003), Abramo, Cicero, & D'Angelo (2011), Abramo & D'Angelo (2014), and Liu et al. (2013). DEA entails the utilization of linear programming techniques to construct a non-parametric piece-wise surface, often referred to as a frontier, based on available data. Subsequently, efficiency metrics are computed relative to this established surface (Coelli, Rao, O'Donnell, & Battese, 2005). Notably, DEA is described as a non-parametric method, meaning it does not make explicit assumptions about the functional form of the production or efficiency frontier. This flexibility is advantageous when dealing with complex real-world data where underlying relationships may be difficult to specify. The discussion of efficiency measures being calculated relative to the constructed frontier highlights the

comparative nature of DEA. It allows for the identification of units that are operating efficiently relative to their peers, as well as those that may have room for improvement.

Compared to alternative methods like stochastic frontier analysis (SFA), which relies on statistical approaches (Coelli et al., 2005; Greene, 2008; Johnes, 2004; Kumbhakar, Wang, & Horncastle, 2015; Parmeter, 2014), DEA, a numerical nonparametric technique, is favored for several reasons (Abramo & D'Angelo, 2014; Chen, Delmas, & Lieberman, 2015). Firstly, DEA allows for the analysis and description of complex production functions involving multiple outputs and inputs using a single efficiency indicator. Secondly, DEA does not require the definition of a specific functional relationship, such as the Cobb-Douglas production function. Thirdly, it enables the direct identification of benchmark best practices. Lastly, DEA provides robust solutions for determining production efficiency.

The first step involves computing bank scores on operational efficiency by fitting the frontier program into STATA. Operational efficiency is the dependent variable which is measured using the weighted sum of inputs over the weighted sum of outputs. From the definition operational efficiency is defined as the measure of output in relation to the input (Lotto, 2019). Similar to Srairi(2010) the study used bank inputs as the price of labor, price of physical capital, and price of deposits and outputs as total loans and other earning assets.

3.8 Model Specification

3.8.1 Panel Data Analysis

Panel data regression, in contrast to pooled ordinary Least Squares (OLS) regression, addresses a range of biases and disturbances inherent in regression analysis by accounting for unobserved disparities among banks' specific variables, which can be challenging to include in practice.

Pooled OLS regression treats all observations as if they are from a single group or entity. It ignores any potential differences or variations among these entities. This approach can be useful when there are no significant differences between the entities

being studied, and the assumption of homogeneity across groups holds. However, in many real-world scenarios, such as analyzing data from multiple banks, this assumption may not be valid. Each bank may have unique characteristics or experiences that could affect the relationship being studied.

Panel data regression, on the other hand, recognizes and accounts for differences among entities by including variables specific to each entity (such as individual banks) and over time. This method allows for the examination of both cross-sectional and time-series variations in the data. By incorporating individual-specific variables and time effects, panel data regression can control for unobserved heterogeneity, time-varying effects, and other sources of bias that may be present in pooled OLS regression. It provides more efficient estimates and allows for a more comprehensive analysis of the underlying relationships.

Generally, panel data regression offers a more robust and flexible approach compared to pooled OLS regression, particularly when dealing with datasets where entities (such as banks) exhibit differences that could affect the analysis. It helps to mitigate biases and disturbances by explicitly modeling individual-specific effects and time variations, thus providing more accurate and reliable results for empirical analysis in fields such as banking and finance.

Common panel data models include Fixed Effects (FE) Models, which control for individual-specific effects by including dummy variables for each individual. Random Effects (RE) Models assume that individual-specific effects are uncorrelated with the independent variables, estimating both individual-specific effects and the coefficients of the independent variables. Dynamic Panel Models, which incorporate lagged dependent variables or first-difference transformations to address endogeneity and serial correlation (Li, Wang, & Zhao, 2016).

The FE and RE models are likely to suffer various challenges which include the following: Heterogeneity, where individuals may vary in unobservable ways, potentially complicating analysis. Endogeneity issues arise when explanatory variables are correlated with error terms, challenging the interpretation of causal

effects. Secondly, serial correlation, where observations within the same individual may be correlated over time, violates the assumption of independence.

To ensure robust estimation, Dynamic Panel Models panel models were estimated. Dynamic Panel Models (DPMs) are a type of econometric model used to analyze panel data, which involves data collected over time from multiple individuals, firms, or other entities (Seo et al.,2019). DPMs accounted for various types of panel effects, such as individual-specific effects (fixed effects), time-specific effects (time-fixed effects), and unobserved heterogeneity that may be correlated with the independent variables (random effects). Additionally, DPMs allow for addressing endogeneity issues by incorporating instrumental variables or other methods to deal with potential biases arising from omitted variables or reverse causality. Estimating DPMs helps ensure robust estimation by capturing the dynamics and dependencies present in panel data, which may not be adequately addressed by traditional cross-sectional or time-series models. By considering both cross-sectional and temporal dimensions, DPMs provide a more comprehensive understanding of the underlying relationships in the data. Additionally, the use of DPMs led to more accurate and robust estimations and enabled to make more informed conclusions about the phenomena under study. The rule of thumb is if your time dimension (T) is small (T<10 or 15) and your entity dimension (N) is large (number of banks or firms), Nickel bias is severe, hence you must use Dynamic Panel Model. Therefore this study based on the rule of thumb hypothesis used the dynamic panel model.

In this study, the bank average for the respective independent variables (capital adequacy, asset quality, earnings quality, and liquidity) serves as the instrumental variable. This variable is likely chosen because it is expected to be correlated with the endogenous variable, but it is assumed to be uncorrelated with the error term in the main regression equation. This ensures that the estimates obtained using the instrumental variable approach are unbiased and consistent.

There are several estimation techniques for DPMs, including the Generalized Method of Moments (GMM), the Arellano-Bond estimator, and the Arellano-Bover/Blundell-Bond system estimator. The study employs the panel Generalized Method of Moments

(GMM) techniques to account for the presence of both individual-specific and time-specific effects and help mitigate potential bias in the estimation due to endogeneity and correlation.

Panel Generalized Method of Moments (GMM) is an extension of the standard GMM technique specifically designed to handle panel data, which consists of observations on multiple entities (e.g., individuals, firms, countries) over multiple periods. Panel data often exhibit both cross-sectional and time-series variation, making them valuable for studying dynamic processes and controlling for unobserved heterogeneity. The model is advantageous in the following way: first, accounting for Panel Data Structure; Panel GMM takes into account the panel data structure by allowing for both cross-sectional and time-series variations in the data. This is important because it helps control for unobserved heterogeneity across entities and captures dynamic relationships over time. Secondly, addressing endogeneity and serial Correlation; the panel GMM addresses issues of endogeneity and serial correlation commonly encountered in panel data analysis. By using moment conditions based on lagged values of the dependent variable and instruments, Panel GMM allows for consistent estimation of parameters even in the presence of these issues. Thirdly, panel GMM provides efficient and consistent estimates of parameters under certain assumptions. By using a system of moment conditions derived from the panel data structure, Panel GMM exploits both cross-sectional and time-series variations to improve the precision of parameter estimates. Fourthly, Panel GMM is particularly useful for controlling for unobserved heterogeneity, such as individual-specific or time-specific effects, which may bias estimates in panel data analysis. By incorporating fixed effects or random effects into the moment conditions, Panel GMM allows for consistent estimation of parameters even when unobserved heterogeneity is present.

3.8.2 Regression Model Specification

Given the potential relationship between the independent variables, the models were defined and run individually for each independent variable. This approach indicates a recognition of the potential for interdependence among the variables being studied. By analyzing each independent variable separately, it was possible to better understand its

unique impact on the dependent variable without conflating effects with other variables. However, it's important to note that this method may overlook potential interactions or combined effects between independent variables, which could impact the overall understanding of the phenomenon under investigation. Therefore, while this strategy offers clarity in isolating the effects of individual variables, researchers should also consider conducting analyses that account for potential interactions among variables for a more comprehensive understanding.

The following models were specified based on each objective:

$$Operational\ Efficiency = \alpha_0 + Capital\ Structure_{it} + \varepsilon_{it} \quad \text{.....1}$$

$$Operational\ Efficiency = \alpha_0 + Asset\ Quality_{it} + \varepsilon_{it} \quad \text{.....2}$$

$$Operational\ Efficiency = \alpha_0 + Earnings\ Quality_{it} + \varepsilon_{it} \quad \text{.....3}$$

$$Operational\ Efficiency = \alpha_0 + \text{Liquidity} + \varepsilon_{it} \quad \text{.....4}$$

Where, α_0 is the constant and ε_{it} Is the error term. The parameters i and t represent firm-specific characteristics and time respectively.

3.8.3 Testing for Moderation Effect of Market Structure

To assess the moderation effect of market structure on the relationship between the operational efficiency of banks and respective independent variables (capital adequacy, asset quality, earnings quality, and liquidity), the analysis used the hierarchical regression analysis, where three regression analysis models tested for moderation. The use of hierarchical regression analysis in this study indicates a sophisticated approach to understanding the interplay between market structure, capital adequacy, and operational efficiency within the banking sector. Hierarchical regression allows researchers to examine the incremental contribution of different variables while controlling for the effects of others, which is particularly useful when investigating complex relationships like those in banking.

By specifically focusing on the moderation effect of market size, the study acknowledges the potential influence of external market conditions on the relationship

between a bank's operational efficiency and the independent variables. This is significant because market structure encompasses factors such as competition levels, regulatory environment, and market concentration, all of which can significantly impact how banks operate efficiently. The decision to test three regression models for moderation suggests a comprehensive analysis, likely aimed at capturing the nuances of how the market structure interacts with the independent variables to affect operational efficiency. This approach allows for a more nuanced understanding of the relationship, potentially revealing insights that a single regression model might overlook.

The following models were used to test for the moderation effect of market size.

$$Y = \alpha_0 + \varepsilon\beta_3 X_1 X_3 + \varepsilon\beta_i X_i + \varepsilon \quad \text{(i)}$$

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_3 + \varepsilon \quad \text{(ii)}$$

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_3 + \beta_3 X_1 X_3 + \varepsilon \quad \text{(iii)}$$

The initial phase of the study examined the correlation between the independent variables and operational efficiency. Subsequently, the focus shifted to predicting operational efficiency, the dependent variable, by incorporating both the independent variables and the moderator (market structure) to validate any alterations in the dependent variable. The third stage introduced an interaction term, which is a combined variable resulting from multiplying the independent variables by market structure.

To evaluate the moderating impact of the hypothesis, three primary conditions need to be met. These criteria encompass assessing the statistical significance of the coefficient linked with the interaction term (independent variable * market structure), analyzing any variations in the overall model effect (R2), and determining the statistical significance of the predictor variables, the moderator, and the interaction term.

According to Preacher et al. (2007) and Baron and Kenny (1986), moderation is evident when there is a shift in the strength or direction of the relationship between an independent variable and a dependent variable upon the introduction of a moderator. Alternatively, if the inclusion of an interaction term in the model alters the overall

impact of the model (as indicated by R^2) and the newly added interaction term exhibits a notable effect, moderation is considered to be present. Moreover, complete moderation is indicated when both the predictor and the moderator become statistically insignificant after the inclusion of the interaction term. Furthermore, moderation is evident when both the predictor and the moderator, along with their main effects, demonstrate significant effects following the addition of the interaction term.

The panel regression model will have two regression as follows. Model 3.4 relates to the panel regression model. This study adopted an empirical model used by Gadzo(2019); Berger (1995); Demirguc-Kunt and Huizinga (2001) and Naceur & Goaied (2008). The first model will be based on the regression model without the moderating variable. The model follows Gadzo (2019) specification of variables including factors such as capital structure, asset quality, earnings and liquidity on operational efficiency of banks.

The model specification is specified as:

$$OE_{it} = \beta_0 + \beta_1 CA_{it} + \beta_2 AQ_{it} + \beta_3 E_{it} + \beta_4 OS_{it} + U_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

In equation (3.5), β_1, β_2, β_3, β_4, and β_5 refer to a group of parameters to be estimated.

OE= Operational efficiency
CA= Refer to the variable on capital adequacy
AQ= represent variable on asset quality
E= represent variable on earnings quality
L= represents liquidity
The second model will be based on the regression model with a moderating variable.

$$OE_{it} = \beta_0 + \beta_1 . (CAMs)_{it} + \beta_2 (AQMs)_{it} + \beta_3 (EQMs)_{it} + \beta_4 (LMs)it + Uit \ldots\ldots\ldots\ldots (3.5)$$

I=1,2,3,4…….n

t= years that will be used
$\boldsymbol{\beta_0}$ = unobserved heterogeneity (individual effect) which is specific for each bank.

u_t= unobserved time effects

Z= represent market size

The bank scores on operational efficiency derived from fitting the frontier in STATA and using bank inputs labour, capital and deposits and outputs as other earning assets and total loans were employed. The study estimated the stochastic production function in the translog cost function, which has also been used by Coelli (2005). The study used the translog cost function which is frequently used in production function formulation that allows investigation of production, cost, and efficiency in a range of areas (Martin & Dorta, 2007).

3.9 Operationalization of Variables

Banks operational efficiency was measured using the Stochastic Frontier Analysis (SFA). The researcher used a parametric approach because it can correct the weaknesses of non-parametric testing. Capital adequacy is represented by Core capital/risk-weighted assets. The choice of capital adequacy justification is that it is a fundamental aspect of measuring a bank's stability and capital base. Higher capital adequacy ratios indicate that a bank has a stronger buffer to absorb potential losses, thus contributing to its operational efficiency. It is a key indicator for regulators and investors alike as it reflects the bank's ability to withstand adverse economic conditions without jeopardizing its solvency. Asset quality is represented by non-performing loans and total loans. The asset quality of banks is an important indicator of financial health, and it also reflects the efficacy of their credit risk. Earnings quality was represented by the sum of net interest income and operating expenses and the ratio of loan loss provision to total assets. The justification for earnings quality is that they reflect the reliability and sustainability of bank earnings quality.

The market size was represented by the ratio of each bank's total assets to the total assets of all banks in the market. To test the moderation effect of market structure on capital adequacy, earnings quality, asset quality, and bank liquidity the hierarchical regression model was used.

Table 3.1: Summary of Variables and Measurement

Variable	Variable Type	Indicator	Proxy	Measurement
Operational Efficiency	Dependent	Bank input-Labor, Capital, deposits Bank output-Other earning assets, Securities	OE	Weighted Sum of Outputs/Weighted sum of inputs
Market Strucuture	Moderating Variable	Market Size	Ms	The percentage of market size
Capital Adequacy	Independent	Risk-Weighted Assets	CA	=Core Capital/Risk Weighted Assets
Asset Quality	Independent	Non-performing loans Total loans	AQ	Non-performing Loans/Gross Loans
Earnings quality	Independent	Total Income Net Interest Income	EQ	The sum of total income/net interest income
Liquidity	Independent	Total Loans Total Deposits	L	=Loan to deposit ratio

Source: Basel Committee on Bank Supervision (2011); CAMEL Rating System (2021), Shawk (2008); Berger and Humprey (1997); Wang (2016); Lawal, Oluoch and Muturi, (2018); Cebenoyan (2003); Yasser, Al Mamun (2017). S represents the market structure of banks in terms of deposits.

3.10 Diagnostic Tests

To ensure the estimated results were valid, the study conducted various tests. These include normality, multicollinearity, heteroscedasticity tests, and cointegration tests.

3.10.1 Normal Distribution Test

A normality test is a statistical procedure used to determine whether a dataset follows a normal distribution, which is a bell-shaped distribution characterized by its symmetry and the majority of data points clustering around the mean. Normality tests are important because many statistical techniques, such as t-tests and analysis of variance, assume that the data are normally distributed. If the data deviate significantly from normality, these assumptions may be violated, leading to incorrect conclusions. There are several methods for testing the normality of data, including graphical methods and formal hypothesis tests, such as Histogram and QQ Plot, Shapiro-Wilk Test, and Kolmogorov-Smirnov Test.

This study uses the Shapiro-Wilk Test for normality. The Shapiro-Wilk test is a formal statistical test for normality. It calculates a test statistic based on the correlation between the observed data and the expected values from a normal distribution. The Shapiro-Wilk test utilizes the null hypothesis principle to assess whether a sample originates from a population with a normal distribution (Shapiro & Wilk, 1965). According to the null hypothesis, the data is assumed to follow a normal distribution, while the alternative hypothesis suggests otherwise. A Shapiro-Wilk test yielding non-significant results ($p > 0.05$) indicates that the sample likely comes from a normally distributed population, hence the null hypothesis is not rejected. Conversely, a significant Shapiro-Wilk test result ($p < 0.05$) supports the alternative hypothesis, suggesting that the sample is not drawn from normally distributed data. Consequently, the null hypothesis is rejected due to the evidence of non-normal distribution in the data.

3.10.2 Multicollinearity Test

Multicollinearity is a statistical phenomenon in regression analysis where independent variables in a model are highly correlated with each other. This can cause issues in interpreting the model coefficients and can affect the stability and reliability of the model predictions. Multi-collinearity was tested by using a Variable Inflation Factor (VIF). VIF measured how much the variance of an estimated regression coefficient

increases if the predictors are correlated. VIF values greater than 5 or 10 are often considered indicative of multicollinearity.

3.10.3 Heteroscedasticity Test

Heteroskedasticity is a statistical concept denoting a condition where the variability of a dependent variable is not consistent across the range of an independent variable. In simpler terms, it means that the spread of the data points around the regression line (in the context of regression analysis) varies as the value of the independent variable changes.

In regression analysis, it is often assumed that the variance of the error terms (or residuals) is constant across all levels of the independent variables. This assumption is known as homoscedasticity. When this assumption is violated and the variance of the error terms is not constant, we have heteroscedasticity. Heteroscedasticity can lead to several issues in statistical analysis: first, biased estimators: when heteroscedasticity is present, the ordinary least squares (OLS) estimators are still unbiased but no longer efficient. This means that they still provide estimates of the true parameters, but they may not be the best estimates possible. Secondly, inefficient estimators: heteroscedasticity leads to inefficient estimators because OLS estimators no longer have the minimum variance property, which can increase the standard errors of the coefficients. Thirdly, heteroscedasticity can lead to incorrect conclusions in hypothesis tests, such as t-tests and F-tests. Standard errors may be underestimated, leading to inflated test statistics and potentially incorrect rejection or acceptance of null hypotheses.

The Breusch Pagan Test was employed in this study. The null hypothesis of the test is whether error terms are normally distributed. A rejection of this hypothesis implies that error terms are normally distributed.

In the case where heteroscedasticity was present, robust standard errors were used. Robust standard errors correct for heteroscedasticity by estimating standard errors that

are robust to violations of the homoscedasticity assumption. This allows for valid inference even when heteroscedasticity is present.

3.10.4 Hausman Test

The specification test is carried out on panel data before running a panel data regression to check whether the researcher would choose fixed effects or random effects in the estimation model. Random effects assume no correlation between group-specific random effects and regressors. However, the fixed effects model does not make such an assumption and the possibility remains that the assumption of zero correlation in the random effects model is not feasible. As a rule of thumb, if carried out and the possibility value is less than 0.05 ($p< 0.05$) then there is a correlation between the error components (defined as $e_{it}= u_i+ e_{it}$) and the explanatory variables and fixed effects adopted in the model estimation: otherwise, the random effects is a more efficient estimator of the parameters under investigation since it establishes that the U_i is random, independent of e_{it} and the explanatory variables.

3.10.5 Cointegration Test

Cointegration in panel data refers to the relationship between variables that exhibit a long-term equilibrium connection, even though they may individually follow non-stationary processes. Panel data, also known as longitudinal or cross-sectional time series data, consists of observations on multiple entities or individuals over multiple periods. Cointegration analysis in panel data allows us to examine whether such long-term relationships exist among variables within and across entities over time.

The study used this to check on the long-run relationship among the co-integrating variables. The null hypothesis was used to check whether there is any co-integration in the variables. The Westerlund Test for cointegration was used with the assumption that there is no trend.

3.10.6 Panel Unit Root Test

The study used the panel unit root test to check on stationarity since panel data contains both cross-sections and time series data. Gujarati & Porter (2009), indicate unit root test to test for non-stationarity for all the data variables. The Fisher-type test of unit root in panel data was employed for this study. The test is advantageous as it accepts the unbalanced panels having gaps and further performs the Phillip-Perron test and Dickey-Fuller test and further reports for four different tests. The null hypothesis is that there a unit roots and therefore we accept the hypothesis if the p-value > 0.05 (significant level). The alternate hypothesis is that at least one panel did not have unit roots and therefore we reject the null hypothesis p-value < 0.05.

3.10.7 Panel Autocorrelation Test

Autocorrelation testing in panel data analysis is crucial for ensuring the validity of the results, especially when dealing with time-series data. Autocorrelation, also known as serial correlation, occurs when the errors in a regression model are correlated over time. In panel data analysis, where you have both cross-sectional and time-series dimensions, it's essential to account for any potential autocorrelation properly. The study used the Wooldridge test for autocorrelation in panel data.

The Wooldridge test for autocorrelation in panel data, also known as the Wooldridge serial correlation test, is a diagnostic test used to detect the presence of autocorrelation in panel data models. Autocorrelation occurs when there is a correlation between the error terms of observations at different time periods within the same panel unit. In other words, it indicates that the error terms are not independent over time. The Wooldridge test is an extension of the Durbin-Watson test for autocorrelation in time series data to the panel data context. It tests the null hypothesis that there is no first-order autocorrelation (serial correlation) in the error terms against the alternative hypothesis that there is first-order autocorrelation.

3.11 Specification Test for the Panel Model

To test the validity of the GMM estimates, two further tests were performed. First, since lagged values are used as instruments, unbiased estimation requires the absence of second-order serial correlation in the error term (Arellano & Bond, 1991). To test this requirement, the Arellano-Bond AR (2) test was carried out. A p-value of greater than 0.05 implies the absence of second-order autocorrelation. Similarly, the GMM estimate can be used without any kind of adjustments to the instrument test. A p-value of less than 0.05 indicates the presence of a moving average error term of order one or higher.

Moreover, determining the validity of the instrument used for justification is necessary to capture appropriateness and validity for the study the Jansen J-test was performed. This was because it is a more robust and appropriate in a dynamic model estimated with GMM (Yinusa, 2015). The probability value of Hansen is expected not to be less than 0.01. Hansen value less than 0.01 signals problem with the validity of instruments employed in the models.

CHAPTER FOUR

RESULTS AND DISCUSSION

The following chapter presents the findings of the estimation process and provides a comprehensive discussion of the results. This study specifically investigated the impact of capital adequacy, asset quality, earnings quality, ownership structure, and operational efficiency of commercial banks in Kenya. In order to assess the impact of market structure on the overall model of the study, the researchers introduced it as a moderator to determine the strength of intensity.

After the introduction, the subsequent sections include the presentation of descriptive statistics, diagnostic tests, and the outcomes of the model. The variables analyzed in this study encompass input and output variables, capital adequacy, asset quality, earnings quality, liquidity, market structure and operational efficiency of banks. The chapter concludes by discussing several diagnostic tests, such as the normality test, multicollinearity test, heteroskedasticity test, cointegration test, and Hausman test.

4.1 Descriptive Statistics

This segment provides comprehensive descriptive statistics for both the input and output variables. In Table 4, the symbols employed are as follows: "SD" signifies the standard deviation, "Min" denotes the minimum value, and "Max" represents the maximum value.

Descriptive statistics play a crucial role in summarizing and interpreting data. By providing measures such as the mean, standard deviation, minimum, and maximum values, researchers can gain insights into the central tendency, dispersion, and range of their data. In this section, the descriptive statistics for both input and output variables are presented, allowing readers to understand the characteristics and variability of the data being analyzed. Thus, this approach facilitates the interpretation of the data and supports informed decision-making in subsequent analyses or discussions.

Table 4.1: Summary Statistics for the Input and Output Variables

Variable	Mean	SD	Min	Max	Skewness	Kurtosis
Total Cost	4.12e+06	6.50e+06	0.0000	4.17e+07	2.8274	11.9786
Total Loans	2.94e+07	4.95e+07	0.0000	3.73e+08	3.1555	15.4550
Earning Assets	1.55e+07	2.29e+07	0.0000	1.35e+08	2.3981	8.9840
Labor	0.0410	0.0394	0.0000	0.6756	8.9566	130.5773
Capital	0.1370	0.1298	-0.4254	1.1218	2.5612	18.6752
Deposits	0.2640	0.3314	0.0000	6.4895	12.3456	222.7268

The results displayed in Table 4.1 demonstrate that the average values of both the input and output variables exhibit a balanced distribution. The descriptive statistics of the data provide an understanding of different sample parameters such as the mean, median, and maximum value. Additionally, the distribution of the sample can be evaluated using measures of skewness and kurtosis, offering further insights.

The mean values of the input variables, namely total loans, earnings from assets, and total costs, were approximately Ksh 29.4 million, Ksh 15.5 million, and Ksh 4.12 million, respectively. Correspondingly, these inputs exhibited standard deviations of approximately Ksh 49.5 million, Ksh 22.9 million, and Ksh 6.5 million, respectively. The standard deviation of the input variables indicates variability or spread of the input variables around the mean. A higher standard deviation indicates greater variability in the data. The standard deviation of total loans is approximately Ksh 49.5 million, suggesting that the values of total loans tend to vary significantly around the mean of Ksh 29.4 million. The standard deviation of earnings from assets is approximately Ksh 22.9 million, indicating some variability around the mean of Ksh 15.5 million, though perhaps not as pronounced as for total loans. The standard deviation of total costs is approximately Ksh 6.5 million, suggesting relatively less variability around the mean of Ksh 4.12 million compared to the other variables.

On the other hand, the input variables, total costs, total loans, and earnings from assets had skewness of 2.82, 3.15, and 2.39 respectively, and Kurtosis of 11.97, 15.45, and 8.98 respectively.

Moreover, the independent factors, encompassing total costs, total loans, and earnings from assets, exhibited skewness values of 2.82, 3.15, and 2.39 correspondingly, with kurtosis values standing at 11.97, 15.45, and 8.98 in the same order. Skewness greater than zero indicates a right-skewed distribution; the tail of the distribution extends more to the right than to the left. Conversely, a negative skewness value suggests a left-skewed distribution. Therefore, the skewness values for the input variables (total costs, total loans, and earnings from assets) indicate some degree of asymmetry in their distributions.

Kurtosis, on the other hand, measures the "tailedness" of the distribution. A higher kurtosis value indicates more extreme outliers in the distribution compared to a normal distribution. A value of 3 represents the kurtosis of a normal distribution. Kurtosis values greater than 3 signify heavier tails, indicating more outliers or extreme values in the distribution. The kurtosis values provided for the input variables suggest that their distributions have heavier tails compared to a normal distribution.

Thus, skewness and kurtosis values provide insights into the shape and characteristics of the distribution of data. In this context, the skewness values greater than zero suggest that the distributions of total costs, total loans, and earnings from assets are right-skewed, indicating that there might be a concentration of lower values with a few higher values extending the distribution's tail to the right. The kurtosis values, being considerably higher than 3, indicate that the distributions have heavy tails, implying the presence of outliers or extreme values in the data sets. To address this problem with outliers, logarithmic transformations were carried out to achieve normality, which is often a prerequisite for certain statistical techniques.

The output variables namely, labor, capital, and total deposits had mean values of 0.0410, 0.1370, and 0.2640 respectively, and standard deviations of 0.0394, 0.1298, and 0.3314 respectively. The total deposits, with a mean of 0.2640 and a standard deviation of 0.3314, indicate data points will be around 0.2640, but they may vary widely from this average value. The standard deviation of 0.3314 suggests that the data points are spread out from the mean, indicating variability in the total deposit amounts.

On the other hand, the output variables exhibited skewness values of 8.9566, 2.5612, and 12.3456 for labor, capital, and total deposits, while their kurtosis values were 130.5773, 18.6752, and 222.7268, respectively. This is an indication that labor and total deposits exhibit positive skewness, suggesting that their distributions are skewed towards higher values, while capital has a smaller positive skewness, indicating a less pronounced asymmetry. The substantially high kurtosis values for labor, capital, and total deposits indicate that their distributions have heavy tails and are more peaked compared to a normal distribution, suggesting the presence of outliers or extreme values in the data.

4.1.1 Operational Efficiency by Year

The summary statistics of operational efficiency by year are presented in Table 4.2.

Table 4.2: Summary Statistics of Operational Efficiency by Year

Year	Mean	SD	Min	Max
2008	0.7282	0.0836	0.3641	0.8530
2009	0.7315	0.0514	0.6230	0.8271
2010	0.7452	0.0736	0.4474	0.8636
2011	0.7553	0.0444	0.6388	0.8772
2012	0.7684	0.5813	0.5942	0.9032
2013	0.7821	0.0581	0.5942	0.9032
2014	0.7748	0.0561	0.6182	0.8923
2015	0.7668	0.0639	0.6376	0.9513
2016	0.7473	0.1183	0.1572	0.8716
2017	0.7877	0.1091	0.1871	0.8911
2018	0.7746	0.0509	0.5667	0.8512
2019	0.7760	0.0381	0.6462	0.8531
2020	0.7839	0.0792	0.4150	0.9056
2021	0.7779	0.0771	0.4633	0.9123
2022	0.8379	0.0809	0.8379	0.8379

The statistical data in Table 4.2 regarding the operational efficiency scores indicate a general enhancement in efficiency across all banks. In particular, the scores displayed a consistent rise, ascending from 72.7 percent in 2008 to 83.7 percent in 2022. The increase from 72.7 percent to 83.7 percent suggests that banks have become more effective in managing their operations and resources over the years. This could be

attributed to various factors such as advancements in technology, streamlining of processes, better risk management practices, or improvements in organizational structure. Additionally, a consistent upward trend in efficiency scores indicates that banks are adapting to changes in the financial landscape and optimizing their operations to remain competitive. This trend further reflects regulatory changes or industry-wide initiatives aimed at enhancing efficiency and transparency. The results indicate the improvement in operational efficiency scores is a positive sign for the banking sector, as it suggests that banks are becoming more adept at navigating challenges and delivering value to customers and stakeholders.

Further, the data reveals that across all years, the top-performing bank achieved an efficiency rate of 95.1 percent, while the least efficient bank operated at only 1.6 percent efficiency. This highlights a significant disparity between the most and least efficient banks, with the top performer operating at a remarkably high level of efficiency (95.1 percent) compared to the lowest performer, which operates at a notably low-efficiency rate (1.6 percent). This underscores the importance of efficiency metrics in evaluating the performance of banks and suggests potential areas for improvement among the less efficient institutions.

4.1.2 Dependent, Independent, and Moderating Variables

Table 4.3 in Appendix II, presents the descriptive statistics for the dependent and independent variables, including measures of central tendency such as mean, standard deviation, maximum, and minimum values.

Appendix II, which provides summary statistics per bank for the dependent, independent, and moderating variables, reports the sample statistics: mean, standard deviation, maximum value, and minimum value. The aggregated mean of 0.77 indicates that the average operational efficiency of the sampled banks was about 77%, likely due to technological integration and regulatory consolidation in the banking sector during the period. The standard deviation of 0.05 indicates a relatively stable efficiency level across the sector, though the wide gap between the minimum value of 0.63 (Habib Bank Ltd) and the maximum value of 0.85 (UBA Kenya Bank) suggests

that deep inefficiencies still plague certain underperforming institutions. The coefficients of variation of 0.065 indicated that there is a low degree of dispersion relative to the mean in terms of efficiency levels of the banks, suggesting a moderate degree of variability. This suggests that the operational efficiency level of all the sampled banks is fair but needs targeted improvement for bottom-quartile performers. This is consistent with studies from Staub et al. (2009) and Pasiouras et al. (2009).

The mean value of Asset Quality at 0.06 further confirms that the proportion of non-performing loans to total assets of the banks within the study period is about 6%. It implies that for every N100 in assets held by the banks, N6 is tied up in bad or risky loans. However, the standard deviation of 0.04, combined with a minimum value of 0.00 (observed in several banks) and a maximum value of 0.83 (Barclays), shows that credit risk management varies drastically across the industry. The average N6 expense is considered manageable, but the maximum extremes indicate that specific banks require strict credit appraisal to prevent future losses (Berger & DeYoung, 1997).

Regarding the remaining predictor variables, the mean, standard deviation, minimum, and maximum values reveal critical cross-sectional disparities. For Earnings Quality, while the majority of banks maintained a mean near 2.0, the maximum value spiked to 77.50 (ECOBANK) and 2389.54 (Giro Bank), indicating extreme volatility in earnings predictability for specific institutions despite a generally stable sector mean. Market Structure means ranged significantly from a minimum of 0.00 to a maximum of 14.63 (Bank of India), reflecting a highly heterogeneous banking environment with both niche players and systemic giants. Capital Adequacy showed generally healthy means (averaging 0.20), but the extreme maximum value of 2.54 (Gulf African Bank) versus a minimum near 0.00 (Sidian Bank) highlights significant differences in how banks buffer against risk. Finally, Liquidity remained adequate on average (mean ~0.80), but the massive maximum value of 23.36 (KCB) compared to a minimum of 0.00 (UBA Kenya Bank) suggests that while some banks are highly liquid, others operated at the absolute edge of illiquidity during the study period.

4.2 Diagnostic Tests

Statistical diagnostic tests are procedures used to assess the assumptions and validity of statistical analyses, as well as to identify any potential in data. The tests are essential in ensuring the reliability and credibility of statistical conclusions.

4.2.1 Normality Test

The Shapiro-Wilk test was used to analyze for normality. The Shapiro-Wilk test is a statistical test used to assess whether a sample of data comes from a normally distributed population, the test was carried out under the null hypothesis that the data are normally distributed. The results are presented in the table below.

Table 4.3: Shapiro -Wilk Test for Normality

Variable	Obs	W	V	z	Prob>z	Status
Operational Efficiency	515	0.78968	72.658	10.316	0.00000	Non-normal
Capital Adequacy	600	0.55117	177.997	12.558	0.00000	Non-normal
Asset Quality	600	0.07525	366.737	14.309	0.00000	Non-normal
Earnings Quality	600	0.04959	376.914	14.376	0.00000	Non-normal
Liquidity ratio	600	0.23461	303.539	13.851	0.00000	Non-normal
Market Structure	00	0.69389	121.397	11.630	0.00000	Non-normal

The Shapiro-Wilk test statistic (W) is calculated based on the covariance matrix of the sample data. This test statistic ranges between 0 and 1, with 1 indicating perfect normality. The calculated test statistic is compared to a critical value from the Shapiro-Wilk table or obtained through statistical software. If the test statistic is less than the critical value, we reject the null hypothesis and conclude that the data are not normally distributed. If the test statistic is greater than the critical value, we fail to reject the null hypothesis, suggesting that the data may be normally distributed. The p-value for all the variables in Table 4.4 was less than 1%, 5%, and 10% significance level, hence we

rejected the null hypotheses suggesting that the data deviates significantly from a normal distribution.

It's worth noting that the Shapiro-Wilk test is sensitive to sample size, meaning that it might detect departures from normality even when the deviations are small, especially with large sample sizes. In this regard, we plotted the Q-Q plots, or kernel density plots to better understand the distribution of the data.

Kernel Density Plot	The Q-Q Plot

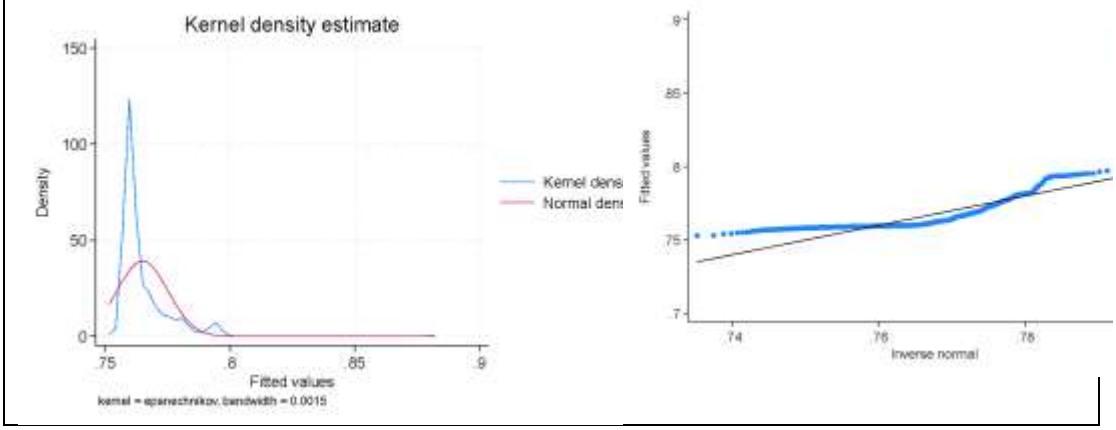


Figure 4.1: Kernel Density and Q-Q Plot for Normality

The concept of a Q-Q plot is straightforward: when the residuals align along a nearly straight line at a 45-degree angle, it suggests that they are approximately normally distributed. From the Q-Q plot presented in Figure 4.1, it's evident that the residuals noticeably diverge from this ideal line, particularly at the extremes, implying a potential departure from normal distribution. Likewise, in the Kernel density plot, the data exhibits deviation from the expected normal density. Therefore, we opted to transform the data to tackle this issue before proceeding with further estimation.

4.2.2 Multicollinearity Test

This research utilized the VIF (Variance Inflation Factor) and its reciprocal, 1/VIF, to examine multicollinearity. According to the conventional guideline, the absence of multicollinearity is suggested when 1/VIF is below 0.1 and VIF is less than 10. A 1/VIF value lower than 0.1, as noted by Dennis (2011), indicates the absence of

multicollinearity among the variables. The findings of the multicollinearity test using the variance inflation factor are presented in Table 4.4.

Table 4.4: VIF Multicollinearity Test Results

Variable	VIF	1/VIF
Earnings Quality	1.00	0.996991
Capital Adequacy	1.10	0.910522
Liquidity Ratio	1.02	0.976664
Market Structure	1.11	0.900822
Asset Quality	1.01	0.989466
Mean VIF	1.05	

In Table 4.4, the mean-variance inflation factor (VIF) for the variables is recorded as 1.05. It is noteworthy that both the VIF and its reciprocal values adhere to the anticipated range. Consequently, following the predetermined thresholds for VIF and 1/VIF, the independent variables do not demonstrate characteristics indicative of multicollinearity. Notably, the VIF and 1/VIF values are within the accepted parameters, typically below 10 for VIF and above 0.1 for 1/VIF. This implies that the regression model is capable of effectively incorporating all variables in its analysis.

Based on the findings presented in Table 4.4, where the mean Variance Inflation Factor (VIF) for the variables is recorded as 1.05 and considering that both the VIF and its reciprocal values adhere to the anticipated range, several implications were drawn.

The mean VIF value of 1.05 suggests that there is no evidence of multicollinearity among the independent variables in the regression model. Multicollinearity occurs when independent variables are highly correlated with each other, leading to inflated standard errors and unreliable coefficient estimates. The fact that the mean VIF is close to 1 indicates that the variables are not exhibiting problematic levels of multicollinearity. The VIF and its reciprocal values are within the accepted parameters typically used to assess multicollinearity. Specifically, VIF values below 10 and reciprocal values (1/VIF) above 0.1 are considered acceptable. Since the mean VIF is 1.05, well below 10, and its reciprocal values are within the expected range, it suggests that multicollinearity is not a concern in the regression model.

The absence of multicollinearity implied that the regression model was capable of effectively incorporating all variables in its analysis without suffering from issues related to collinearity-induced bias or inefficiency. The absence of multicollinearity enhanced the robustness of the regression results, as it reduced the risk of obtaining spurious or misleading findings.

4.2.3 Test for Heteroskedasticity

The Breusch-pagan/Cook-Weisberg test was used to test for heteroskedasticity. The test adopts the null hypothesis of the constant variance of the regression residuals, where the null hypothesis assumes homoscedasticity and the alternative heteroscedasticity. The testing of the null hypothesis was at a significant level of 5%, thus we fail to reject the null hypothesis if the p-value is greater than 0.05($p>0.05$). However, if this condition is not satisfied, we fail to accept the null hypothesis and assume the data was heteroskedasticity. Results for the Breusch-Pagan test are shown in Table 4.5.

Table 4.5: Heteroskedasticity Test Results

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: Fitted Values of Financial Performance
chi2(1) = 55.95
Prob > chi2 = 0.0000

The study utilized the Breusch-Pagan test to assess the presence of homoscedasticity in the model. This test is commonly employed to examine the assumption of constant variance in the residuals of the model. The null hypothesis posits that the model exhibits homoscedasticity, while the alternative hypothesis suggests heteroskedasticity.

Table 4.6 presents the findings of the Breusch-Pagan test, indicating a chi-square value of $X2 = 55.95$ with a p-value greater than 0.05. At the 5% significance level, the study accepted the null hypothesis of homoscedasticity and rejected the alternative hypothesis of heteroscedasticity. This implies that the variance of the error term

remains constant, thus supporting the conclusion that the data is homoscedastic. Thus, the data can be deemed reliable for regression analysis, having satisfied all the assumptions of the classical linear regression model.

The acceptance of the null hypothesis suggested that there was no evidence to suggest that the variance of the error term is dependent on the values of the independent variables, supporting the assumption of constant variance in the data. The acceptance of the null hypothesis implies that the data exhibits homoscedasticity, meaning that the variance of the error term remains constant across all levels of the independent variables. This enhanced the reliability of the data for regression analysis, as it indicates that the assumptions of the classical linear regression model were met.

Therefore, the acceptance of the null hypothesis of homoscedasticity based on the Breusch-Pagan test findings indicated that the data satisfied the assumption of constant variance in the error term. This supported the reliability of the data for regression analysis and ensured that the conclusions drawn from the regression results were valid.

4.2.4 Unit Root Test/ Stationarity Test

The presence of a unit root within a time series dataset indicates its nonstationary, implying that its statistical characteristics like mean and variance fluctuate over time. Dealing with nonstationary data presents challenges in employing conventional estimation methods such as ordinary least squares (OLS), which assume stationarity. Failure to properly address nonstationary variables in regression analysis can result in spurious regression outcomes. Spurious regression arises when two nonstationary series are regressed against each other, yielding regression coefficients that seem significant despite lacking genuine correlation. This phenomenon occurs because nonstationary series may display long-term trends and exhibit drifting patterns over time, misleadingly suggesting correlation where none truly exists.

To address this issue, we employed the LLC (Levin, Lin, & Chu) test to determine the presence of unit root. The LLC test is an extension of the popular Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Similarly to these tests, the LLC test examines

the null hypothesis of a unit root against the alternative hypothesis of stationarity. The LLC test improves upon the Dickey-Fuller and Phillips-Perron tests by allowing for more flexible lag structures and better performance in finite samples. The results of the test are shown in table 4.6.

Table 4.6: LLC Unit Root Test Results

Variable	Levels		First Difference		Second Difference	
	Adjusted	Adjusted and Trend	Adjusted	Adjusted and Trend	Adjusted	Adjusted and Trend
OE	11.0163	13.1469	-12.919**	3.1482	-22.019***	
CA	-11.2445***	-13.6440***				
AQ	-68.8265***	-58.6454***				
EQ	-33.4328***	-51.1940***				
L	-12.5972***	-18.2498***				
MS	-0.0039	6.0163	-8.8807***	-8.3060***		

Note: *, **, *** indicates 1%, 5%, and 10% significance level.

The LLC unit root test presupposes independence across different sections. The unit root examinations outlined in Table 4.6 demonstrate varying orders of integration among the variables when a trend is included in the test equation. The null hypothesis states that the individual panel series contains a unit root (non-stationary). Where the adjusted p-values are less than 0.05 level of significance (at a 95% confidence level), the null hypothesis is rejected, and the series is deemed stationary.

4.2.4.1 Results with Trend

Based on the results showed in Appendix III, the variables exhibit mixed stationarity properties. Capital adequacy, asset quality, earnings quality and liquidity ratio were found to be stationary at levels. This indicates that the variables are integrated of order zero, I (0). Market size was found to be non-stationary at levels but achieved stationarity after the first differencing. Therefore, market size is classified as an I(I) stochastic process. Operational efficiency results show stationarity only after second differencing, indicating it is integrated of order two, I(2). Those variables that were initially non-stationary at their original levels were subjected to differencing once, resulting in their attainment of stationarity.

4.2.4.2 Results without Trend

The Levin Lin Chu was further exhibited to examine the variables without a deterministic trend. The results without trend corroborate the findings of the trend model, confirming the stationarity of capital adequacy, asset quality, earnings quality, liquidity and operational efficiency at levels.

According to Gujarati (2004), where data are stationary, variances and covariance do not vary systematically over time, and the tendency for the estimates to change over time does not exist. The rejection of the unit root hypothesis for our core variables confirms that the resultant regression models will be fit and immune to the pitfalls of spurious regression.

The unit root tests conducted revealed important insights about the stationarity properties of the variables under consideration. The presence of both non-stationary and stationary traits suggests that these variables may possess different underlying trends or behaviors. The fact that some variables were initially non-stationary at their original levels but became stationary after differencing implies that these variables may exhibit stochastic trends or cyclical patterns that necessitate differencing to achieve stationarity. This highlights the importance of appropriately pre-processing data before conducting further analysis.

4.2.5 Co-integration Test

The study employed the Westerlund co-integration examination to assess the long-term relationship among the co-integrating variables. Co-integration refers to the scenario in which two or more non-stationary time series variables share the same level of integration, and there exists a linear combination of them that is stationary. The Westerlund test operates under the assumption of the null hypothesis, suggesting no co-integration, against the alternative hypothesis, indicating the presence of co-integration within the data. This test, introduced by Westerlund (2007), is well-suited for small sample sizes, enhancing its practical utility. It is particularly advantageous in

scenarios where the time series data may exhibit structural breaks or possess different orders of integration. The results are shown in table 4.7.

Table 4.7: Westerlund Test for Cointegration Results

Statistic	Value	Z-value	P-value
Gt	-2.299	-0.625	0.266
Ga	-1.240	8.635	1.000
Pt	-4.839	5.777	1.000
Pa	-1.088	5.523	1.000

Xtwest operational_efficiency assetquality market_calculating westerlund ECM panel cointegration tests
Results for H0: nointegration with 40 series and 5 covariates

From the result Westerlund test for cointegration in Table 4.7 indicates since the P-values are greater than 0.05, we fail to reject the Ho and hence conclude that there is no cointegration. The outcome indicate that the p-value exceeds the significance levels of 1%, 5%, and 10%. Consequently, we do not have sufficient evidence to reject the null hypothesis, suggesting the absence of cointegration. Therefore, we infer that there are no long-term relationships among the variables.

Based on the outcome of the Westerlund test for cointegration, which indicate the absence of cointegration among the variables. Therefore, there is no evidence of cointegration implies that there are no long-term relationships among the variables under consideration. This suggests that changes in one variable are not systematically related to changes in the other variables over the long run. The absence of cointegration suggests that the variables may evolve independently of each other over time, without any stable long-term relationship.

Moreover, while cointegration deals with long-term relationships, the absence of cointegration does not preclude the existence of short-term dynamics or correlations among the variables. The variables may exhibit short-term relationships or co-movements that are not captured by cointegration. Based on the findings, models that assume cointegration or long-term equilibrium relationships may not be suitable for these variables. Instead, alternative modeling techniques that account for short-term dynamics or non-stationarity may be more appropriate. Thus, the absence of

cointegration among the variables implies that they do not share stable long-term relationships, highlighting the need for alternative approaches to modeling and analysis, such as the panel data analysis models. Therefore, the study employed two-step generalized method of moments (Blundell and Bond (1988).

4.2.6 Panel Autocorrelation Test Results

The Wooldridge test for autocorrelation in panel data was carried out under the null hypothesis of no autocorrelation, and the test statistic follows a chi-square distribution with one degree of freedom. If the calculated test statistic is significantly different from zero, then it indicates the presence of first-order autocorrelation in the panel data model. The results are shown in table 4.8.

Table 4.8: Wooldridge Test for Autocorrelation in Panel Data Results

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F(1, 39) = 3.858
Prob> F =0.0567

The result in Table 4.9 shows that autocorrelation was not a serious problem after failing to reject the null hypothesis Based on the findings, the p-value surpasses the thresholds of 1%, 5%, and 10% significance levels. As a result, we lack adequate evidence to refute the null hypothesis, indicating the lack of first-order autocorrelation within the panels. This implies that the observations within each panel are not significantly correlated with each other at the first lag. The lack of statistical significance in detecting first-order autocorrelation suggests that the results of the analysis are robust and reliable.

The absence of first-order autocorrelation within the panels further indicated that the chosen panel data model adequately captured the underlying relationships in the data, hence there was no need for additional adjustments to account for autocorrelation.

4.2.7 Hausman Test

The study utilized a panel least regression model analysis, highlighting the importance of tackling common estimation and inference issues inherent in panel data, as outlined by Gujarati (2004). To address these concerns, the researcher employed the Hausman specification test, as demonstrated in table 4.9. The Hausman test is a statistical test used to compare the efficiency of two different estimators, typically the fixed effects estimator and the random effects estimator, in panel data analysis. It helps in determining whether the assumptions underlying these estimators hold true for their dataset. Employing this test indicates a rigorous approach to model specification and selection.

Table 4.9: Hausman Test Results

Variable	Coefficients		Difference	Sqrt(diag(V_b-V_B)
	fe (b)	re (B)	(b − B)	Std. Err.
capitaladequacy	-0.191329	-0.1916608	0.0003318	0.0191511
assetquality	0.0103071	0.0132604	-0.0029533	0.0030933
earningsquality	-0.0001346	-0.0001211	-0.0000136	0.0000161
liquidityratio	-0.0011515	-0.0007573	-0.0003941	0.0019364
market_size	0.0305277	0.0110419	0.0194857	0.0117231

b=consistent under H_0 and H_a, obtained from xtreg
$_{B=}$ consistent under $H_{a;\ \text{efficient under}}$ H_0; obtained from xtreg
Test of H0 : Difference in coefficients not systematic
Chi2=(b-B)*[(V_b-V_B)^(-1)](b-B) =3.53
Prob>chi2=0.6193

To determine the appropriate estimation strategy for the panel data model, this study employed the Hausman specification test. The test evaluates the null hypothesis that the unobserved individual-specific effects are uncorrelated with the explanatory variables. As reported in Table 4.9, the hausman test results indicate a p-value greater than 0.05 (p = 0.62). Consequently, we fail to reject the null hypothesis of random effect model. Furthermore, the overall model specification for the RE estimator is highly significant (Wald chi-square = 3.53, p = 0.62). According to Baltangi (2002), the random and fixed effects are biased and inconsistent unless the number of time periods is large and number is equal to 30. Moreover the period included in the study is 15 years, therefore, the study employed the panel equations for dynamic GMM.

4.2.8 Summary of Diagnostic Tests

The researcher conducted diagnostic examinations aimed at evaluating the effectiveness of statistical models, pinpointing anomalies, detecting deviations from underlying assumptions, and gauging the significance of connections among variables. These assessments play a crucial role in data analysis by enabling informed decision-making regarding both the data and the models employed.

One of the tests performed was the Normality Test, which aimed to ascertain whether the dataset adhered to a normal distribution. Utilizing the Shapiro-Wilk test along with graphical representations such as Kernel density and Q-Q plots, it was established that the data did not conform to a normal distribution, necessitating data transformation.

Multicollinearity tests were conducted to identify any multicollinearity among the predictor variables in the regression analysis. Based on the assessment of the variance inflation factor (VIF), it was determined that multicollinearity did not pose an issue within the dataset.

The researcher employed the Breusch-Pagan test to examine heteroskedasticity, where the dispersion of a dependent variable varies across different levels of an independent variable. Following the analysis, the researcher inferred that the data exhibited homoscedasticity.

Additional examinations were conducted, encompassing tests for stationarity, panel autocorrelation, and cointegration. The findings indicated the absence of serial correlation issues and the lack of long-term relationships among variables (cointegration). Moreover, the stationarity test revealed that certain variables initially exhibited non-stationarity at their original levels, prompting the application of differencing once to achieve stationarity.

The Hausman test was employed to assess the potential existence of endogeneity and to determine the suitable model selection between random effects and fixed effects. The findings indicated that the random effect model was the preferred option. However, the test also uncovered the presence of an endogeneity problem, requiring

the estimation of a robust model to address these issues. Therefore the two step generalized method of moments was used in the study.

4.3 Panel Regression Analysis

Stochastic Frontier Analysis (SFA) was employed to compute operational efficiency scores. The SFA estimated the cost frontier of each bank, separating observed output or cost levels into two components: the productive efficiency level and random noise.

The SFA was advantageous because it was capable of handling multiple inputs and outputs simultaneously, which is particularly useful when analyzing complex production processes where multiple factors contribute to the final output. Additionally, SFA accounted for heterogeneity across banks by allowing for individual-specific effects. This is important considering that different differences in efficiency levels may be influenced by factors other than firm-specific characteristics. Consequently, SFA is robust to measurement error in the input and output variables, making it less sensitive to data imperfections compared to other methods like Data Envelopment Analysis (DEA).

To explore the presumed connection between operational efficiency scores and various independent factors, we conducted regression analysis, using the components of capital adequacy, asset quality, earnings quality, and ownership structure as variables. The results of the regression analysis aligned with the research goals outlined in the first and second chapters of this study, as well as the null hypotheses.

The fixed effects (FE) and random effects (RE) models are likely to suffer various challenges which include the following, heterogeneity, endogeneity, and serial correlation, which necessitates the need for robust models' estimation. To ensure robust estimation, Dynamic Panel Models panel models were estimated. Dynamic Panel Models (DPMs) can address multifaceted issues, including individual-specific effects (fixed effects), time-specific effects (time-fixed effects), and unobserved heterogeneity potentially correlated with the independent variables (random effects). Additionally, DPMs provide a framework for resolving endogeneity challenges by

incorporating instrumental variables or employing alternative methodologies to mitigate biases stemming from omitted variables or reverse causality.

Specifically, the Panel Generalized Method of Moments (GMM) estimation model which is a form of the DPM was used. The model was deemed robust since it accounted for panel data structure, hence addressing heterogeneity, and serial correlation endogeneity and serial correlation commonly encountered in panel data analysis. In this model, the lagged values of the dependent variable were used as the instruments. The estimation was carried out per each of the objectives, followed by interpretation and discussion of the results.

Table 4.10: Dynamic Panel Estimation-Two Step System GMM (Without Interaction Terms)

Dynamic Panel Estimation-Two Step System GMM				
Variable	**Coefficient**	**Std. Error**	**t-static**	**Probability**
Operational Efficiency	1.194259	0.4361015	2.74	0.009
L_Operational Efficiency	-0.44316	0.279723	-1.58	0.002
Earnings Quality	0.000147	0.000052	2.8	0.008
Capital Adequacy	0.040226	0.000067	0.59	0.005
Asset Quality	0.019019	0.020013	0.95	0.003
Liquidity ratio	-0.004548	0.012759	0.36	0.007
Observation				
No. of Groups				
	Z			**Probability**
Arellano-Bond test	1.77			0.578
Saragan test	3.35			0
Hansen test	37.36			0

Model 1:

$$\mathbf{1.1943OE_{it} = \beta_0 + 0.0402CA_{it} + 0.0190AQ_{it} + 0.0001E_{it} - 0.0045L_{it} + U_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4)}$$

For the estimated model in table 4.10 the Arellano and bond (AR2) test of second-order autocorrelation shows a value of 0.578 which is greater than 0.05 which suggest absence of second order autocorrelation, denoting that the model was correctly specified. Results Hansen test indicate validity of the instruments employed in the

model that shows it is robust and not weakened by many variables while Sargan test shows not robust but weakened by some of the variables in the study.

4.3.1 Capital Adequacy and Operational Efficiency

This objective sought to explore how capital adequacy influences operational efficiency, and further explore how market structure may influence this relationship. To achieve this, the researcher employed risk-weighted assets as a measure of capital adequacy, serving as the independent variable, while operational efficiency served as the dependent variable.

The study anticipated that there would be no significant correlation between capital adequacy and operational efficiency. Operational scores were subjected to regression analysis with capital adequacy to either confirm or refute the null hypothesis. The hypothesized association between capital adequacy and operational efficiency was investigated using a dynamic panel data model, specifically employing the Panel Generalized Method of Moments (GMM). Nonetheless, it was the findings in model that provided the conclusive interpretation of the presumed relationship between capital adequacy and operational efficiency.

The results obtained from the panel GMM model in Table 4.10 reveal a significant positive significant relationship between capital adequacy and operational efficiency of commercial banks in Kenya (Coefficient=0.0402, P=0.005). %. Specifically, the panel GMM outcomes highlight that core capital, which is the minimum amount of capital a bank must hold in order to comply with the Central Bank of Kenya regulations, plays a particularly beneficial role in improving operational efficiency. This finding implies that adequate capital allows banks to absorb losses, maintain stability, and invest in improving their operational processes. Efficient operations can lead to cost savings, enhanced customer service, and better overall performance.

The significance level indicates that the study failed to reject the null hypothesis, meaning that increase in capital adequacy led to meaningful increase in operational efficiency. These findings concur with results from Estrada and Osorio (2004), which

indicate capital adequacy requirement influences the operational efficiency of banks since they act as fixed inputs during the production process. Accord to the findings adequate capitalization allows banks to better manage risks associated with their operations. With a sufficient capital buffer, banks are better positioned to absorb unexpected losses, whether they stem from credit risk, market risk, or operational risk. This enhances the overall risk management framework of the bank, contributing to operational stability and efficiency (Ogboi and Unuafe, 2013).

This is inconsistent with findings by Yener, Carbo, Gardener, and Molyneux (2007). The findings indicated that a negative correlation existed between capital adequacy and operational efficiency. The finding of a negative correlation suggests that as banks allocate more capital to ensure safety and regulatory compliance, their operational efficiency may suffer. Additionally, regulatory requirements often dictate the minimum levels of capital banks must hold to safeguard against financial risks. If higher capital adequacy is associated with lower operational efficiency, it might indicate challenges for banks in meeting regulatory requirements without compromising their operational performance. Therefore, the findings of the study suggest an important trade-off that banks must navigate between capital adequacy and operational efficiency, highlighting the complex relationship between risk management, regulatory compliance, and profitability in the banking sector.

On a different note, Khalifaturofi'ah (2023) indicates that adequate capitalization can lead to a reduction in the cost of capital for banks. When banks maintain higher levels of capital, they are perceived as less risky by investors and creditors, resulting in lower borrowing costs. This, in turn, enhances the bank's profitability and operational efficiency by reducing its overall funding expenses.

4.3.2 Effect of Asset Quality on Operational Efficiency

This objective sought to investigate the impact of asset quality on operational efficiency and subsequently examine the moderating role of market structure in the relationship between asset quality and operational efficiency. To accomplish this

objective, the researcher employed asset quality as the independent variable and operational efficiency as the dependent variable.

The research expected to find no notable connection between asset quality and operational efficiency. Operational performance ratings underwent regression analysis with asset quality to test the initial assumption. The presumed link between asset quality and operational efficiency was explored through a dynamic panel data model, utilizing the Panel Generalized Method of Moments (GMM). However, it was the outcomes of the model below in Table 4.10 that ultimately shed light on the assumed correlation between asset quality and operational efficiency.

The results derived from the panel generalized method of moments (GMM) analysis in Table 4.12 demonstrate a statistically significant positive relationship between asset quality and operational efficiency within the banking sector of Kenya (Coefficient=0.0190, P=0.003). This significance is notably observed at the levels of 1%, 5%, and 10% confidence. Specifically, a unit improvement in asset quality corresponds to a 1.2 percent increase in operational efficiency.

The positive correlation between asset quality and the operational efficiency of banks in Kenya can be inferred as follows. Firstly, a high standard of asset quality typically denotes a lower incidence of non-performing loans (NPLs) or impaired assets. Banks maintaining lower NPL ratios tend to exhibit more rigorous credit risk management practices, resulting in decreased necessity for loan loss provisions and diminished costs associated with credit risk management (Ali, Shuib, & Nor, 2021). Consequently, this fosters an enhancement in operational efficiency

Secondly, as depicted by Bruno, Iacoviello, and Lazzini (2015), maintaining a portfolio of high-quality assets reduces the need for extensive resources to manage and recover non-performing or impaired loans. Banks can allocate fewer resources to loan workout processes, legal actions, and collections, leading to cost savings and improved operational efficiency.

High asset quality contributes to higher interest income and lower provisioning expenses. As a result, banks with strong asset quality are often more profitable, which can support further investments in technology, talent, and infrastructure to improve operational efficiency (Ahamed, 2017).

In another instance, banks with high asset quality typically have a healthier balance sheet, which can enhance their capital adequacy ratios. A strong capital position allows banks to absorb unexpected losses, pursue growth opportunities, and maintain investor confidence, all of which contribute to operational efficiency (Salike, and Ao, 2018).

In line with the research conducted by Piskorski, Seru, and Witkin (2015), there exists a notable correlation between banks' reputations for maintaining high asset quality and their associated funding costs. The study suggests that banks with a well-established reputation for managing their assets prudently are perceived by investors as being less susceptible to risk. Consequently, such banks tend to enjoy the advantage of lower funding costs. This finding holds significant implications for banks, as reduced funding costs directly contribute to the enhancement of net interest margins and overall profitability. The ability to secure funding at lower costs not only bolsters financial stability but also facilitates the allocation of resources toward more lucrative opportunities. Moreover, the observed relationship underscores the importance of maintaining and cultivating a strong reputation for asset quality management within the banking industry. In essence, the research underscores the pivotal role of reputation in shaping investors' perceptions of risk and subsequently influencing funding costs for banks. By prioritizing asset quality and garnering a positive reputation in this regard, banks can potentially leverage this advantage to optimize operational efficiency and drive sustainable profitability.

As noted by Duffie (2018), regulators often favor banks with strong asset quality as it signifies sound risk management practices and compliance with regulatory requirements. Banks that meet regulatory standards may face fewer regulatory interventions and enjoy operational efficiencies associated with streamlined compliance processes.

In conclusion, maintaining high asset quality is essential for banks to achieve operational efficiency, profitability, and sustainable growth. By effectively managing credit risk and maintaining a healthy portfolio of assets, banks can realize several positive effects that contribute to their overall efficiency and long-term success.

4.3.3 Effect of Earnings Quality on Operational Efficiency

The objective sought to analyze the influence of earnings quality on the operational efficiency of banks in Kenya. To achieve this objective, the researcher employed earnings quality as the independent variable and operational efficiency as the dependent variable.

The objective set out to investigate the potential correlation between earnings quality and operational efficiency. Initially, operational performance ratings were subjected to regression analysis alongside asset quality as part of the research methodology, based on the presumption of a connection. Employing a dynamic panel data model, utilizing the Panel Generalized Method of Moments (GMM), the study explored the hypothesized link between earnings quality and operational efficiency. However, it was the results derived from the model below in Table 4.13 that ultimately elucidated the presumed association between earnings quality and operational efficiency.

The results obtained from the panel GMM analysis in Table 4.11 indicate a statistically significant positive correlation between the earning quality of banks and their operational efficiency (Coefficient=0.0001, P=0.008). This significance is observed at the 1%, 5%, and 10% levels. The findings suggest that a one-unit increase in earnings quality results in a 0.01 percent improvement in the operational efficiency of banks in Kenya.

The positive results are justifiable in several ways. First, high earning quality indicates that a bank's income is stable and predictable over time. This stability allows banks to plan their operations more effectively, leading to smoother day-to-day functioning and better resource allocation (Sharma, 2016).

Secondly, banks with high earning quality are better equipped to manage risks associated with their operations. They are more likely to have accurate assessments of credit, market, and operational risks, enabling them to make informed decisions and mitigate potential losses.

As noted by Ekwe (2013), investors tend to have greater confidence in banks with consistent and reliable earnings. High earning quality signals financial stability and prudent management practices, which can attract investors and positively impact a bank's stock price and access to capital.

A bank's earning quality can influence customer trust and loyalty. Customers are more likely to have confidence in a bank that consistently delivers positive financial results and demonstrates stability, which can lead to increased deposits and revenue generation (Omoregie et al., 2019).

Finally, Mäntymaa (2013) showed that high-earning quality can provide a competitive advantage in the banking industry. Banks with a track record of strong and reliable earnings may attract more customers, talented employees, and business opportunities, positioning them ahead of competitors in terms of operational efficiency.

Therefore, earning quality is essential for enhancing the operational efficiency of commercial banks by promoting stability, risk management, investor confidence, cost efficiency, regulatory compliance, customer trust, and competitive advantage. Banks that prioritize earning quality are better positioned to navigate challenges, capitalize on opportunities, and achieve long-term success in the dynamic banking landscape.

4.3.4 Effect of Bank Liquidity on Operational Efficiency

This objective aimed to investigate the impact of bank liquidity on operational efficiency, and subsequently examine the moderating role of market structure in the relationship between bank liquidity and operational efficiency. In order to accomplish this goal, the researcher used bank liquidity as the independent variable and operational efficiency as the dependent variable.

At first, the research methodology involved analyzing operational performance ratings through regression analysis in conjunction with bank liquidity, operating under the assumption of a correlation. By employing a dynamic panel data model and utilizing the Panel Generalized Method of Moments (GMM), the study investigated the proposed relationship between bank liquidity and operational efficiency. However, it was the findings from Table 4.10 that ultimately clarified the expected connection between earnings quality and operational efficiency.

The findings derived from the panel GMM analysis in Table 4.10 reveal a notable positive correlation between the liquidity of banks and their operational effectiveness (Coefficient=-0.0045, P=0.07). This observed significance holds true at levels of 1%, 5%, and 10%. The research highlights a positive association between a bank's liquidity and its operational efficiency, indicating a 0.4% increase in efficiency for each incremental increase in liquidity.

The findings concur with Sufian and Habibullah (2014) found out that bank liquidity, proxied by a ratio of loans to total assets, consistently exhibited a negative relationship with bank efficiency levels. While, Odunga and Nyangweso (2020) found liquidity proxy by interbank ratio was insignificant in explaining operational efficiency.

However, Ratemo and Ndede (2021) research shows liquidity has a positive association with performance of commercial banks in Kenya. Dell'Atti (2015) also indicated a positive association between liquidity and efficiency while Sing and Malik (2018) indicates a positive relationship between bank liquidity and efficiency. However, while various authors on liquidity and efficiency indicate a positive relationship,

4.4 Moderation Effect of Market Structure on Relationship between Capital Adequacy, Asset Quality, Earnings Quality, Bank Liquidity and Operational Efficiency

The hierarchical multiple regression approach was utilized to explore how market structure might influence the connection between capital adequacy, asset quality, earning quality, bank liquidity, and operational efficiency. To assess the moderating impact proposed in the hypothesis, it is essential to meet three fundamental conditions. This entails evaluating the statistical significance of the coefficient linked with the interaction term, scrutinizing any alterations in the overall model effect (R2), and establishing the statistical significance of the predictor variables, the moderator, and the interaction term.

Moderation occurs when there is a change in the strength or direction of the relationship between an independent variable and a dependent variable due to the introduction of a moderator. This change was observed through alterations in the overall impact of the model, and the significant effect of the newly added interaction term. Complete moderation is indicated when both the predictor and the moderator become statistically insignificant after the inclusion of the interaction term. Moderation was tested for each of the independent variables against the dependent variables and the results were presented.

Table 4.11: Dynamic Panel Estimation-Two Step System GMM (With Interaction Terms)

Variable	Coefficient	Std. Error	t-static	Probability
Operational Efficiency	1.244135	0.522427	2.38	0.022
L_Operational Efficiency	-0.52994	0.388504	-1.36	0.18
Earnings Quality	0.000348	0.000065	-5.38	0.00
Capital Adequacy	-0.101283	0.07251	0.17	0.028
Asset Quality	0.087415	0.054545	1.60	0.017
Liquidity ratio	-0.049249	0.035179	1.4	0.017
Market_earning_inter	-0.000637	0.000189	3.36	0.002
Market-capital_inter	0.128915	0.056739	2.27	0.029
Market_asset_inter	0.007081	0.004743	-1.49	0.144
Market_liquidity_inter	0.003854	0.002587	1.49	0.014
Observation	530660			
No. of Groups	40			

Model 2:

The second model based on the regression model with a moderating variable.

$$\mathbf{1.2441OE_{it} = \beta_0 + 0.1289(CAMs)_{it} + 0.0071(AQMs)_{it} - 0.0006(EQMs)_{it} + 0.0038 (LMs)it + Uit \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.5)}$$

4.4.1 Moderation Effect of Market Structure on Relationship between Capital Adequacy and Operational Efficiency

The Table 4.11 presents the hierarchical regression outcomes pertaining to the moderating impact of market structure on the relationship between capital adequacy and operational efficiency within the banking sector of Kenya.

The findings in Table 4.11 revealed that upon introducing the moderating variable, there was a notable change in the relationship of the independent variable (capital adequacy). Specifically, it increased from 0.04 in model one to 0.129 in model two. Consequently, the coefficients for both the interaction term and predictor variable became significant. This indicates a clear moderation effect of market structure on the relationship between capital adequacy and the operational efficiency of banks in Kenya.

The results imply the following. First, in markets dominated by a few large banks, the relationship between capital adequacy and operational efficiency might be positive. Large banks have economies of scale that allow them to maintain operational efficiency without necessarily having high levels of capital adequacy. Moreover, in less competitive environments, banks may prioritize other strategies, such as market power or risk-taking, over operational efficiency (Tabak et al., 2012).

Atuahene et al., (2021), concurs with our findings and indicates that market structure through regulatory framework influences the relationship between capital adequacy and operational efficiency. Stringent capital requirements may force banks to allocate more resources to capital, potentially limiting investments in efficiency-improving initiatives. Conversely, lax regulations might allow banks to operate with lower capital buffers but may not necessarily translate into improved operational efficiency.

The results are further consistent with the findings of Chen (2020), indicating that the moderation effect of market structure informs regulatory decisions, such as capital adequacy requirements and antitrust measures, as well as strategic decisions within individual banks regarding resource allocation and competitive positioning, which influence the operation efficiency of banks.

4.4.2 Moderation Effect of Market Structure on Relationship between Asset Quality and Operational Efficiency

The findings presented illustrate the implementation of a hierarchical multiple regression approach to examine the moderating influence of market structure on the association between asset quality and operational efficiency.

The results delineated in Table 4.11 pertain to Model 2, which incorporates market structure alongside an interaction term to scrutinize the moderating influence of market dynamics. The findings indicate that the regression coefficient associated with the interactive term, along with asset quality, lacks statistical significance (0.144). Furthermore, the inclusion of the moderating variable in Model 2 did not yield a change in direction. These outcomes unequivocally suggest that market structure does

not exert a moderating impact on the relationship between asset quality and the operational efficiency of banks in Kenya.

The findings concur with Mwali et al., (2025) indicates that market power had a negative and significant moderating effect on the relationship between bank-specific characteristics (bank size, capital adequacy, liquidity, and asset quality) and profitability of commercial banks in Kenya. Wanjagi et al., (2025) further indicates that market structure does not exert a moderating impact on the relationship between asset quality and the operational efficiency of banks in Kenya.

The absence of no moderation effect implies the following regarding the banks in Kenya. First, if there is no moderation effect of market structure on the relationship between asset quality and operational efficiency, it suggests that regardless of whether the market is highly competitive or less competitive, banks with better asset quality still tend to be more operationally efficient.

Secondly, the lack of a moderation effect could be that operational efficiency and asset quality are largely determined by internal factors within banks, such as management practices, risk management strategies, and operational processes (Saeidi et al.,2019). Alternatively, it could be that the effects of market structure on bank performance operate through different channels that are not directly related to asset quality and operational efficiency.

4.4.3 Moderation Effect of Market Structure on Relationship between Earnings Quality and Operational Efficiency

The outcomes delineated exemplify the implementation of a hierarchical multiple regression methodology aimed at scrutinizing the moderating impact of market structure on the nexus between a bank's earnings quality and operational efficiency.

The results shown in Table 4.11 indicate that when the moderating variable was incorporated, there was a significant alteration in the association between the independent variable (earnings quality). Notably, the coefficient changed from (coefficient=0.000348) being positive to negative (-0.000637) model. Consequently,

the predictor variable, the moderator variable, and the interaction term coefficients became statistically significant in the model. This suggests a distinct moderating influence of market structure on the connection between earnings quality and banks' operational efficiency in Kenya.

The results concur with findings by Dechow and Schrand (2004), which indicate earnings quality has a positive significant effect on operational efficiency of banks. According to the researchers in competitive markets, banks are under greater scrutiny from regulators, investors, and the public. Therefore, there's increased pressure on them to maintain high standards of transparency and financial reporting, which can further enhance the quality of earnings.

The results imply the following in relation to the banks in Kenya. In a competitive market with multiple banks, where there are relatively low barriers to entry, banks are incentivized to differentiate themselves from competitors. One way to differentiate is by providing high-quality earnings reports that accurately reflect the bank's financial health (Schaeck and Čihák, 2010). Within such markets, investors and depositors enjoy a wider range of choices and can easily switch between banks based on their perception of financial stability and performance. Furthermore, when banks operate in such competitive environments, they are motivated to improve their operational efficiency to maintain profitability and attract capital. High-quality earnings reports can contribute to this by enhancing transparency and investor confidence, reducing the cost of capital for banks, and allowing them to allocate resources more efficiently.

Generally, the positive moderation effect of market structure on the relationship between earnings quality and operational efficiency of banks suggests that in competitive markets, where there's more pressure to compete and differentiate, banks are likely to place greater emphasis on both earnings quality and operational efficiency, leading to overall better performance and stability in the banking sector.

4.4.4 Moderation Effect of Market Structure on Relationship between Bank Liquidity and Operational Efficiency

The findings presented illustrate the application of a hierarchical multiple regression method to examine the moderating influence of market structure on the association between a bank's liquidity and operational efficiency.

The results in Table 4.11 indicate that when the moderating variable was introduced, it significantly altered the relationship between the independent variable (bank liquidity). Specifically, the coefficient of the independent variable shifted from (Coefficient=-0.049249) negative in the first model to positive (Coefficient=0.003854) in the introduction of the moderating variable. Consequently, the coefficients of the predictor variable, the moderator variable, and the interaction term became statistically significant in the both models (P=0.014). This suggests that the market structure has a distinct moderating effect on the relationship between bank liquidity and operational efficiency.

The findings concur with Musyoki and Kallui (2026), research on the relationship between liquidity and operational efficiency of commercial banks in Kenya. The findings indicated that bank liquidity has a positive significant effect on operational efficiency of commercial banks in Kenya. Moreover, Abuga et al. (2023) research on liquidity capacity and financial performance of commercial banks in Kenya, indicated that net stable funding and liquidity coverage exert a positive impact on the financial performance of commercial banks in Kenya.

Table 4.12: Results Summarized of Hypothesis Testing

Hypothesis Formulated	Coefficient	P-values	Decision
H_{01}: Capital adequacy has no significant effect on the operational efficiency of banks in Kenya	0.040226	0.005	Rejected
H_{02}: Asset quality has no significant effect on the operational efficiency of banks in Kenya	0.019019	0.003	Accepted
H_{03}: Earning quality has no significant effect on the operational efficiency of banks in Kenya	0.000147	0.008	Rejected
H_{04}: Liquidity has no significant effect on the operational efficiency of banks in Kenya	-0.004548	0.007	Accepted
Model 2: Moderation effect			
H_{05a}: Market share has no significant moderating effect on capital adequacy and operational efficiency of commercial banks in Kenya	-0.101283	0.028	Rejected
H_{05b}: Market share has no significant moderating effect on asset quality and operational efficiency of commercial banks in Kenya	0.087415	0.017	Accepted
H_{05c}: Market share has no significant moderating effect on earnings quality and operational efficiency of commercial banks in Kenya	0.000348	0.00	Rejected
H_{05d}: Market share has no significant moderating effect on liquidity and operational efficiency of commercial banks in Kenya	-0.049249	0.017	Rejected

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The primary objective of this study was to assess the influence of capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency within the banking sector of Kenya. Additionally, the research aimed to investigate the potential moderating effect of market structure on the relationship between these determinants and operational efficiency. This chapter provides a comprehensive overview of the research findings in alignment with the specified objectives. The conclusions and recommendations derived from the study are articulated herein, informed by the acquired results. Finally, the research concludes by highlighting avenues for future exploration in this domain.

Capital adequacy, referring to the sufficiency of a bank's capital to cover potential losses, is essential for maintaining stability and mitigating risks. Asset quality, encompassing the composition and performance of a bank's loan portfolio and other assets, reflects its ability to generate sustainable earnings. Earnings quality, on the other hand, evaluates the reliability and sustainability of a bank's earnings stream, which is vital for long-term viability. Additionally, liquidity, which evaluates the ability of a bank to pay for liabilities in the period of maturity

Understanding how these factors interplay in the context of the Kenyan banking sector is imperative for stakeholders, policymakers, and researchers alike. The study's exploration of potential moderating effects of market structure adds further depth to the analysis, considering the broader industry dynamics and competitive forces at play.

The comprehensive overview of research findings provided in this chapter offers valuable insights into the nuanced relationships between these determinants and operational efficiency. By synthesizing empirical evidence and drawing meaningful conclusions, the study contributes to the body of knowledge in banking research and informs strategic decision-making within the sector. Moreover, the implications and

recommendations derived from the study can serve as practical guidance for banks, regulators, and investors seeking to enhance efficiency and sustainability in the Kenyan banking landscape. Lastly, by identifying avenues for future research, the study paves the way for continued exploration and refinement of our understanding of the intricate dynamics shaping the banking sector's performance and resilience.

5.2 Summary of Findings

The primary scope of inquiry pertained to the commercial banking sector within the confines of Kenya. The principal objective of this investigation was to scrutinize the influence of capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency within Kenya's banking landscape. Moreover, the study endeavored to explore the potential moderating impact of market structure on the nexus between these variables and operational efficiency.

The study sought to answer the following hypothesis:

H_{01}: Capital adequacy has no significant effect on the operational efficiency of banks in Kenya

H_{02}: Asset quality has no significant effect on the operational efficiency of banks in Kenya

H_{03}: Earning quality has no significant effect on the operational efficiency of banks in Kenya

H_{04}: Liquidity has no significant effect on the operational efficiency of banks in Kenya

H_{05}: Market structure has no significant moderating effect on capital adequacy, asset quality, earnings quality, liquidity, and operational efficiency of commercial banks in Kenya.

5.2.1 Operational Efficiency

The operational efficiency scores were derived employing the Stochastic Frontier Analysis (SFA) model, specifically estimated as a Translog cost function. Within this analytical framework, input variables encompassed loans and other assets associated with earnings quality. Conversely, output variables comprised labor, quantified as personnel expenses divided by total assets, capital, measured by operating expenses minus personnel expenses divided by fixed assets, and deposits, assessed as total interest expenses divided by total funding. Therefore, the application of the SFA model allowed for a comprehensive evaluation of operational efficiency by considering both input and output factors.

The findings on the operational efficiency of banks in Kenya indicated a consistent improvement over the years. Appendix III illustrates the efficiency of the respective banks. Descriptive statistics in Table 4.2 indicates scores rising from 72.7 percent in 2008 to 83.7 percent in 2022. This suggests that banks have become more effective in managing their operations and resources, possibly due to factors such as technological advancements, streamlined processes, improved risk management, or organizational enhancements. Consequently, the upward trend reflects the adaptability of banks to changes in the financial landscape and their efforts to remain competitive. Thus, increasing operational efficiency scores signified positive developments for the banking sector, indicating enhanced capability in addressing challenges and delivering value to customers and stakeholders. Upon establishing operational efficiency, the researcher advanced to the subsequent phase of analysis. This phase entailed evaluating the influence of capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency.

5.2.2 Effect of Capital Adequacy on Operational Efficiency

The initial null hypothesis(H_{01}) examined the relationship between capital adequacy and operational efficiency. Here, we conducted an empirical investigation to examine the hypothesis that there exists no significant effect of capital adequacy on operating efficiency.

To achieve this objective, the panel GMM model was estimated. The panel GMM analysis revealed a strong positive link between capital adequacy and operational efficiency, with significance at 1%, 5%, and 10% levels. Specifically, higher capital adequacy contributed to a 4.02 % increase in the operational efficiency of banks in Kenya. The implication drawn from the findings indicates that adequate capitalization enables banks to absorb losses, improve processes, and deliver better services while managing risks effectively. Well-capitalized banks can expand lending, reduce borrowing costs, and pursue growth opportunities, fostering operational efficiency and long-term sustainability. This underscores the importance of maintaining optimal capital levels for enhancing operational efficiency and the overall performance of banks in Kenya.

The conclusions drawn and the rationale provided regarding the positive impact of capital adequacy on the operational efficiency of banks in Kenya agree with the research findings of Odekina (2019), Ogboi and Unuafe (2013), Khalifaturofi'ah (2023), and Ayadi et al. (2016). However, these findings diverge from the perspectives put forth by Pradhan and Shrestha (2017), as well as Siddik and Kabiraj (2019), who contend that metrics such as loan loss provision to total loan, core capital ratio, risk-weighted ratio, and total capital ratio exert a negative influence on the financial performance of commercial banks.

5.2.3 Effect of Asset Quality and Operational Efficiency

The second null hypothesis(H_{02}) examined the relationship between asset quality and operational efficiency. The researcher conducted an empirical investigation to examine the hypothesis that there exists no significant effect of asset quality on operating efficiency. The findings from the panel GMM analysis revealed a significant positive link between asset quality and operational efficiency in Kenya's banking sector, with significance levels at 1%, 5%, and 10%. A unit improvement in asset quality corresponds to a 1.9% boost in operational efficiency. The positive correlation stems from various factors. Firstly, superior asset quality signifies fewer non-performing loans (NPLs), leading to reduced costs in credit risk management and provisions, thus enhancing operational efficiency. Secondly, high-quality asset portfolios require fewer

resources for managing non-performing loans, resulting in cost savings and improved efficiency. Thirdly, strong asset quality leads to higher interest income, lower provisioning expenses, and increased profitability, allowing for investments in technology and talent to further enhance operational efficiency. Furthermore, banks with robust asset quality boast healthier balance sheets, enhancing capital adequacy ratios and investor confidence, which in turn support operational efficiency.

The research findings highlighting a significant positive correlation between asset quality and operational efficiency within Kenya's banking sector, along with their substantiation, resonate with previous scholarly works such as those authored by Ali, Shuib, & Nor (2021), Bruno et al. (2015), Ahamed (2017), Piskorski, Seru, and Witkin (2015), and Duffie (2018). These studies underscore the critical importance of maintaining high asset quality as a fundamental driver for banks to achieve operational efficiency, profitability, and sustainable growth. Through adept management of credit risk and the cultivation of a robust asset portfolio, financial institutions stand to realize a multitude of beneficial outcomes that significantly enhance their overall operational efficiency and long-term viability.

5.2.4 Effect of Earning Quality and Operational Efficiency

The relationship between operational efficiency and earnings quality was investigated in the third null hypothesis (H_{03}). To test the hypothesis that earnings quality has no significant impact on operating efficiency, the researcher carried out an empirical analysis. At the 1%, 5%, and 10% significance levels, the panel GMM analysis showed an important positive correlation between Kenyan banks' earning quality and operational efficiency. A one-unit increase in earnings quality corresponded to a 0.01 percent enhancement in operational efficiency. This finding is supported by several reasons: First, higher earning quality implies stable and predictable income, facilitating effective operational planning and resource allocation. Secondly, the banks with high earning quality are better at managing risks such as credit, market, and operational risks, enabling informed decision-making and loss mitigation. Thirdly, consistent earnings signal financial stability and management prudence, attracting investor confidence and potentially improving stock price and access to capital. Fourthly,

reliable financial performance enhances customer trust and loyalty, leading to increased deposits and revenue generation. Generally, the findings showed that prioritizing earning quality enhances operational efficiency by promoting stability, risk management, investor confidence, cost efficiency, regulatory compliance, customer trust, and competitive advantage among banks in Kenya.

The results indicating a notable positive relationship between the financial performance of banks and their operational effectiveness in Kenya, along with the reasoning provided, align with earlier research, including works by Sharma (2016), Ekwe (2013), Omoregie et al. (2019), and Mäntymaa (2013). These studies collectively underscore the critical importance of earning quality in augmenting the operational efficiency of commercial banks. This is achieved through a multifaceted approach encompassing the promotion of stability, effective risk management, cultivation of investor confidence, enhancement of cost efficiency, adherence to regulatory requirements, establishment of customer trust, and attainment of competitive advantage.

5.2.5 Effect of Bank Liquidity on Operational Efficiency

The fourth null hypothesis(H_{04}) examined the relationship between liquidity and operational efficiency. The researcher conducted an empirical investigation to examine the hypothesis that there exists no significant effect of liquidity on operating efficiency. The panel GMM analysis revealed a significant inverse correlation between bank liquidity and operational effectiveness at 1%, 5%, and 10% levels. Each incremental increase in liquidity results in a 0.5% reduction in the efficiency of banks in Kenya. This indicates that the influence of liquidity on operational efficiency is still quite low. This indicates that liquidity of a bank is not critical in determining the operational efficiency of a bank.

The findings are consistent with Odunga and Nyangweso (2020) found that liquidity proxy by interbank ratio was insignificant in explaining operational efficiency. Moreover, Sufian and Habibullah (2014) found out that bank liquidity, proxied by a

ratio of loans to total assets, consistently exhibited a negative relationship with bank efficiency levels.

According to Matunda et al. (2024), research on liquidity management and financial performance of commercial banks in Kenya, results indicate an increase in capital adequacy increases return on assets, while a rise in non-performing loans negatively impacts ROA. Thus effective liquidity management is essential in optimizing financial performance, particularly in balancing liquid assets to meet regulatory requirements and operational demands.

5.2.6 The Moderating Effect of Market Structure on the Relationship between Capital Adequacy, Earnings Quality, Asset Quality, Bank Liquidity, and Operational Efficiency

The investigation employed a hierarchical multiple regression methodology to explore the potential moderating impact of market structure on the correlations between capital adequacy, earnings quality, asset quality, liquidity, and operational efficiency. The examination of the moderating effect was conducted independently for each of the aforementioned factors.

The findings indicated that market structure played a moderate effect on the relationship between capital adequacy and the operational efficiency of banks in Kenya. These findings implied that in markets dominated by a few large banks, the link between capital adequacy and efficiency may weaken or become negative. Large banks might maintain efficiency through economies of scale rather than high capital adequacy. Regulatory frameworks can also influence this relationship, with stringent requirements potentially limiting efficiency investments. Conversely, relaxed regulations may allow lower capital buffers without efficiency gains. These results align with prior research, suggesting that regulatory and strategic decisions can influence bank efficiency through market structure moderation (Tabak et al.,2012; Atuahene et al.,2021; and Chen, 2020).

These findings indicated that market structure has no moderating influence on the relationship between asset quality and operational efficiency in Kenyan banks. This suggests two key points. Firstly, regardless of market competitiveness, banks with higher asset quality are consistently more operationally efficient. Secondly, the absence of moderation may indicate that internal factors like management practices and risk strategies primarily determine operational efficiency and asset quality. Alternatively, it suggests that market structure impacts bank performance through channels unrelated to asset quality and operational efficiency. The findings are consistent with the findings of Saeidi et al., (2019).

The study found that market structure plays a crucial role in influencing the link between earnings quality and operational efficiency among banks in Kenya. In competitive markets with multiple banks and low entry barriers, there's a strong incentive for banks to distinguish themselves through high-quality earnings reports, reflecting their financial health accurately. This is vital as customers have more choices and can switch banks based on perceived stability and performance. In such environments, banks are driven to enhance operational efficiency to stay profitable and attract capital. Transparent and accurate earnings reports reduce the cost of capital, bolster investor confidence, and aid efficient resource allocation. Moreover, in competitive markets, banks face heightened scrutiny from regulators, investors, and the public, compelling them to maintain high standards of transparency and financial reporting, thus improving earnings quality. Thus, the findings are consistent with previous studies such as Schaeck and Čihák (2010) and Dechow and Schrand (2004).

The study found that market structure moderates the link between bank liquidity and banks' efficiency in Kenya. In a competitive market, banks are compelled to enhance efficiency to remain competitive, prompting different strategies to adopt efficient practices for market share and profitability. Market dynamics also drive innovation and adaptation to customer needs. Moreover, market concentration affects resource accessibility and risk management approaches. A well-regulated, competitive market encourages banks to improve operational efficiency through sound risk management. Therefore, market competition fosters efficiency improvements in Kenyan banks,

influenced by factors like competition, innovation, regulation, resource allocation, and risk management (Chan et al., 2015; Barry et al., 2011).

5.3 Conclusion from the Findings of the Study

Based on the investigation conducted within the commercial banking sector in Kenya, the study aimed to scrutinize the impact of capital adequacy, asset quality, earnings quality, and liquidity on operational efficiency. Additionally, it explored the potential moderating effect of market structure on these relationships. The hypotheses formulated for this study was: H_{01}: Capital adequacy has no significant effect on the operational efficiency of banks in Kenya. H_{02}: Asset quality has no significant effect on the operational efficiency of banks in Kenya. H_{03}: Earning quality has no significant effect on the operational efficiency of banks in Kenya. H_{04}: Bank Liquidity has no significant effect on the operational efficiency of banks in Kenya. H_{05}: Market structure has no significant moderating effect on the relationship between capital adequacy, asset quality, earnings quality, bank liquidity, and operational efficiency of commercial banks in Kenya.

To address these objectives, the study conducted a two-stage analysis. The first stage involved determining operational efficiency scores, while the second stage focused on assessing the influence of the aforementioned variables on operational efficiency.

In summary, the two-stage analysis conducted in this study provided valuable insights into the operational efficiency of the observed units and the factors influencing it. By systematically examining operational efficiency scores and assessing the impact of various variables, significant findings were obtained, contributing to both theoretical understanding and practical applications.

The conclusions drawn from the findings are discussed below per each of the hypotheses. By structuring the conclusions according to each hypothesis tested, readers can easily grasp the specific insights gained from the study and understand how they contribute to the broader research objectives.

5.3.1 Conclusion on Effect of Capital Adequacy on Operational Efficiency

Based on the empirical investigation utilizing the panel GMM model, the initial null hypothesis regarding the relationship between capital adequacy and operational efficiency (H_{01}) was thoroughly examined. The findings decisively reject the notion of no significant effect, revealing a robust positive link between capital adequacy and operational efficiency in the banking sector of Kenya. This positive relationship, evidenced by significant coefficients at various levels, underscores the crucial role of adequate capitalization in enhancing operational efficiency.

Specifically, the analysis indicates that higher financial leverage leads to a substantial increase in operational efficiency, with a notable 4.02% improvement observed in Kenyan banks. This finding emphasizes the pivotal importance of maintaining optimal capital levels, as it enables banks to not only absorb losses effectively but also to enhance their processes and service delivery while managing risks prudently. The implications drawn from these findings highlight that well-capitalized banks possess the capacity to expand lending, lower borrowing costs, and pursue growth opportunities, thereby fostering long-term operational efficiency and sustainability within the banking sector of Kenya.

In summary, the empirical evidence presented in this objective underscores the critical importance of maintaining optimal capital levels for enhancing operational efficiency and overall performance within the banking sector of Kenya. These findings not only contribute to the existing body of knowledge but also offer valuable insights for policymakers, practitioners, and stakeholders seeking to promote a sound and sustainable banking environment.

5.3.2 Conclusion based on Effect of Asset Quality on Operational Efficiency

The empirical investigation undertaken to examine the second null hypothesis (H_{02}) regarding the relationship between asset quality and operational efficiency in Kenya's banking sector has yielded compelling findings. Contrary to the hypothesis of no significant effect, the panel GMM analysis reveals a strong positive link between asset

quality and operational efficiency, with significance levels observed at 1%, 5%, and 10%.

The study elucidates that a unit improvement in asset quality corresponds to a notable 1.9% increase in operational efficiency. This positive correlation is underpinned by several key factors. Firstly, superior asset quality, characterized by fewer non-performing loans (NPLs), results in reduced costs associated with credit risk management and provisions, thereby enhancing operational efficiency. Secondly, high-quality asset portfolios necessitate fewer resources for managing non-performing loans, leading to cost savings and improved efficiency. Thirdly, robust asset quality translates into higher interest income, lower provisioning expenses, and increased profitability, enabling investments in technology and talent that further bolster operational efficiency.

Moreover, banks with strong asset quality enjoy healthier balance sheets, which in turn enhance capital adequacy ratios and investor confidence, thereby reinforcing operational efficiency. These findings not only highlight the intrinsic link between asset quality and operational efficiency but also underscore the critical role that adept management of credit risk plays in fostering a sustainable banking environment.

Generally, the empirical evidence presented for this objective underscores the paramount importance of robust asset quality in enhancing operational efficiency within Kenya's banking sector. These findings not only contribute to the existing body of knowledge but also offer actionable insights for policymakers, practitioners, and stakeholders seeking to promote sound risk management practices and foster a resilient and efficient banking landscape.

5.3.3 Conclusion based on Effect of Earning Quality on Operational Efficiency

The examination of the third null hypothesis (H_{03}) pertaining to the relationship between earnings quality and operational efficiency within Kenya's banking sector has yielded insightful findings. Contrary to the hypothesis positing no significant effect, the panel GMM analysis unveils a significant positive correlation between banks'

earnings quality and operational efficiency, with significance levels observed at 1%, 5%, and 10%.

The study elucidates that a one-unit increase in earnings quality corresponds to a notable 0.01% enhancement in operational efficiency. This positive relationship is underpinned by several key factors. Firstly, higher earnings quality fosters stability and predictability in income, facilitating effective operational planning and resource allocation. Secondly, banks with high earnings quality demonstrate superior capabilities in managing various risks such as credit, market, and operational risks, enabling informed decision-making and effective loss mitigation strategies.

Furthermore, the consistency in earnings signals financial stability and management prudence, thereby attracting investor confidence and potentially improving stock prices and access to capital. Additionally, reliable financial performance enhances customer trust and loyalty, leading to increased deposits and revenue generation, thereby contributing to operational efficiency.

Therefore, the findings underscore the significance of prioritizing earnings quality as a strategic imperative for enhancing operational efficiency among banks in Kenya. This is achieved through the promotion of stability, effective risk management, cultivation of investor confidence, enhancement of cost efficiency, adherence to regulatory requirements, establishment of customer trust, and attainment of competitive advantage.

5.3.4 Conclusion based on Effect of Bank Liquidity and Operational Efficiency

The examination of the fourth null hypothesis (H_{04}) regarding the relationship between liquidity and operational efficiency within Kenya's banking sector has produced significant insights. Contrary to the hypothesis proposing no significant effect, the panel GMM analysis reveals a notable inverse correlation between bank liquidity and operational effectiveness, with significance levels observed at 1%, 5%, and 10%. The study indicates that each incremental increase in liquidity results in a 4.9% reduction

in the efficiency of banks in Kenya. This indicates that liquidity of a bank is not critical in determining operational efficiency of banks.

5.3.5 The Moderating Effect of Market Structure on the Relationship between Capital Adequacy, Earnings Quality, Asset Quality, Bank Liquidity, and Operational Efficiency

The investigation employed a hierarchical multiple regression methodology to explore the potential moderating impact of market structure on the correlations between capital adequacy, earnings quality, asset quality, liquidity, and operational efficiency within Kenya's banking sector. The examination of the moderating effect was conducted independently for each of the aforementioned factors, yielding insightful findings that shed light on the intricate interplay between these variables and market dynamics.

Firstly, the findings indicated that market structure plays a moderation effect on the relationship between capital adequacy and operational efficiency of banks in Kenya. In markets dominated by a few large banks, the link between capital adequacy and efficiency may weaken or become negative, suggesting that large banks may maintain efficiency through economies of scale rather than high capital adequacy. Regulatory frameworks also influence this relationship, with stringent requirements potentially limiting efficiency investments, while relaxed regulations may allow lower capital buffers without efficiency gains. These results align with prior research, suggesting that regulatory and strategic decisions can influence bank efficiency through market structure moderation.

Secondly, the study found that market structure has no moderating influence on the relationship between asset quality and operational efficiency in Kenyan banks. This suggests that banks with higher asset quality are consistently more operationally efficient regardless of market competitiveness. The absence of moderation may indicate that internal factors like management practices and risk strategies primarily determine operational efficiency and asset quality, or that market structure impacts bank performance through channels unrelated to these variables. These findings are consistent with previous studies.

Thirdly, market structure was found to play a crucial role in influencing the link between earnings quality and operational efficiency among banks in Kenya. In competitive markets with multiple banks and low entry barriers, there is a strong incentive for banks to distinguish themselves through high-quality earnings reports, reflecting their financial health accurately. Transparent and accurate earnings reports reduce the cost of capital, bolster investor confidence, and aid efficient resource allocation. Moreover, in competitive markets, banks face heightened scrutiny from regulators, investors, and the public, compelling them to maintain high standards of transparency and financial reporting, thus improving earnings quality.

Lastly, the study found that market structure moderates the link between liquidity and banks' efficiency in Kenya. In a competitive market, banks are compelled to enhance efficiency to remain competitive, prompting different strategies to adopt efficient practices for market share and profitability. Market dynamics also drive innovation and adaptation to customer needs. Moreover, market concentration affects resource accessibility and risk management approaches. A well-regulated, competitive market encourages banks to improve operational efficiency through sound risk management.

Overall, the findings underscore the intricate relationship between market structure and various determinants of operational efficiency within Kenya's banking sector. These insights contribute to a deeper understanding of how market dynamics shape the performance and strategic decisions of banks, with implications for regulatory frameworks, corporate governance practices, and competition policies.

5.4 Policy Recommendation on Effect of Capital Adequacy, Asset Quality, Earnings Quality, Liquidity and Operational Efficiency of Banks

The study findings add body of knowledge to literature on the banking sector in Kenya. The study identified relationship between capital adequacy, asset quality, earnings quality and liquidity of banks in Kenya. The Stochastic Frontier Analysis model indicates that the higher the operational efficiency the more stable a financial institution. Bank stability is important since other sectors rely on them for their stability. The study attempted to provide a suitable model which Central bank of

Kenya may use in reviewing operational efficiency of banks. This will assist bank managers reduce risk exposure. Bank managers need to pay close attention to the variables that lead to an increase in operational efficiency for the respective banks.

5.4.1 Policy Recommendation on Moderation Effect of Market Structure on Capital Adequacy, Asset Quality, Earnings Quality, Liquidity and Operational Efficiency of Banks

In light of the findings that market structure moderates the relationship between certain factors (capital adequacy, earnings quality, liquidity) and the operational efficiency of Kenyan banks, but does not moderate the relationship between asset quality and operational efficiency, the following policy recommendations can be made:

First, there is need for promotion of financial inclusion. It is recommended that the banks should encourage initiatives to promote financial inclusion and access to banking services, particularly in underserved or remote areas. By expanding the customer base and diversifying sources of revenue, banks can enhance their operational efficiency and adapt to different market structures, thus mitigating the potential adverse effects of concentrated markets.

Secondly, there is a need for enhanced market transparency. It is recommended that banks should promote transparency in market operations and financial reporting to facilitate informed decision-making by investors, regulators, and other stakeholders. Greater transparency can improve market efficiency, reduce information asymmetries, and enhance market discipline, thereby fostering a more competitive and resilient banking sector.

5.5 Contributions of the Study

5.5.1 Contribution to Theory and Practice

The results obtained from this study make significant contributions to the field of financing theory and practice in multiple aspects. The study's findings, specifically the examination of hypothesis (H_{01}), provide support for the utilization of the hierarchical

structure of financing proposed in the pecking order theory (Myers & Majluff, 1984). According to the pecking order theory, companies prefer to finance their investments using internal funds generated from operations, such as retained earnings. This is because internal financing does not involve any information asymmetry issues or signaling problems. If internal financing is insufficient to fund investment opportunities, companies may then turn to debt financing. Debt is considered a less preferred source of financing compared to internal funds because taking on debt can signal that a company's future cash flows may not be sufficient to cover its obligations. Equity financing, such as issuing new shares, is considered the least preferred option according to the pecking order theory. This is because issuing new equity can signal to investors that management believes the company's stock is overvalued, leading to a negative impact on the stock price. The pecking order theory is based on the idea that managers have better information about the company's financial condition and future prospects than outside investors. As a result, they prefer to use internal funds first to avoid sending negative signals to the market. However, if internal funds are insufficient, they may resort to external financing, starting with debt and then equity if necessary.

Banks acquire financial resources through the issuance of share capital and the accumulation of deposits from their members. This position aligns with the theoretical framework of social capital as proposed by Lin (1982). Moreover, according to the pecking order theory, interest-bearing liabilities (specifically debt finance) played a relatively minor role in the overall capital adequacy compared to other sources of finance.

Additionally, by emphasizing how the choice of financial instruments can successfully inculcate financial discipline within banks, this work significantly advances agency theory. Because a sizable amount of debt financing is included in the capital adequacy, banks must be cautious about how they manage their operational costs and compensation to reduce the possibility of a hostile takeover. As a result, banks' behavior is determined by how much they refrain from doing business which could result in agency issues.

According to the pecking order principle, businesses choose internal funding over external funding. For banks, this can include depending less on issuing fresh equity and more on debt and retained earnings. By prioritizing internal funds and debt financing, banks are incentivized to manage their resources more efficiently and prudently.

Including a significant proportion of debt financing within a bank's capital structure is often a regulatory requirement for ensuring capital adequacy. This requirement encourages banks to manage their risk exposures more effectively, as excessive risk-taking could lead to financial distress and potentially a hostile takeover. This aligns with the goals of agency theory, which emphasizes the need for managers to act in the best interests of shareholders and creditors. Generally, the pecking order theory, when applied to banks, can contribute to financial discipline and risk management, which are essential components of agency theory. By prioritizing internal funds and debt financing, banks can align their interests with those of stakeholders and mitigate the risk of agency problems, ultimately enhancing their overall governance and performance.

5.5.2 Managerial Policy and Practices Contribution

The implications of the study's findings hold significance for various stakeholders, encompassing banks, investors, managers, government entities, and members associated with the respective banks.

First, the stakeholders—banks, investors, managers, government entities, and members associated with the respective banks—would all have vested interests in the findings. For banks, the findings could impact their risk management strategies and capital allocation decisions. Investors would be interested in understanding how these findings affect the performance and stability of the banks they invest in. Government entities may use the findings to inform regulatory policies and oversight practices.

Secondly, the study underscores the importance of the findings as a financial risk factor. This suggests that the insights gained could be crucial for assessing and

mitigating risks within the banking sector. Banks, regulators, and investors alike would need to take these findings into account when evaluating risk profiles and making investment decisions.

The findings also have managerial implications, particularly in terms of investment diversification and capital adequacy optimization strategies. Bank managers would need to consider how best to allocate capital across various assets to achieve both diversification and adequate levels of capitalization. This could involve reassessing investment portfolios and capital allocation frameworks.

The study highlights the role of contextual variables in the correlation between capital adequacy and operational efficiency. This suggests that there may be specific contextual factors that influence how effectively banks can deploy capital to optimize operational performance. Understanding these variables could be crucial for developing tailored strategies to enhance operational efficiency.

Lastly, the implications of the study's findings are far-reaching and extend beyond academic interest to practical implications for stakeholders across the banking and regulatory landscape. Utilizing these insights effectively could lead to more informed decision-making and potentially contribute to a more stable and efficient financial system.

5.6 Areas of Further Study

The primary objective of this study was to examine the unilateral association between capital adequacy, asset quality, earnings quality, liquidity, and operational efficiency. However, it would be beneficial to explore the significance of the bilateral relationship between the factors and further examine the applicability of the proposed methodology in studying operational efficiency and other related factors in cross-country comparisons. This would allow for a more rigorous evaluation of our findings. This will also facilitate the evaluation of how various economic and institutional characteristics can influence decisions regarding operational efficiency, and subsequently, how these decisions can impact firm performance.

While the study highlights the positive relationship between capital adequacy, financial leverage, and operational efficiency, there may be additional factors influencing this dynamic. Future research could explore other variables, such as technological innovations, management practices, or market conditions, to provide a more comprehensive understanding of the determinants of operational efficiency in the banking industry.

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APPENDICES

Appendix I: Descriptive Statistics of Operational Efficiency by Bank

Bank	Mean	SD	Min	Max	Skewness	Kurtosis
ABC Bank	0.8355	0.0353	0.7721	0.8836	-0.4681	2.1582
Bank of Africa	0.8165	0.0758	0.5705	0.8826	-2.4726	8.6441
Bank of Baroda	0.7958	0.1092	0.4586	0.9338	-1.9063	7.3183
Bank of India	0.7991	0.0275	0.7429	0.8698	0.5913	4.8179
Barclays	0.8411	0.0452	0.7731	0.9720	1.3478	6.0041
CITIBANK	0.7732	0.0391	0.6903	0.8332	-0.2982	2.5981
Commercial Bank	0.8075	0.0368	0.7285	0.8708	-0.3211	2.7974
Consolidated Ban	0.8275	0.0299	0.7536	0.8678	-1.2848	3.8964
Cooperative Bank	0.7819	0.1188	0.5258	0.8725	-1.0912	2.5498
Credit Bank	0.7443	0.0835	0.5944	0.8364	-0.5069	1.7587
DTB	0.8112	0.0403	0.7287	0.8691	-0.9531	2.9504
Development Bank	0.8119	0.0954	0.4850	0.8842	-2.8961	10.6064
ECB_SPIRE	0.7966	0.0502	0.7073	0.8660	-0.4763	1.9217
ECOBANK	0.8257	0.0257	0.7703	0.8569	-0.7200	2.6460
Equity	0.8626	0.0181	0.8300	0.8949	-0.0676	2.7179
Family Bank	0.8538	0.0243	0.8041	0.8958	-0.2625	3.1083
First Community	0.7877	0.0428	0.7166	0.8616	0.0110	2.3299
GT Bank	0.8509	0.0381	0.7690	0.9372	-0.1203	4.1565
Giro Bank	0.8174	0.0334	0.7489	0.8785	-0.1997	2.6228
Guardian Bank	0.8577	0.0397	0.7770	0.9158	-0.1538	2.3336
Gulf African Ban	0.8204	0.0770	0.6616	0.8910	-1.3208	3.7466
Habib AG Zurich	0.7692	0.0417	0.6904	0.8404	-0.0235	2.2646
Habib Bank ltd	0.6467	0.1697	0.2777	0.9052	-0.9853	3.1200
Housing Finance	0.7985	0.1771	0.1961	0.8918	-3.0910	11.1020
I&M Bank	0.8174	0.0425	0.7119	0.8729	-1.0611	3.7188
Jamii Bora Bank	0.8456	0.0731	0.6650	0.9312	-1.5414	4.4540
KCB	0.8484	0.0206	0.8034	0.8729	-0.8730	2.9058
KWFT	0.8564	0.0186	0.8432	0.8695	0.0000	1.0000
MOriental Bank	0.7988	0.0574	0.6593	0.8687	-1.2732	3.9892
Middle East Bank	0.8338	0.0349	0.7592	0.8758	-0.9725	3.0242
NBK	0.7870	0.2011	0.0784	0.8998	-3.1882	11.8320
NIC Bank	0.8227	0.0248	0.7675	0.8554	-0.9962	3.0346
Paramount Univer	0.8581	0.0207	0.8248	0.9090	0.9283	4.1307
Prime Bank	0.8404	0.0369	0.7508	0.9035	-0.7629	3.7874
SIDIAN	0.7669	0.2964	0.0351	0.9522	-2.0881	5.4945
Stanbic	0.7800	0.0591	0.6626	0.8420	-0.9172	2.5497
Stanchart	0.7707	0.1381	0.2854	0.8578	-3.1591	11.7166
Transnational Ba	0.8419	0.0145	0.8139	0.8643	-0.2561	2.5099
UBA Kenya Bank	0.8927	0.0276	0.8465	0.9313	-0.2674	2.1607
Victoria Commerce	0.7860	0.0523	0.6697	0.8706	-0.6795	3.5648
Total	**0.8092**	**0.0965**	**0.0351**	**0.9720**	**-4.3511**	**29.6293**

Appendix II: Summary Statistics of Dependent, Independent, and Moderating Variables by Bank

Bank	**Variable**	**Mean**	**SD**	**Min**	**Max**
ABC Bank	Operational efficiency	.7818408	.0360102	.7235388	.8379114
	Earnings Quality	2.387632	.5008969	1.847107	3.573806
	Market Structure	.642	.0592698	.55	.74
	Capital Adequacy	.164225	.0348572	.1127609	.2125914
	Asset Quality	.0462677	.0403452	.0069643	.1364688
	Liquidity	.7265394	.1466694	.5477571	1.030534
Bank of Africa	Operational efficiency	.6985054	.0531309	.6230309	.776662
	Earnings Quality	2.613287	.8862386	1.618529	5.172855
	Market Structure	2.809333	.1291965	2.6	3
	Capital Adequacy	.1320915	.0218847	.1006548	.1759691
	Asset Quality	.0356406	.0498927	0	.1573491
	Liquidity	.8140654	.1087334	.6604651	1.086957
Bank of Baroda	Operational efficiency	.776919	.0626182	.6876066	.91234
	Earnings Quality	2.017533	.3156156	1.497959	2.896015
	Market Structure	1.215333	.2426226	.9	1.85
	Capital Adequacy	.2345892	.075306	.0182292	.3311871
	Asset Quality	.0320001	.0324117	.002774	.1267232
	Liquidity	.5152591	.0936966	.2674798	.6480263
Bank of India	Operational efficiency	7742289	.031075	.7179531	.8420986
	Earnings Quality	2.307214	.5565002	1.818966	3.874531
	Market Structure	10.102	2.737369	6.8	14.63
	Capital Adequacy	.3701062	.0596577	.251537	.45421
	Asset Quality	.0125171	.0111656	.0006773	.0365478
	Liquidity	.429441	.0617102	.3053628	.518732
Barclays	Operational efficiency	.7974774	.0472812	.7646483	.951318
	Earnings Quality	1.766862	.1355531	1.608466	2.063005
	Market Structure	6.190667	.5693036	5.3	7.12
	Capital Adequacy	.1680817	.044512	.1215686	.2654206
	Asset Quality	.8331078	3.121477	0	12.11613
	Liquidity	.7821835	.2265971	.0007448	.9908257
CITIBANK	Operational efficiency	.7346486	.027742	.6885046	.7851453
	Earnings Quality	2.095981	.2358328	1.629113	2.515232
	Market Structure	2.694	.3847078	2.12	3.3
	Capital Adequacy	.2716024	.0714414	.1545871	.4101942
	Asset Quality	.0106048	.0127571	0	.0383172

	Liquidity	.4799604	.0622097	.3823913	.6147309
Commercial Bank of Africa	Operational efficiency	.7540005	.0301544	.7048124	.8196588
	Earnings Quality	2.436114	.4788726	1.716707	3.573858
	Market Structure	3.3	2.184949	0	5.8
	Capital Adequacy	.1411843	.0330365	.1140496	.2470901
	Asset Quality	.0190598	.014261	.0050241	.0479378
	Liquidity	.5362059	.1126872	.2876397	.6506024
Consolidated Bank	Operational efficiency	.7913059	.0319431	.7207296	.8375773
	Earnings Quality	2.787934	.6904666	2.001942	4.525064
	Market Structure	8.310667	.423004	7.62	8.97
	Capital Adequacy	.1362228	.0723723	.0587328	.3056708
	Asset Quality	.1034793	.0567262	.046066	.2659033
	Liquidity	.9521116	.1962863	.7377443	1.531083
Cooperative Bank	Operational efficiency	.805336	.0235476	.7635346	.851773
	Earnings Quality	2.037765	.3086309	1.431973	2.684521
	Market Structure	.3626667	.057179	.26	.45
	Capital Adequacy	.1513012	.0399638	.0655274	.2198953
	Asset Quality	.0666333	.1208418	0	.3736018
	Liquidity	.8562145	.1150333	.7086614	1.095588
Credit Bank	Operational efficiency	.6935183	.0638789	.5942149	.7734776
	Earnings Quality	1.941682	.4956314	1.264988	2.66364
	Market Structure	4.4	.8305459	3.1	5.7
	Capital Adequacy	.2586644	.0610511	.1500971	.36768
	Asset Quality	.0724877	.0426462	.0257125	.1469298
	Liquidity	.7057217	.1030507	.5299245	.8845737
DTB	Operational efficiency	.7598479	.0367179	.6883917	.8187709
	Earnings Quality	2.051155	.2388682	1.764102	2.499318
	Market Structure	1.465333	.1625628	1.2	1.72
	Capital Adequacy	.1596103	.0205866	.1113987	.1948837
	Asset Quality	.0028209	.0033888	0	.0094383
	Liquidity	.828296	.0616391	.7308404	.9552239
Development Bank	Operational efficiency	.7637854	.0964644	.4473829	.841328
	Earnings Quality	2.898656	1.195136	1.505494	5.72988
	Market Structure	10.988	2.475536	7	14.57
	Capital Adequacy	.3689111	.2123199	.2088035	.9156862
	Asset Quality	.1016915	.0524868	.0384765	.2459436
	Liquidity	1.021555	.2018549	.7772627	1.409556
ECB_SPIRE	Operational efficiency	.7560761	.0538049	.67912	.8626304
	Earnings Quality	2.760607	1.184336	1.601399	6.018127

	Market Structure	1.6	.1961269	1.3	1.95
	Capital Adequacy	.16466	.0703873	.057316	.2983139
	Asset Quality	.0710066	.0409232	.0098738	.1328372
	Liquidity	.7263691	.1320821	.5707943	.9738346
ECOBANK	Operational efficiency	.7785265	.0236519	.7284704	.8164042
	Earnings Quality	9.154395	19.05474	2.300493	77.5047
	Market Structure	.5	.0319502	.45	.55
	Capital Adequacy	.195459	.0366759	.1426606	.2740637
	Asset Quality	.1345852	.1099419	.0130059	.2921172
	Liquidity	.7937408	.0832708	.5857143	.8956522
Equity	Operational efficiency	.8123892	.0204664	.7703865	.8528008
	Earnings Quality	2.4092	1.761144	1.660969	8.699058
	Market Structure	13.29467	.4396367	12.71	14.41
	Capital Adequacy	.2120829	.0879262	.1384277	.458194
	Asset Quality	.0250567	.0150744	0	.0630633
	Liquidity	.823042	.1316881	.5655265	.9811321
Family Bank	Operational efficiency	8064736	.0251579	.7595852	.8545502
	Earnings Quality	1.879645	.195631	1.608487	2.23327
	Market Structure	.4606667	.0067194	.45	.47
	Capital Adequacy	.1704058	.0388846	.1075352	.2332813
	Asset Quality	.0329486	.0132667	.0144046	.0690297
	Liquidity	.8403932	.1391657	.6855346	1.261792
First Community Bank	Operational efficiency	.7600126	.0331923	.7232079	.8264095
	Earnings Quality	1.624407	.0638275	1.486403	1.706289
	Market Structure	4.3	.8305459	3	5.6
	Capital Adequacy	.2397696	.135751	.1037594	.4608738
	Asset Quality	.1005836	.0767866	.0006702	.2408498
	Liquidity	.5581857	.2527052	.1820401	.9370078
GT Bank	Operational efficiency	.7995554	.0406278	.7303392	.9056194
	Earnings Quality	2.263684	.4151672	1.713137	3.495375
	Market Structure	3.5	1.086084	1.8	5.2
	Capital Adequacy	.1926706	.0628947	.1230956	.3210716
	Asset Quality	.0357973	.0261113	.0046011	.1013049
	Liquidity	.58997	.1594935	.093617	.8023952
Giro Bank	Operational efficiency	.7607607	.0323866	.702484	.8280517
	Earnings Quality	306.6076	802.7473	2.116468	2389.544
	Market Structure	2.713333	1.708411	0	4.1
	Capital Adequacy	.2095083	.048056	.1398413	.281649
	Asset Quality	.0581245	.0673737	.0007629	.194901
	Liquidity	.6565529	.0722412	.5306926	.7923977

Guardian Bank	Operational efficiency	.80741	.0515319	.714275	.8809912
	Earnings Quality	2.484873	.4299525	1.908942	3.550067
	Market Structure	1.822	.2046235	1.5	2.13
	Capital Adequacy	.2045827	.0340458	.1631155	.2633421
	Asset Quality	.0880552	.0879127	0	.2418257
	Liquidity	.8675583	.1081401	.7421353	1.094294
Gulf African Bank	Operational efficiency	.7798424	.0702404	.6488537	.8515448
	Earnings Quality	1.220654	.6090864	.0751919	2
	Market Structure	7.25	1.054153	5.6	8.9
	Capital Adequacy	.7342729	.8922492	.131142	2.547527
	Asset Quality	.0433114	.0310332	0	.1054891
	Liquidity	.7681744	.260709	.5377058	1.625
Habib AG Zurich	Operational efficiency	.718611	.0342459	.6670021	.7804853
	Earnings Quality	1.944772	1.039782	1.046795	5.631822
	Market Structure	.3846667	.1041366	.24	.55
	Capital Adequacy	.3253819	.1071717	.0456495	.5566612
	Asset Quality	.0111886	.0113173	.0002169	.0311524
	Liquidity	.3597261	.0768457	.2108437	.5276219
Habib Bank ltd	Operational efficiency	.6353622	.1163777	.4149669	.8636242
	Earnings Quality	1.593211	.088759	1.462812	1.755049
	Market Structure	.2173333	.1162731	.04	.4
	Capital Adequacy	.4418186	.106519	.3115	.6389657
	Asset Quality	.0318404	.0305158	.000335	.0825085
	Liquidity	.8272013	1.281974	.2803592	5.276072
Housing Finance	Operational efficiency	.7542892	.1234927	.3640836	.8444065
	Earnings Quality	2.035984	.3408196	1.512707	2.739421
	Market Structure	.55	.0638813	.45	.65
	Capital Adequacy	.1777848	.0847961	.1047395	.4051783
	Asset Quality	.1173388	.1015522	.0368449	.3222222
	Liquidity	1.280018	.1049108	1.062264	1.463917
I&M Bank	Operational efficiency	.7691184	.0377575	.6869571	.8269256
	Earnings Quality	2.079948	.225495	1.733872	2.676852
	Market Structure	.33	.2789009	0	.55
	Capital Adequacy	.1586455	.0253616	.109548	.2041699
	Asset Quality	.0265113	.0222083	.0025971	.0681492
	Liquidity	.8202736	.116647	.5338195	.9673629
Jamii Bora Bank	Operational efficiency	.8097355	.0590372	.6902957	.9064203
	Earnings Quality	2.083634	.7740572	1.288889	3.771338
	Market Structure	.426	.1399696	.2	.63

	Capital Adequacy	.681039	.3141446	.153941	1.101719
	Asset Quality	.1828116	.160157	.0154622	.5416667
	Liquidity	1.82379	1.357614	.7383819	4.753425
KCB	Operational efficiency	.796234	.016796	.7677326	.8251929
	Earnings Quality	1.893393	.2264193	1.634483	2.464396
	Market Structure	.3146667	.0278056	.24	.35
	Capital Adequacy	.1696607	.0293647	.1229828	.2315789
	Asset Quality	.0439075	.042472	0	.1736112
	Liquidity	2.29276	5.829452	.5735099	23.36031
KWFT	Operational efficiency	.8383236	.0038768	.8355823	.8410649
	Earnings Quality	1.251035	.1688907	.9880582	1.517488
	Market Structure	.7336667	.0447325	.65	.8
	Capital Adequacy	.1533551	.03848	.0896027	.2067158
	Asset Quality	.1030361	.0614449	.0129109	.2403904
	Liquidity	1.162351	.4153626	.8617364	2.128205
MOriental Bank	Operational efficiency	.7324528	.0650598	.566748	.8100947
	Earnings Quality	10.31602	21.91395	1.887535	89
	Market Structure	.3026667	.06573	.2	.41
	Capital Adequacy	.4217075	.1306525	.245148	.7137216
	Asset Quality	.1060981	.1191043	.0078321	.442388
	Liquidity	1.330828	.7915809	.7628736	3.467909
Middle East Bank	Operational efficiency	.7713594	.0349526	.7056897	.820709
	Earnings Quality	2.652537	.751573	1.837696	4.011464
	Market Structure	.552	.1322802	.35	.79
	Capital Adequacy	.3485017	.0874603	.220063	.5163457
	Asset Quality	.1024927	.0815916	.0005902	.231877
	Liquidity	.7905402	.126571	.5299245	1.004679
NBK	Operational efficiency	.7692759	.0213377	.7297407	.8067025
	Earnings Quality	1.934683	.241828	1.563052	2.397609
	Market Structure	.4526667	.1255724	0	.5
	Capital Adequacy	.2106577	.1251333	.0454072	.4079971
	Asset Quality	.086966	.081393	.0103524	.3017493
	Liquidity	.8217745	.5816171	.3148688	2.022388
NIC Bank	Operational efficiency	.7692759	.0213377	.7297407	.8067025
	Earnings Quality	1.924459	.4117565	1.3125	2.622186
	Market Structure	.375	.0479221	.3	.45
	Capital Adequacy	.1585267	.0303458	.1329821	.2594386
	Asset Quality	.0241645	.0249695	.0012944	.0896911
	Liquidity	.9139833	.0636028	.7963801	1.037383

Paramount Universal Bank	Operational efficiency	.8048466	.0724422	.5737067	.8717238
	Earnings Quality	3.001135	1.677753	1.38253	6.592591
	Market Structure	.25	0	.25	.25
	Capital Adequacy	.2486702	.0801971	.1596002	.4163142
	Asset Quality	.0691968	.0661196	.0102041	.23761
	Liquidity	.9648204	.2995854	.5997977	1.336432
Prime Bank	Operational efficiency	.7928539	.0347739	.7373081	.8656453
	Earnings Quality	2.65652	.5396476	2.181033	4.015691
	Market Structure	.3666667	.0408248	.3	.43
	Capital Adequacy	.1656568	.0189298	.1300064	.2004272
	Asset Quality	.0295166	.0313109	.0017347	.0948263
	Liquidity	.6300121	.0884682	.5073268	.7866927
SIDIAN	Operational efficiency	.7084743	.2419873	.1572011	.9497822
	Earnings Quality	74.23529	105.2083	1.638679	308.9958
	Market Structure	.2193333	.0067194	.21	.23
	Capital Adequacy	.2695137	.2135903	.000786	.8166519
	Asset Quality	.2796056	.8522259	.0134977	3.357143
	Liquidity	1.540113	1.135589	.0279005	4.33633
Stanbic	Operational efficiency	.7599868	.0367662	.6880397	.7956078
	Earnings Quality	2.29238	.4211348	1.683799	3.226852
	Market Structure	.2046667	.0094041	.19	.22
	Capital Adequacy	.1305528	.0507197	.044963	.2010715
	Asset Quality	.0153341	.0105042	.0024786	.0348961
	Liquidity	.7289086	.167395	.5419847	1.198649
Stanchart	Operational efficiency	.7418413	.0355833	.6482159	.7948899
	Earnings Quality	1.816595	.1312142	1.60396	2.085834
	Market Structure	.1706667	.0458984	.1	.25
	Capital Adequacy	.1561961	.0183197	.1226087	.1830853
	Asset Quality	.0270049	.0189896	.0026134	.0580829
	Liquidity	.6583703	.1627803	.3547794	1.006944
TransNational Bank	Operational efficiency	.7825249	.0152628	.752247	.8062113
	Earnings Quality	10.58826	20.48327	1.687936	73.6
	Market Structure	.16	.1011608	0	.3
	Capital Adequacy	.4696252	.1998962	.1973771	.7051163
	Asset Quality	.0701957	.0406233	.012558	.1564569
	Liquidity	1.057818	.46047	.6926612	2.307955
UBA Kenya Bank	Operational efficiency	.8534799	.0394454	.7889138	.9048003
	Earnings Quality	3.782414	4.09581	.1587403	17.22865
	Market Structure	1.35	.2874881	.9	1.8

	Capital Adequacy	.6959727	.6002202	.0216773	2.703925
	Asset Quality	.0076397	.0124668	0	.031479
	Liquidity	.4516099	.2535782	0	.940308
Victoria Commercial Bank	Operational efficiency	.7416775	.0428972	.6574349	.8213174
	Earnings Quality	2.265422	.2247752	1.849257	2.650943
	Market Structure	.425	.0798532	.3	.55
	Capital Adequacy	.2332972	.0367378	.1816226	.3153846
	Asset Quality	.0044296	.0142372	0	.0549828
	Liquidity	.745153	.1299873	.5419804	.9745223

Appendix III: Stochastic Frontier Model Estimation

Inefficiency effects model (truncated-normal) — Number of obs = 511
Group variable: id — Number of groups = 40
Time variable: year — Obs per group: min = 2
avg = 12.8
max = 14

Prob > chi2 = 0.0000
Log likelihood = -201.6785 — Wald chi2(5) = 8144.70

Ln_TC	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
Frontier						
Ln_TL	.6328639	.0185661	34.09	0.000	.596475	.6692529
Ln_EA	.2862596	.018604	15.39	0.000	.2497965	.3227227
Labor	6.088923	.6468928	9.41	0.000	4.821036	7.356809
Capital	.8265781	.1338909	6.17	0.000	.5641569	1.088999
Deposits	.2378211	.0723906	3.29	0.001	.0959381	.3797041
_cons	-.5888781	.1721777	-3.42	0.001	-.9263402	-.2514159
Mu						
_cons	-108.9722	97.89763	-1.11	0.266	-300.848	82.90365
Usigma						
_cons	3.245472	.8946176	3.63	0.000	1.492054	4.99889
Vsigma						
_cons	-2.587347	.083249	-31.08	0.000	-2.750512	-2.424182
sigma_u	5.066935	2.266485	2.24	0.025	2.108606	12.17574
sigma_v	.2742615	.011416	24.02	0.000	.2527749	.2975745
lambda	18.47483	2.266856	8.15	0.000	14.03187	22.91779