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"Effects of Non-Performing Loans on Technical Efficiency of Commercial Banks in Kenya"

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Abstract:*This study analyzes the effects of non-performing loans (Np-Loans) on technical efficiency in the Kenyan commercial banks. The study points to establish the technical efficiency scores of banking performance in Kenya and also determine the effect of NP-loans on bank efficiency in Kenya. The technical efficiency scores were evaluated using the Data envelopment analysis approach while the Tobit regression model is used to determine the effect of NP-Loans on bank efficiency. The results show that commercial banks in Kenya operate with some inefficiency. Tier 1 banks operate at 95.4 percent, tier 2 banks at 97.9 and tier 3 banks 97.9 Percent. The Tobit regression results indicate that non-performing loans have negative and statistically significant effect on Kenyan commercial banks.*

Keywords: *Data envelopment Analysis (DEA), Commercial banks, Technical efficiency, Non-performing loans*

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I. Introduction

Banks are financial institutions that are authorized to accept deposits and provide loans. Their performance should be rigorously monitored to protect a country's interests. They are economic growth drivers since they give financial services to citizens. Bank profitability translates to financial stability, which leads to economic affluence and stability. Studies by Nichols et al. (2019) found out that the banking industry is recognized worldwide as a sector that drives economic growth. They perform the following functions; accepting deposits from the general public, taking deposits in the form of current deposits, fixed deposits and savings. They also provide loans and advances to entrepreneurs and business entities primarily to make profits, provide credit cash. When banks provide loans or cash, they provide it in liquid cash, that's by opening and transferring money to customers' accounts. In the process, they create money, provide facilities whereby selling and buying of securities take place, and finally, have locker facilities where customers store valuables and documents. The general characteristics of banks are lending and borrowing, that is, the transfer of funds from areas of surplus units to areas of deficit.

Banks take a lion share in the financial intermediation role; they significantly contribute to the investment-resource mobilization. Loan assets dominate commercial banks' inversible assets, accounting for approximately 55% to 75% of total assets. They expose banks to significant credit risks, and credit risk determines financial institution performance. The greater a bank's exposure to credit risk, the more likely it is that the bank will face financial difficulties (Al-Wesabi & Ahmad, 2013).Banks are in trouble with non-performing loans. Loans become non-performing loans when they have more than 90 days and repay the principal amount and interest have not been made. Originally NP-Loans may seem not to harm banks as banks remain liquid, assuring depositors in the system over time (Njue, 2020). When banks are allowed to accumulate interest on NPloans, then the scope of this problem expands.

NPloans impact the feasibility and constancy of the banking sphere. They impact negatively on the pecuniary intermediation purpose of banks, which directly impacts the main income-generating channel of banks. The impact is passed to the financial dependability of the general economy (Alshebmi, et al., 2020). They have an adverse and direct effect on the profit gain due to deliveries banks are required to record; therefore, they affect the production performance of commercial banks (Ezeoha, 2011). Financial distress and poor bank in an economy are solely associated with erratic changes in levels of loans that are deemed as non-performing (Otwori, 2013).Non-performing loans put less pressure on the revenue of effective banks as it does not drive them into making uncertain credit offerings, but unproductive banks fall to problems due NP-Loans. The rise in non-performing loans is a sign of a lack of credible credit policy (Muluwork, 2016). Incompetent management will suggest poor control on the creditworthiness of clients' and operating costs, accompanied by large credit loss. The bad administration hypothesis states that managers with poor skills cannot effectively estimate and regulate risks when lending to new customers (Njihia, 2005).

1.1 Commercial Banks in Kenya

There are 42 commercial banking institutions in Kenya, some being locally owned while others are foreign. They are grouped into tiers; a bank is classified under a certain tier using the weighted composed index, which comprises net assets, clientele capital, deposits and reserves, number of loaned accounts and number of deposit accounts. A banking institution with a 5 percent or more weighted composed index is classified into a tier 1 bank.The large bank whose weighted composed index lies between 1 and 5 percent is a tier 2 bank (medium bank), and one whose index is less than 1 percent is classified into tier 3 (small bank).

The Kenyan banking sector has experienced numerous changes, with 28 mergers in the 1990s, 10 in the 2000s, 3 in the 2010s. Besides, there are 12 acquisitions in the 2000s, 6 in the 2010s. After the implementation of financial amendments in 1992, the banking sphere underwent significant policy and operational changes. Consolidations occurred in all banking sector spheres, including tier 1, tier 2, and tier 3. Banks' profitability, asset quality, efficiency, and capitalization were expected to improve due to the consolidation. The amendments were also expected to trigger the creation of strong banks that compete with lots of effectiveness among themselves, leading to lower costs of products and services offered to customers.

Due to competition, innovations, and product diversification for different market segments due to technological advancement, the sector has experienced monumental expansion within the east-African region. Since there is increased utilization of information and communication technologies in the banking industry, improved services' delivery and effected customer care services have been improved. With intensive use of ATMs, some banks have branch interconnections that enable branchless banking and E-banking. It is evident from reduced queues in banking facilities (CBK, 2018).

The banking sector contributes 7.7% to Kenya's gross domestic product providing over 1.5 million employment opportunities (Bloom et al., 2018). Over the study period, commercial banks increased the number of customer deposits, profitability, and loan books. However, the number of banks has not changed significantly, with 43 commercial banks in 2013 and 42 in 2019. (CBK 2019). Several banks have been placed in receivership throughout the period, including Dubai Bank on 14 August 2015, Imperior Bank Limited on 13 October 2015, and Chase Bank Limited on 7 April 2014.

Despite the growth and improvement in profitability, commercial banks continue to post declining Returns on Assets (ROA). The pretax profit grew by 16.6% in 2013 from 2012. Over the period, the returns on assets were 4.7% (CBK, 2013). In 2014, pretax profit grew by 12.2% to Ksh. 141.1 billion from 125.8 billion in 2013.ROA declined to 4.5% (CBK, 2014).in 2015 the sector registered a decline in both pretax and ROA. The pretax declined by 5.03% to Ksh 134 billion from 141 billion the previous year, and ROA declined to 4.0% (CBK, 2015). In 2016, commercial banks registered a 10.91% growth in pretax profit to Ksh 147.4 billion, and Returns on Assets remained at 4.0% (CBK, 2016). In 2017, pretax profit declined by 9.6% to Ksh 133.2 billion at the period ROA declined to 3.4% (CBK, 2017).in 2018, banks experienced a 14.64% growth in pretax profits to Ksh 157.7 billion and slight growth in ROA to 3.5% (CBK, 2018). In 2019, pretax profit increased by 4.2% to Ksh 159 billion, and ROA declined to 3.3% (CBK, 2019).

Customer deposits over the study period grew; the growth is anticipated to mobilize deposits through Mobile Money and agent banking platforms. In 2013, the stakes grew by 13.34% to Ksh 1.935 trillion from 2012. In 2014, they grew by 18.42% to stand at Ksh 2.681 trillion in 2016 (CBK, 2016). In 2017, they grew by 11% to Ksh 2.9 trillion; in 2018, they increased to Ksh 3.26 trillion, a 12.41% growth, and in 2019 they expanded to Ksh 3.53 trillion, an 8.26% growth (CBK, 2019).

In 2013, the net loans and advances for commercial banks stood at Ksh 1532.4 billion; a 12.75% increase grew to Ksh. 1.881 trillion in 2014. In 2015, the loans and advances stood at Ksh. 2.091 trillion representing a 11.02% growth (CBK, 2015). The following year (2016) grew to Ksh 2.182 trillion a 4.36% (CBK, 2016). In 2017, the loans declined by 5% to Ksh 2.16 trillion (CBK, 2017).in 2018, the loans and advances grew by 3.07% to Ksh 2.49 trillion, and in 2019 they grew by 8.8% to Ksh 2.707 trillion (CBK, 2019).

Despite the growth in pretax profits, Net loans and advances, and customer deposits, commercial banks' loan book quality has declined. The sector is characterized by a spread of high-interest rates, bank failures, high non-performing assets, and low lending rates. Over the study period, Non-Performing loans have been increasing. The non-performing loans condemn banks to risks of non-collection of funds advanced to borrowers.

In the first half of 2012, the high-interest rate negatively influenced loan and advance quality. The NP-loans grew by 16.8% in 2012 from the previous year (CBK, 2012). The proportion of gross non-performing loans to gross loans and advances hit 4.7 percent, up from 4.4 percent in 2011. (CBK, 2012). Non-performing loans increased to Ksh 81.9 billion in 2013, bringing the gross NPLs to gross loans ratio to 5.2 percent. Also, NPLs grew to Ksh 108 billion in 2014, making the ratio of non-performing loans to gross loans 5.6% (CBK, 2014). In 2015, NPLs grew to Ksh 147.3 billion, growing the proportion of NP-loans to gross loans to 6.8%. Due to the challenging business environment, delayed payments in the public and private sectors, and poor weather, the ratio of gross non-performing loans increased to 9.3 percent, putting NP-loans at Ksh. 214.3 billion (CBK, 2016). In 2017, non-performing loans grew by 23.4% to stand at Ksh 264.6 billion, increasing the NP-loan ratio to 12.3% (CBK, 2017).

In 2018, the challenging business environment and delayed payments grew NP-loans by 19.6% to Ksh 316.7 billion. During the same period, the gross NP-loans to gross loans ratio was 12.7 percent. In the following year, NP-loans increased by 6.3% to Ksh 335.9 billion, representing a 12.5% gross NP-loan ratio to gross loans, an improvement due to payment of pending bills and recovery efforts made by banks (CBK, 2019). To lessen the number of non-performing loans in 2013, theCredit Reference Bureau (CBK, 2013).

Evaluating the efficiency of banking institutions in Kenya will be necessary to shareholders, regulators and customers since efficiency refers to the employment of fewer resources whilst producing excellent results in terms of yield. Bank managers and supervisors will benefit from this study in scheduling resources adequately to maximize outputs. Non-performing loans are by-products of loans; therefore, the study will give managers insights into the adverse effects in the overall spheres of banks.

Past studies in Kenya inquired into the influence of bank-specific characteristics on the conduct and performance of financial organizations. They have considered factors such as ownership, loan loss provisioning, bank strategy, and capital, among others. Non-performing credit advances are items that impact a bank's growth and stability (Messai and Jouini, 2013). Despite the potential linkage of non-performing loans to banking efficiency (Barros et al., 2012), there is little research on this area compared to other sector spheres. This research tries to bridge the gap by:

- To determine the technical efficiency levels of commercial banks in Kenya.
- To ascertain the effects of the gross NP-loan ratio on the technical efficiency scores of commercial banking institutions in Kenya.

The remainder of the paper is organized as follows. Section 2 reviews relevant studies on the efficiency of banks and the effects of NP loans on the technical efficiency of banks. Section 3 gives the methodology utilized in the analysis. Section 4 and 5 will present the research findings and conclusions, policy implications, limitations and areas for future research, respectively.

II. Literature review

Following the financial liberalization of the 1990s, researchers shifted their focus to the efficiency of the finance world. The banking sphere has been the primary focus because it dominates the sector. Numerous studies have yielded inconclusive results. Hall et al. (2000) examined the technical efficiency of Hong Kong's banking institutions from 2000 to 2006. The slack-based measurement methodology was used in the study, and variables implying a profit approach were chosen. According to the study, Hong Kong banking institutions experienced a downswing in technical efficiency in the year 2001 but regained in the period up until 2006. This study is different from Hall et al. 's study as it uses DEA methodology and selects variables based on the intermediation approach. Between 1997 and 2001, Batchelor and Gerrard (2004) looked into how much technical efficiency and technological enhancements triggered production changes in three Singaporean commercial banking entities. MPI was used in the study on a data set that included labor, total deposits, total loans, and other investments. In terms of TFP, they discovered that the bank's performance improved by 11.7 percent. Technical efficiency remained constant over time. This study is different as it uses the DEA approach, and its variables are based on the intermediation role of banks. Becks and Fuchs (2004) examined productivity across banks in Kenya regarding ownership and compared the results with banks from other sub-Saharan African countries and emerging countries. The study found out that Kenya banks are overstaffed, and the employees are less productive. Secondly, state-owned banks have twice many employees, assets, loans and deposits as foreign-owned banks. The high performance of foreign-owned banks was a result of the high wages they paid. Private domestic banks were more staffed and less productive than foreign-owned banks, but they were more productive and less staffed than state-owned banks. The disparities across different banks concerning ownership reflect a significant potential gain from increased competition and improve efficiency. The current study employs variables other than Becks and Fuchs' no-interest expenses, interest expenses, equity capital, no-interest income, and interest income. Between 1995 and 2003, Reda and Isik (2006) utilized DEA and MPI to analyze the efficiency and productiveness of Egyptian banks. The study revealed that banking entities were inefficient regarding technology and that this inefficiency deteriorated with time. Data on labor, capital, loanable money, other earning assets, and off-balance-sheet entities are used in this study, which is unique. The influence of proprietorship structure and strict budget limitations on the efficiency of Chinese banking institutions were explored by Yao et al. (2007). Between 1995 and 2001, the SFA studied a dataset of 22 banks and discovered that privately-owned banks were 8 to 18 percent more efficacious than those that the state had greater intervention in. The current study's most noticeable difference is the employment of the output-oriented DEA technique. A study by Kamau (2009) employed the DEA technique to scrutinize the banking sphere's efficiency and productiveness following liberalization. Labor, capital and deposits formed the study's inputs. In contrast, loans and investments were used as outputs. The enquiry revealed that most banking entities performed fairly well, with the bulk of the scores lying below 40% during the study period. Furthermore, foreign banks outperformed domestic banks, and local private banks outperformed local public banks. The current study

differs in that it focuses on the role of banks in intermediation. Between 2012 and 2016, Henriques et al. (2018) evaluated the efficiency levels in the Brazilian banking entities. The study used the DEA technique and a 37-bank dataset to select variables using an intermediation approach. According to the study, the average efficiency of the system was 51.4 percent, which was influenced by technological and administrative concerns. The current study differs from the previous ones in that it pays attention to the role of banking entities in intermediation. Between 2001 and 2017, Kiemo and Kamau (2020) assessed the efficiency and competitiveness in the Kenyan banking industry. In evaluating efficiency, the study used DEA methodology, and data variables were selected to represent banks' production, intermediation and profit approaches. The study established that banks operated at 69% on average technical efficiency. The difference is that the current study will evaluate technical efficiency for each commercial bank category. Banks are not homogeneous in terms of NPLs (KBA,2020). Large banks' loan books are growing faster; therefore, even if loan defaulters increase, the effect is marginal compared to small and medium banks with a double-digit ratio of gross NPLs to gross loans (KBA, 2020).

Non-performing loans can have a great influence on the efficiency, stability and effectiveness of a bank. According to the preceding literature, there are numerous types of literature concerning bank efficiency using various approaches. However, previous studies in Kenya have either examined only commercial bank efficiency or other aspects of banks such as ownership, loan loss provisioning, bank strategy, capital, and their effects on bank performance. In Kenya, the effects of NP loans on bank technical efficiency are yet to be assessed.

III. Methodology

The paper adopts a two-stage analysis procedure in evaluating the performance of banks. In the first stage, data envelopment analysis will be used to estimate technical efficiency scores; in the second part, Tobit regression is employed to determine the effects of non-performing loan ratios on the efficiency of banks.

Data envelopment analysis (DEA) is a common mathematical linear programming approach. It utilizes input and output amounts as data for a group of decision-making units (DMUs) to create a pair-wise linear surface over datum (Coelli et al., 2005). The characteristics of the decision-making units guide the researcher in selecting either the constant returns to scale (CRS) DEA or the variables return to scale (VRS) DEA.DEA can be either output- or input-oriented. If the researcher assumes CRS, the two give similar results and different results if VRS is assumed. The characteristics of decision-making units also influence the choice of orientation.

Developing a frontier surface data envelopment analysis solves a series of linear programming problems that help establish the input or output function necessary for estimating the technical efficiency scores for decision-making units. The linear programming problem for establishing period s output distance function is given as:

$$\{d_0^s (y_{s,}\, x_s)\}^{-1} = \max_{\varphi} \lambda\gamma. \quad (1)$$

Subject to: $-\gamma y_{is} + Y_s\lambda \geq 0.$ (2)

$$x_{is} - X_s\lambda \geq 0. \quad (3)$$

$$I1'\lambda = 1. \quad (4)$$

$$\lambda \geq 0. \quad (5)$$

Where y_{is} is an M×1 output vector for the i^{th} firm in period s, x_{is} is an N×1 input vector at period s for the i_{th} firm. Y_s is a 1×M vector of output for all firms in period s. X_s is a 1×N vector of inputs for all firms at period s, λ is a 1×1 matrix of weights, γ is a scalar and $I1'\lambda = 1$ is a convexity condition provided for variable returns to scale (VRS).

The outcomes are based on the best firm within the sample under consideration. Including a sample of other firms from the global market may reduce domestic firms' efficiency scores (Coelli et al., 2005). The choice of a representative sample is important, it should be as representative as possible, and if possible, a population study is recommended (Zhung, 1998).

DEA has got advantages that make it appropriate for this study. It uses decision-making units rather than averages, producing single efficiency scores for each DMU (Kirigia, 2013). The ability to use input and output data in their natural units without normalizing them is an added advantage (Ogada et al., 2014). The flexibility enables the researcher to take care of exogeneous variables beyond control in the DMUs under consideration.

Considering a situation of n banks, each producing two outputs while using three inputs. The i^{th} bank uses x_{ki} units of the k^{th} inputs to produce y_{mi} units of the m^{th} output. For each of the banks, a separate linear programming program will be solved. Solving the linear programming problem yields the output-Oriented technical efficiency for the i^{th} bank in Tier 1:

Max φ_i. (6)

St: $\varphi_i y_{mi} - \sum_{j=1}^{n} \lambda j \text{ymj} \leq 0$ m = 1 & 2 outputs. (7)

$x_{ki} - \sum_{j=1}^{n} \lambda j$ xki ≥ 0 k = 1,2 & 3 inputs. (8)

$\sum_{j=1}^{n} \lambda j = 1.$ (9)

$\lambda j \geq 0$ j = 1, … n banks. (10)

Where φ_i represents the possible proportional increment in output, λj is the weight variable for deriving the possible linear combination of all banks in the study. When $\varphi_i = 1$thus $\lambda j = 0$, therefore, the i^{th} bank rests on the frontier thus, making it technically efficient. For inefficiency $\varphi_i \geq 1$ and $\lambda j \neq 0$. The technical efficient index in output-oriented DEA for the i^{th} bank is computed as:

$TE_i = \frac{1}{\varphi i}$. (11)

3.1 Selection of inputs and outputs

Researchers have not agreed on the bank inputs and outputs following the complexity of banking activities. However, several approaches to banking behavior can support the input-output specifications, such as intermediation, value-added, production, and user cost. The intermediation technique is used to define inputs as well as outputs in this research.

Table 1: Variables in the DEA Model: Description and Measurement

Variable		Variable Description and Measurement
Input variables	Non-interest expenses;	operating expenses of a bank that are classified separately from interest expenses, for example, salaries, allowances, rent cost of information technology (Ksh millions)
	Interest expenses;	the total of payments made on fixed deposits, savings deposits, and demand deposits (Ksh millions)
	Equity Capital;	The portion of bank capital which is raised in exchange for bank shares (Ksh millions)
Output Variables	Non-interest income	the sum of income to commercial bank from fees and activities not related to lending (Ksh millions)
	Interest income;	the amount received by banks for lending out money or other financial investment (Ksh millions)

Source: Literature review

3.2 Tobit regression

The results of equation 3's technical efficiency will be regressed against a number of predictor variables (x). The predictor variables will be obtained from past studies on efficiency in the banking industry. Because theoretical explanations of market-related or bank-specific characteristics that may affect efficiency are lacking; Karim et al. (2010), Garza-Garcia (2012), and Muda et al. (2013) suggested the use of non-performing loan ratio (NPL-R), the overhead cost to total assets (OHTA), the ratio of total loan total assets (LOTA), the natural logarithm of total assets (LOGTA), the ratio of equity to total assets (EQTA) and the ratio of non-interest income to total assets (NIE)

TE = f (NPL-R, OHTA, LOTA, LOGTA, EQTA, NIE). (12)

Where TE is technical efficiency estimated in equation 3, NPL is non-performing loans, OHTA is overhead to total assets, and LOTA is total loans over total assets. LOGTA is the natural logarithm of total assets, EQTA is the ratio of equity to total assets, and NIE is the ratio of non-interest income to total assets. Technical efficiency is a continuous variable with a range of zero to one; the Tobit regression model will be utilized to investigate the impact of NP loans on technical efficiency.

Table 2: Variables in the regression and Measurement

Variable	Variable Definition and Measuring
TE (Technical efficiency)	Refers to a bank's potential to optimize output, given several fixed inputs. (estimates from equation 11)
NPL Ratio	Is the proportion of total non-performing loans to total loaning
OHTA	The proportion of overhead costs to total assets
LOGTA	It is the proxy of bank size, given by the logarithm of total assets
LOTA	It is a proportion of total loaning to total assets that is a proxy for loan intensity.
EQTA	Represents a percentage of total shareholders' equity to total assets
NIE	Represents the ratio of non-interest income to total assets

Source: Literature review

3.3 Data and Analysis

The data set spans six years, from 2014 to 2019, and includes 26 Kenyan commercial banks, 9 in tier 1, 7 in tier 2 and 10 in tier 3. It will be derived from economic surveys, World Bank indicators, and the Annual Supervision Reports of the Central Bank of Kenya. The data will be analyzed using DEAP and EViews 8 software to produce technical efficiency scores and regression results, respectively.

IV. Discussion of results

This chapter presents the study's findings, whereby Section 4.1 gives the preliminary analysis of the data and the test results for the appropriateness of variables. Section 4.2 gives the technical efficiency indices for commercial banks whereas, section 4.3 gives the Tobit regression analysis results.

4.1 Description Statistics of Inputs and Outputs

Table 3 presents the mean and standard deviation of inputs and outs used to generate efficiency scores.

Tables 3: Mean and Standard Deviation of Inputs and Outputs (billions)

Variable	Mean	Standard deviation
Interest expenses	4.05	3.96
Non-interest expenses	7.2	8.52
Equity capital	19.9	22.8
Interest income	12.1	14.3
Non-interest income	3.81	5.24

Source: Own calculations

From Table 3 above, the mean for all inputs and outputs under the study is less than the standard deviation except interest expenses. The high standard deviation shows heterogeneity in scales of operations. This implies that commercial banks in Kenya have a higher heterogeneity since the variations are on both inputs and outputs. However, the heterogeneity will not pose any challenges in the estimations since DEA ignores scale differences among DMUs (Coelli et al., 2005).

Table 4 presents the Pearson's correlation coefficient between inputs and outputs used in the DEA model to estimate efficiency scores. The inputs are non-interest expenses, interest expenses, and equity capital and outputs are interest income and non-interest income.

Table 4: The Correlation Coefficient Between Inputs and Outputs.

	Interest expenses	Non-interest expenses	Equity capital	Interest income	Non-interest income
Interest expenses	1.000				
Non-interest expenses	0.8060	1.000			
Equity capital	0.8940	0.9347	1.000		
Interest income	0.9076	0.9602	0.9642	1.000	
Non-interest income	0.7619	0.9628	0/9269	0.9183	1.000

Source: Own Calculations

From Table 4, there exists a positive correlation between inputs and outputs. This implies that variables under consideration move in the same direction. That is, commercial banks employ more resources to increase their lending. Correlation can be used to show the appropriateness of variables (Avkiran, 1990); the high positive correlation implies that variables in the study are appropriate for estimating the technical efficiency of commercial banks. The findings collaborate with Kamau (2011) and Tesfay and Tesfay (2013); in their findings, there was a high correlation between inputs and outputs.

Section 4.2 presents the technical efficiency of commercial banks for each tier. Commercial Banks in Kenya are classified into tiers based on their market share.

4.2 Technical Efficiency

Following objective one, to evaluate the technical efficiency of commercial banks in Kenya. Table 5 presents the technical efficiency results for tier 1 commercial banks. The tier 1 bank is a commercial bank whose market share is greater than 5 percent.

Table 5: Technical Efficiency Indices for Tier 1 Commercial Banks.

Year	2014	2015	2016	2017	2018	2019
Equity bank	1.000	0.912	1.000	0.971	1.000	1.000
Cooperative bank	1.000	0.935	1.000	0.968	0.941	1.000
KCB	1.000	0.950	1.000	1.000	0.972	1.000
Absa	1.000	1.000	0.967	1.000	1.000	1.000
Standard Chartered bank	0.998	1.000	0.972	1.000	1.000	1.000
Diamond trust bank	0.983	1.000	1.000	1.000	1.000	0.970
Stanbic bank	0.900	1.000	1.000	0.952	1.000	0.860
NIC bank	1.000	1.000	0.916	1.000	1.000	0.790
I & M bank	1.000	1.000	1.000	1.000	1.000	0.924
Mean	**0.987**	**0.977**	**0.984**	**0.988**	**0.990**	**0.949**

Source: Own Calculations

Table 5 shows that technical efficiency for the year 2014 stood at 98.7%. It declined to 97.7% in 2015, corresponding with a 5.03% decline in pre-tax profits. The technical efficiency improved to 98.4% in 2016, 98.8% in 2017, and 99% in 2018 due to improved recovery efforts, safe lending, and pending bills. In 2019, the score dropped to 94.9 %. The drop is attributed to late payments and abolishment of interest rate cap that skewed lending.

On average, over the six years, tier 1 banks operated at a 95.4 percent efficiency level, reflecting that banks are inefficient since they haven't achieved a score of 1. Implies that the inputs (interest expenses, non-interest expenses and equity capital) can be reduced by 4.6 percent to achieve efficiency or increase outputs (interest income and non-interest income) by 4.6 percent without any additional input to achieve efficiency. Efficiency has improved over the six years, and this can be attributed to regulatory compliance. This corroborates the study by Kiemo and Kamau (2020), which established that the average efficiency score of the banking industry in Kenya was 69 percent. Indicating the industry could produce the same output with 31 percent few resources.

Table 6 presents technical efficiency scores for tier 2 commercial banks in Kenya. Tier 2 bank is a bank whose market share lies between 1 percent and 5 percent.

Table 6: Technical Efficiency Indices for Tier 2 Commercial Banks

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
National bank of Kenya	1.000	1.000	1.000	0.903	1.000	1.000
Family bank	0.902	1.000	1.000	0.848	1.000	1.000
Bank of Baroda	0.928	0.879	0.944	0.883	1.000	1.000
HFC limited	1.000	0.966	1.000	1.000	1.000	0.972
Prime bank	0.983	1.000	1.000	1.000	0.788	1.000
Eco bank	0.914	1.000	1.000	0.955	1.000	0.530
Bank of India	1.000	0.955	0.956	0.964	1.000	0.758
Mean	**0.961**	**0.971**	**0.993**	**0.936**	**0.970**	**0.894**

Source: Own Calculations

The results in Table 6 show that in the year 2014, technical efficiency stood at 96.1%. Efficiency improved consecutively in 2015 and 2016 to 97.1 and 99.3%, respectively. The improvement is attributed to policy compliance and safe lending with the introduction of the interest cap Act that skewed lending favouring government agencies. As a result of poor weather and political tension due to the general elections, technical efficiency declined to 93.6% in 2017. The improved recovery efforts and payment of pending bills increased efficiency to 97% in 2018. But it worsened in 2019 as it dropped to 89.4%, attributed to poor weather, abolishing the interest rate cap at the end of 2018 and late payments in both the public and private sectors.

On average, tier 2 commercial banks operate at 97.9 percent efficiency levels; this implies that the banks are inefficient. 2.1 percent of inputs are not reflected in the output. To achieve efficiency, inputs (interest expenses, non-interest expenses and equity capital) can be reduced by 2.1 percent or increase outputs (interest income and non-interest income) by 2.1 percent.

Table 7 presents the technical efficiency scores for tier 3 banks. Tier 3 bank is a commercial bank whose market share is less than 1 percent.

Table 7: Technical Efficiency Indices for Tier 3 Commercial Banks

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bank of Africa	1.000	1.000	1.000	1.000	1.000	1.000
Gulf African bank	0.971	0.910	0.792	1.000	1.000	1.000
African banking corporation	1.000	0.969	0.819	1.000	1.000	1.000
Sidian bank	1.000	1.000	1.000	0.959	0.991	1.000
First community bank	1.000	1.000	1.000	1.000	1.000	1.000
Guardian bank	1.000	0.953	1.000	0.972	1.000	1.000
Paramount universal	1.000	0.927	1.000	0.992	1.000	0.954
Credit bank	1.000	0.957	1.000	1.000	1.000	0.991
Uba Kenya bank	1.000	1.000	1.000	1.000	1.000	1.000
Consolidated bank	0.891	0.937	1.000	0.911	0.905	0.934
Mean	**0.986**	**0.965**	**0.961**	**0.983**	**0.990**	**0.988**

Source: Own calculation

From Table 7, in 2014, efficiency stood at 98.6%. This is attributed to proper customer review and selection resulting from the enactment of CRB in 2013. CRB helped small banks in their lending by providing

accurate information about clients. The efficiency dropped to 96.5% and 96.1% in 2015 and 2016, respectively. The drop is attributed to the contagious effect of putting Chase bank, Imperial Bank, and Dubai bank under receivership. After which, the banks experienced an improvement in technical efficiency of 96.3% in 2017 and 99% in 2018. The poor weather and Abolishment of the interest rate cap in 2018 led to a slight drop in efficiency to 98.8% in 2019.

Tier 3 banks operated at a 97.9 percent efficiency level on average over the study period. The banks were inefficient, implying that output (interest income and non-interest income) can be increased by 2.1 percent without any additional cost on inputs.

4.4 Tobit regression analysis

The study's second objective was to establish the effects of gross non-performing loans on the technical efficiency of commercial banks in Kenya. The study used the Tobit regression since the dependent variable is limited. The study used variance inflation factors (VIF) to examine the presence of multicollinearity problems. VIF is a test used to determine multicollinearity among explanatory variables in a regression model (Gujarati and Porters, 2009).

Table 8: The Variance Inflation Factors (VIF)

Variable	**VIF**	**1/VIF**
OHTA	3.46	0.2887
NIE	2.67	0.3742
LOGTA	1.40	0.7145
NPL-R	1.39	0.7185
LOTA	1.31	0.7659
EQTA	1.24	0.8076
Mean VIF	1.91	

Source: Own Calculations

From Table 8, the results indicate that the VIF values for the variables in the model lie between 3.46 and 1.24. This means the model does not have any multicollinearity issues since the values are all less than 10. The dependent variable is limited; in such cases, the normality assumption of residuals is often violated (Tobit, 1958). The study uses the skewness-kurtosis test of normality to test the normality of residuals.

Table 9: Skewness/Kurtosis test of Normality

Variable	**Pr (skewness)**	**Pr (kurtosis)**	**Adj Chi2(2)**	**Prob > chi2**
Residuals	0.3044	0.5087	1.53	0.4658

Source: Own Calculation

From Table 9, it is noted that the probability value for skewness and kurtosis are greater than 0.05. Therefore, we reject the null hypothesis and conclude there is no skewness and kurtosis. The overall probability is also 0.4658, which is also greater than 0.05. The residuals have a normal distribution. Since the residuals have a normal distribution and the explanatory variables are not suffering from multicollinearity. The Tobit regression applies to this data.

4.5 Regression results

Table 10: Tobit Regression Results for Commercial Banks

Dependent Variable: Technical Efficiency

Explanatory Variables	**Coefficient**	**Std Error**
Natural Logarithm of Total Assets	0.0016	0.0048
Total Loans to Total Assets	0.0003*	0.0002
Equity to Total Assets	0.0004	0.0007
Overhead Cost to Total Assets	0.0030**	0.0013
Gross Non-performing Loan Ratio	-0.0008***	0.0002
Non-Interest Income to Total Assets	-0.0018	0.0026
Constant	0.9467***	0.0396
Observations	97	97
***** p<0.01, ** p<0.05, * p<0.1**		

Source: Own calculation

The multiple regression was carried out to evaluate the relationship between technical efficiency and six explanatory variables.

TE = 0.9467 -0.0008 NPL-R + 0.0030 OHTA + 0.0003 LOTA + 0.0016 LOGTA + 0.0004 EQTA -0.0018 NIE + ε.

From Table 10 above, the Gross loans to total assets (LOTA) coefficient are positive and significant at 10%. This indicates a positive and significant relationship between loans and technical efficiency. The findings show that the higher efficiency of a commercial bank is reliable with the higher loan to total assets. Banks should have higher levels of liquidity to meet their daily obligations; highly liquidity ratio means better managerial efficiency (Boldbaatar, 2006).

Overhead cost to total assets (OHTA) coefficient is positive and significant at 5%. The finding is inconsistent with San et al. (2011) and Garza-Garcial (2012); in their findings increase in expenses other than interest rate related leads to a reduction in overall efficiency. The study finding is inconsistent with the theory. Overhead cost to the total asset is a management proxy; financial institutions prefer top managers with high quality and experience for their success. When banks have high operational costs to total assets, they are likely to be inefficient (Olweny, 2011).

The gross non-performing loans ratio (NPL-R) coefficient is negative and statistically significant at 1%. This implies that non-performing loan ratios have a negative effect on the technical efficiency of commercial banks in Kenya. The results are consistent with the findings of Karim et al. (2010) and Garza-Garcia (2012). In their findings, they established that NPL-R increases inefficiency in the banking sector. High inefficiency is a sign of poor performance by top management in day-to-day bank activities. Guy (2011) established that banks with poor administration with deplorable skills in monitoring borrowers, appraising collaterals and credit scoring is likely to accumulate non-performing loans. The healthiness of financial institutions against loss in value is subject to asset quality. Asset quality is subjective; therefore, a proxy ratio of non-performing loans to total loans is used.

The constant term is positive and significant at 1%. Holding all factors constant, the overall efficiency of a commercial bank is 94.67%. Additional, bank characteristics such as bank size, non-interest income to total assets and capital strengths of banks do not affect the efficiency of commercial banks since the coefficients are insignificant.

V. Summary, Conclusions andRecommendations

5.1 Summary

The banking industry is one of the sectors that shapes economic growth. Banks, as financial institutions, are authorized to accept deposits and provide credit. As such, their performance should be rigorously monitored in order to protect an economy's interest. Banks are the economic drivers of economic growth through the provision of financial services to economic agents. Banks' profitability translates to financial stability, which results in the economic affluence and stability of a nation.

In the financial sector, banks take the lion's share in the intermediation role. Banks greatly contribute to the mobilization of investible resources. Loan assets dominate commercial banks' investible assets, accounting for approximately 55 percent to 75 percent of total assets. They expose banks to significant credit risks, which determine the performance of financial institutions. The greater a bank is exposed to credit risk, the more likely it will face financial distress. Loans are deemed "non-performing" when it has been more than 90 days, and the repayment of the principal amount and interest amount has not been made. Banks are in distress with non-performing loans as these loans impact negatively on the pecuniary intermediation purpose of banks, which directly impact the main income-generating channel of banks.

The rise in non-performing loans is a sign of a lack of credible credit policy (Muluwork, 2016). Incompetent management will suggest poor control on the creditworthiness of clients and operating costs, which will be accompanied by large credit loss. The poor administration hypothesis argues that managers with poor and incompetent skills cannot effectively estimate and regulate risks when lending to new customers (Njihia, 2005).

Efficiency is a general indicator of performance. Banks are homogenous in operation, but some are more efficient than others. Those operating at the technological frontier earn high profits while others are barely able to survive. Efficiency enables banks to be more resilient to shocks, hence enhancing positive growth.

The Kenyan banking sector has experienced numerous changes, with 28 mergers in the 1990s, 10 in the 2000s, and 3 in the 2010s. Besides, there were 12 acquisitions in the 2000s and 6 in the 2010s. After 1992, the banking sphere underwent significant policy and operational changes. Consolidations occurred in all banking-sector spheres, including tier 1, tier 2, and tier 3 banks. Banks' profitability, asset quality, efficiency, and capitalization were expected to improve due to the consolidation. The amendments were also expected to trigger the creation of strong banks that compete with lots of effectiveness among themselves, leading to lower costs of products and services offered to customers.

Despite the growth in pretax profits, net loans and credit advances, and customer deposits, commercial banks' loan book quality has been declining. The sector is characterized by a spread of high interest rates, bank

failures, high non-performing assets, and low lending rates. Over this paper's study period, non-performing loans have been increasing. The non-performing loans condemn banks to risks of non-collection of funds advanced to borrowers.

The study evaluated the performance of commercial banks in terms of technical efficiency. The study also estimated the effects of gross non-performing loan ratios on the technical efficiency of commercial banks in Kenya. The output-oriented DEA was used to estimate the technical efficiency indices for commercial banks. Data Envelopment Analysis was perfect for the study as it does not require the predetermined production function. The study has multiple inputs and multiple outputs that needed to be worked out to obtain a single indicator per period per bank; therefore, DEA was applicable.

The dependent variable (technical efficiency) is limited. The second part was regressed against the logarithm of total assets, the overhead cost to total assets, total loans to total assets, gross non-performing loan ratios, shareholders equity to total assets, and non-interest income to total assets.

The banks in Kenya are classified based on ownership and further in terms of their market share; tier 1, tier 2 and tier 3. These categories of banks compete among each other, disadvantaging small banks whose share is less than 1 percent. The study considered this argument and evaluated the technical efficiency of banks in each category. Banks in tier one had an overall average efficiency of 95.4 percent over the study period, implying that the inputs can be reduced by 4.6 percent in order to achieve efficiency or increase outputs by 4.6 percent without any additional input to achieve efficiency. In 2018, the banks recorded a score of 99%, the highest, and over the six years, they recorded the lowest score in 2019, 94.9%.

Tier 2 operated at 97.9 percent and tier 3, 97.9 percent; this implies that the banks are inefficient. In both categories, 2.1 percent of inputs are not reflected in the output. To achieve efficiency inputs can be reduced by 2.1 percent or increase outputs by 2.1 percent. The efficiency fluctuated over the study period across the three groups. The fluctuations result from policy compliance and safe lending, poor weather, political tension, late payments in both the public and private sectors, and policy implementations in the banking sector. In tier 2 banks, the highest score was obtained in 2016 at 99.3% and the lowest score of 89.4%. For tier 3, the lowest record was 96.1 percent in 2016 and the highest of 99% in 2018.

At the end of 2018, the implementation of the interest rate cap was abolished. The cap skewed, lending in favor of government institutions and banks recorded high-efficiency levels over its implementation period. In 2019, all the categories recorded the lowest average technical efficiency.

The second part revealed that gross non-performing loan ratios have a negative and significant effect on the technical efficiency of commercial banks. Banks with high non-performing loan ratios are highly inefficient. Other bank characteristics, such as the ratio of total loans to total assets, have a positive effect and are significant at 10 percent level; also, overhead costs to total assets positively and significantly affect the performance of commercial banks. Other characteristics such as bank size, non-interest income to total assets, and banks' capital strength are insignificant to efficiency scores.

5.2. Conclusions

The study concludes that over the study period, it was noted that technical efficiency fluctuated. The fluctuations are attributed to the changing business environment, weather conditions and policy implementations in the banking sector. In all the banking categories, fluctuations were experienced where the banks performed best in 2016 to 2018 when the enactment of interest rate cap law was in place. In 2019, banks recorded the lowest efficiency across all categories, following the abolishment of the interest rate cap act. The study further revealed that the technical efficiency of banks depends on the total loans, the overhead costs and the gross non-performing loans. Gross non-performing loan ratios bring about inefficiency in the banking industry. Other bank characteristics such as bank size, capital strengths and non-interest income are insignificant to bank efficiency scores.

5.3. Policy Recommendations

The study findings indicate that across all banking categories, there is a degree of inefficiency. The inefficiency is brought about by the accumulation of non-performing loans in commercial banks' financial statements. Therefore, the policies adopted in the sector should be in line with improving asset qualities. The banks should invest heavily in loan recovery and customer credit score monitoring. Relying on private credit collection agencies that look into resolving disputes and refer accounts to the credit reference bureau. This will avoid piling non-performing loans on their financial statements and other long-term legal processes such as court cases. Secondly, the banks should create a good rapport with their customers. The one-on-one sharing with clients will ensure that customers are honest and do not change their names or business names before notifying the financial institutions. This will reduce cases of increasing bad debts that eventually result in bank losses.

The study limitations are based on the heterogeneity of banks and assumptions of Data envelopment analysis. Despite the study assuming banks are homogenous groups, banks are heterogeneous. They differ in terms of asset size, different services offered, capital requirements and locations; these characteristics are

incomparable. Secondly, DEA assumes a full efficiency isoquant is known; however, the efficient DMUs are estimated from within the samples in its application. Finally, the assumptions that the DEA model does not establish a predetermined distribution between the inputs and output make Data envelopment analysis attractive and distinctive. However, it fails to show the relative importance between inputs and outputs.

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