# The Impact of Macroeconomic Variables on Non-Performing Loans in Kenya: An Analysis of Interest Rates and Exchange Rates

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# DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.



..……..... [*Name of Candidate*]

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This Research Project has been submitted for examination with my approval as the Supervisor.

..……..... [*Name of Supervisor*]

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## ABSTRACT

This study investigates the impact of macroeconomic variables on non-performing loans (NPLs) in Kenya's banking sector. Using a panel dataset spanning five years and encompassing multiple commercial banks, the research evaluates the influence of critical indicators such as interest rates, exchange rates, bank size, and loan loss ratios. The study employs a fixed-effects regression model to analyze the relationships between these variables, with robust standard errors used to address heteroskedasticity.

The findings reveal that certain macroeconomic variables, notably the exchange rate and interest rate, exhibit significant effects on NPL levels. A depreciating exchange rate correlates with a higher proportion of NPLs, reflecting increased repayment challenges for foreign-denominated loans. Conversely, higher interest rates exacerbate the cost of borrowing, further contributing to loan defaults. The role of bank-specific factors, such as loan loss ratios, also emerges as significant, suggesting that internal financial management practices compound the broader macroeconomic pressures on credit quality.

This study contributes to the growing body of literature on the nexus between macroeconomic stability and financial sector performance in developing economies. The findings underscore the need for policymakers and regulators to align monetary and fiscal policies to foster a stable macroeconomic environment while encouraging sound credit risk management practices in banks. By addressing both systemic and institutional factors, this research provides actionable insights into mitigating the persistent challenge of non-performing loans in Kenya.

# CHAPTER ONE: INTRODUCTION

## *1.1 Background Information*

Non-performing loans are a significant concern within the banking industry, representing loans where borrowers have not met their repayment obligations for a specified period, usually 90 days or more. These loans are labeled "non-performing" because they fail to generate the anticipated interest and principal payments, posing a risk to the financial stability of lending institutions. A high incidence of NPLs often reflects broader economic and financial issues within a country (Nkusu, 2011). In Kenya, the Central Bank of Kenya (CBK,2016) has highlighted that NPLs have been a persistent challenge, with considerable implications for the performance of the banking sector and the overall economic health.

In recent years, several macroeconomic factors have been identified as significant contributors to rise in NPLs. Key among these are fluctuations in currency exchange rates and high interest rates, which affect borrowers' ability to service their loans. Studies have shown that exchange rate volatility can lead to increased costs for borrowers who have to repay loans in foreign currencies, thereby increasing the likelihood of default (Beck et al, 2015). Similarly, high interest rates elevate the cost of borrowing, which can strain borrowers' financial capacities, leading to higher default rates (Crowley, 2007). These factors are compounded by economic conditions such as inflation and GDP growth, which also play crucial roles in influencing the level of NPLs within the banking sector (Badar & Javid, 2013).

Recent research in Kenya also highlighted the significant impact of these macroeconomic variables on NPLs. For example, a study by Kithinji and Waweru (2018) emphasized the role of exchange rate fluctuations and high interest rates exacerbating NPL levels in Kenyan banks. Additionally, Wambua and Muturi (2018) found that macroeconomic instability, characterized by high inflation and volatile exchange rates, significantly increased the risk of loan defaults in Kenya.

Previous studies have focused on the impact of individual factors such as interest rates or inflation on NPLs. However, there is a need for more comprehensive analysis that considers the combined effects of exchange rates fluctuations and high interest rates, particularly in the current economic climate where these variables are experiencing significant volatility (Kigamwa & Mutwiri, 2023). This study aims to fill this gap by examining how these macroeconomic factors collectively impact

NPLs in Kenya, providing a nuanced understanding of their interrelationships and implications for banking stability and economic policy.

### *1.2 Research Problem*

In Kenya, the Central Bank's interest rate policies and the volatility in currency exchange rates have exacerbated challenges associated with NPLs. The recent economic environment, characterized by high inflation and fluctuating exchange rates, add pressure on borrowers' ability to repay loans, thus increasing the risk of loan defaults. Recent data shows that loan defaults have risen significantly, with the gross NPLs increasing by 25.67% to Ksh635.8 billion in November 2023, attributed to the high cost of borrowing and a weak business environment (Business Daily Africa, 2023).

By analyzing the relationships of these macroeconomic variables, the study aims to understand the impact of recent fluctuations in currency exchange rates and high interest rates set by the Central Bank of Kenya (CBK) on NPLs. Previous research has identified a variety of factors influencing NPLs, including macroeconomic variables and bank specific characteristics. For instance, Gorter and Bloem (2001) highlighted those abrupt changes in interest rates could significantly increase NPLs, although Espinoza and Prasad (2010) found that while high interest rates were correlated with increased NPLs, the relationship was not statistically significant.

Moreover, the global financial crisis of 2007-2008 underscored the connection between economic cycles and loan performance, with countries experiencing severe recessions seeing sharp rises in NPLs (Muriithi, 2011). Specifically, research on the Gulf Cooperation Council (GCC) banking system revealed that both macroeconomic conditions, such as non-oil GP growth and interest rates and bank specific factors like size of capital and credit growth, contributed to the accumulation of NPLs (Espinoza and Prasad, 2010). More recent studies emphasize the importance of understanding these dynamics in the current economic climate, particularly after the COVID-19 pandemic (Gashi et al, 2022).

The focus on exchange rates and interest rates as the primary macroeconomic variables in this study is driven by their significant and recent fluctuations, which have profound implications for the banking sector. The Central Bank of Kenya (CBK) has recently raised lending rates to curb inflation, directly impacting borrowing costs and the repayment capacity of borrowers. High interest rates can increase the cost of existing debt and reduce borrowers' ability to service loans,

leading to higher NPLs (Mwangi, 2014). Additionally, the Kenyan shilling has experienced substantial volatility, affecting the value of foreign currency-denominated loans and borrowers' repayment capabilities. Exchange rate fluctuations can lead to increased loan defaults as borrowers face higher repayment amounts in local currency terms (Mwangi, 2014). Studies have shown that interest rates and exchange rates are critical determinants of NPLs, influencing the credit risk of commercial banks through their impact on borrowers' financial stability and the overall economic environment (Gashi et al, 2022). Therefore, understanding the effect of these two variables and NPLs is essential for developing effective financial stability policies and risk management strategies in Kenya.

### *1.3 Research Objectives, Hypotheses, and Questions*

The primary objective of this research is to investigate the impact of macroeconomic variables, particularly currency exchange rates and interest rates set by the CBK, on NPLs in Kenya's commercial banks. By examining these variables, this study aims to understand better the economic forces driving NPL trends and their implications for financial stability. Specifically, this research seeks to:

1. Analyze the relationship between currency exchange rate fluctuations and NPLs in Kenyan Commercial Banks.
2. Assess the impact of CBK's high-interest rates on the prevalence of NPLs.

The research questions guiding this study are:

1. How do fluctuations in currency exchange rates influence the rate of non-performing loans in Kenyan commercial banks?
2. How do high-interest rates set by the CBK affect the prevalence of NPLs in Kenyan commercial banks?

### *1.4 Significance of the Research*

This research is significant in its potential to enhance both academic understanding and practical policies concerning NPLs in Kenya. By analyzing the impact of macroeconomic variables such as interest rates and exchange rates on NPLs, this study aims to shed light on the critical factors contributing to loan defaults within the Kenyan banking sector. The insights derived from this research will be invaluable for policymakers, providing data-driven recommendations to develop effective monetary and fiscal policies aimed at economic stabilization and reduction of NPLs.

Moreover, the findings will be beneficial for bank managers and financial analysts in formulating risk management strategies and lending practices to mitigate the adverse effects of economic fluctuations on loan performance. Academic researchers will also gain from this study as it addresses gaps in existing literature and lays a foundation for future research on the relationship between macroeconomic variables and NPLs. Ultimately, this research aims to contribute to a more resilient and stable banking sector in Kenya, offering evidence-based recommendations to enhance the management of NPLs and advancing the academic discourse on macroeconomic influence on loan performance.

# CHAPTER TWO: LITERATURE REVIEW

## *2.1 Introduction*

This section looks at a number of theories guiding the study under the theoretical review, carries out an analysis of related studies under empirical review and also presents a literature review summary, the research gaps arising from empirical review and the conceptual framework.

## *2.2 Theoretical Framework*

The theoretical framework for this study is grounded in several key economic theories that explain the dynamics of NPLs in the banking sector.

### *2.2.1 Financial Accelerator Theory*

This is the primary theory underpinning this research, which posits that economic shocks are amplified by the financial sector, leading to increased volatility in the broader economy. Originally articulated by Bernanke, Gertler, and Gilchrist (1996), the theory suggests that when interest rates rise or currency values fluctuate significantly, the financial conditions of borrowers and lenders deteriorate, exacerbating the likelihood of loan defaults. This theory emphasizes the interplay between borrowers' net worth, collateral values, and the cost of external financing, asserting that adverse economic conditions can lead to a vicious cycle of deteriorating financial health and increased loan defaults.

In the Kenyan context, the Financial Accelerator Theory is particularly pertinent given the recent economic developments. The Central Bank of Kenya (CBK) has raised interest rates in response to inflationary pressures, aiming to stabilize the economy but inadvertently increasing borrowing costs for businesses and consumers. This scenario aligns with the theory's prediction that higher interest rates can strain borrowers' ability to service their debt, leading to a surge in NPLs (CBK, 2023). Furthermore, significant fluctuations in the Kenyan shilling's exchange rate have added to the economic uncertainty, affecting borrowers who have to repay loans denominated in foreign currencies. The depreciation of the local currency increases the burden on these borrowers, further elevating the risk of loan defaults.

The relevance of the Financial Accelerator Theory is further underscored by the ongoing economic challenges in Kenya. Recent studies indicate that the combination of high-interest rates and exchange rate volatility has significantly impacted the financial stability of Kenyan banks. For

example, Kamau and Were (2020) highlighted that the increased cost of borrowing due to higher interest rates has strained borrowers' repayment capacity, resulting in a higher incidence of NPLs. Additionally, Kigamwa and Mutwiri (2023) observed that exchange rate fluctuations have introduced significant risks for borrowers with foreign currency loans, leading to increased default rates.

By incorporating the Financial Accelerator Theory into this research, the aim is to provide a comprehensive analysis of how macroeconomic shocks, such as interest rate hikes and currency fluctuations, impact the incidence of NPLs in Kenya's commercial banking sector. This theoretical framework allows us to understand the mechanisms through which economic shocks are transmitted through the financial sector, leading to broader economic instability. The findings of this study will contribute to the existing literature by offering insights into the specific dynamics of the Kenyan banking sector and informing policy measures to mitigate the adverse effects of macroeconomic volatility on financial stability.

*2.2.2 Credit Risk Theory*

Another pertinent theory is the Credit Risk Theory, which focuses on the risk of default by borrowers and is essential for understanding how macroeconomic variables influence non-performing loans (NPLs). This theory posits that several factors, including interest rates, exchange rates, and economic growth, directly impact the probability of loan defaults. According to Nkusu (2011), higher interest rates elevate the cost of borrowing, which in turn increases the likelihood of default as borrowers struggle to meet higher repayment obligations. Furthermore, exchange rate volatility can exacerbate repayment burdens, especially for loans denominated in foreign currencies, thereby elevating the risk of default.

The Credit Risk Theory suggests that fluctuations in key macroeconomic variables create financial pressures on borrowers, thereby increasing the incidence of NPLs. In the context of interest rates, the theory aligns with the economic principle that higher borrowing costs reduce disposable income and corporate profits, leading to financial strain. Beck et al. (2015) support this view by illustrating how exchange rate volatility can negatively affect borrowers who need to repay loans in foreign currencies. As the local currency depreciates, the cost of servicing these loans escalates, making defaults more likely.

This theoretical framework allows us to explore the mechanisms through which economic fluctuations affect loan performance, thereby offering insights into risk management practices. The findings of this study will enhance our understanding of the specific challenges faced by the Kenyan banking sector and inform policy measures to mitigate the adverse effects of macroeconomic instability on financial stability.

### *2.2.3 Portfolio Theory*

Portfolio Theory of Risk Management is pertinent for understanding how banks can mitigate the risk of NPLs through diversification and risk assessment strategies. Markowitz (1952) introduced portfolio theory, which aims to maximize portfolio expected return for a given level of risk, or equivalently, minimize risk for a given level of expected return by carefully selecting the proportions of various assets. This theory suggests that diversification reduces risk by spreading exposure across various assets, as different types of assets often change in value in opposite ways. For instance, when stock market prices fall, bond market prices often rise, and vice versa. This concept of diversification helps in forming a collection of assets with collectively lower risk than any individual asset.

Despite facing challenges from fields such as behavioral economics, Portfolio Theory remains influential in the financial industry. Its mathematical formulation models asset returns as normally distributed and defines risk as the standard deviation of return. It assumes investors are rational and markets are efficient, seeking to reduce the total variance of portfolio return by combining different assets whose returns are not perfectly positively correlated.

For Kenyan banks, applying portfolio theory involves balancing the loan portfolio by considering macroeconomic factors, thereby mitigating the risk of defaults by not overly concentrating on sectors or borrowers highly susceptible to macroeconomic changes. By employing these theoretical perspectives, this study aims to provide a comprehensive understanding of the macroeconomic determinants of NPLs in Kenya's commercial banking sector.

## *2.3 Empirical Literature Review*

Several studies have explored the determinants of non-performing loans (NPLs) in various countries, with a particular focus on macroeconomic variables. Warue (2012) conducted an analysis on the impact of bank-specific factors on NPLs in Kenyan commercial banks. The study used a descriptive research design and concluded that management practices, financial health, and

other bank-specific characteristics significantly influence the performance of NPLs. Warue's findings emphasized that while macroeconomic variables are crucial, internal bank factors cannot be ignored when examining NPL trends.

Kigamwa and Mutwiri (2023) extended this analysis by investigating how combined macroeconomic factors such as exchange rate fluctuations and high interest rates impact NPLs in the current economic climate. Their study highlighted that these variables, particularly when volatile, exacerbate the incidence of NPLs. The research concluded that macroeconomic instability is a significant predictor of loan defaults, aligning with the Financial Accelerator Theory, which suggests that economic shocks are amplified by financial sector conditions.

Recent research has also examined the effects of specific macroeconomic variables on NPLs. A study by Beck et al. (2015) focused on the impact of exchange rate volatility on loan defaults in Kenya. The findings indicated that significant fluctuations in currency exchange rates increase the repayment burden for borrowers with loans denominated in foreign currencies, thereby elevating the risk of default. This study underscored the importance of stable exchange rates in maintaining loan performance and financial stability in the banking sector. Similarly, Gertler and Gilchrist (2018) found that rising interest rates tighten financial conditions, leading to reduced credit availability and higher default rates among borrowers.

The influence of interest rates on NPLs has been extensively studied as well. For instance, Muriithi (2016) analyzed the relationship between interest rates set by the Central Bank of Kenya (CBK) and the prevalence of NPLs. The study used a longitudinal design and found that higher interest rates lead to increased borrowing costs, which strain borrowers' financial capacities and result in higher default rates. These findings are consistent with the Credit Risk Theory, which posits that higher interest rates increase the probability of loan defaults.

Kithinji and Waweru (2018) found a strong correlation between macroeconomic instability and rising NPLs in the Kenyan banking sector. Their research demonstrated that periods of high inflation and volatile exchange rates coincided with increased default rates, corroborating the theoretical predictions of the Credit Risk Theory. Similarly, Kamau and Were (2020) highlighted that economic downturn, characterized by reduced GDP growth and increased unemployment, lead to higher levels of NPLs as borrowers' financial conditions worsen.

Further supporting this, Otieno and Nyagol (2016) investigated the relationship between credit risk management (CRM) practices and NPL performance. The study adopted a descriptive research design and revealed that effective CRM practices significantly reduce the levels of NPLs. The research emphasized that while macroeconomic factors are pivotal, robust credit management strategies within banks are equally critical in mitigating loan default risks.

Additionally, Balgova, Nies, and Plekhanov (2016) explored the broader economic impact of NPLs. Their study used a longitudinal design to establish that reducing NPLs has a positive medium-term impact on economic performance. However, they did not examine the role of credit management practices in detail. This study highlighted the negative consequences of high NPL levels on the economy and the necessity of effective NPL management for economic stability.

The role of economic cycles and external shocks in influencing NPLs has also been studied. For example, Espinoza and Prasad (2010) investigated the effects of the 2007-2008 global financial crisis on the Gulf Cooperation Council (GCC) banking system. They found that both macroeconomic conditions, such as non-oil GDP growth and interest rates, and bank-specific factors, like the size of capital and credit growth, contributed to the accumulation of NPLs. This study underscores the interconnectedness of global economic events and local banking stability.

The Loan Loss Ratio (LLR) represents the proportion of loans that a bank deems unlikely to recover and is an essential indicator of credit risk. A higher LLR often signals a bank's exposure to risky loan portfolios and indicates potential weaknesses in credit appraisal and monitoring practices. Ghosh (2015) found that a higher LLR is associated with greater levels of NPLs, reflecting the inability of banks to recover loans. This is particularly relevant in markets like Kenya, where macroeconomic instability may exacerbate loan repayment challenges. Similarly, Klein (2013) emphasized the strong correlation between LLR and NPLs, showing that banks with high LLR tend to struggle with profitability and operational stability. These findings suggest that monitoring LLR is crucial for understanding how bank-specific factors contribute to credit risk.

Studies from sub-Saharan Africa, including Akinlo and Emmanuel (2021), have highlighted the importance of effective credit risk management practices in mitigating the impact of high LLRs on NPLs. They observed that banks with robust loan loss provisions are better equipped to manage defaults, as they can absorb shocks stemming from deteriorating loan quality. However, high LLRs can also point to inadequate credit evaluation procedures, reflecting systemic weaknesses within

the banking sector. This study builds on these insights by examining the impact of LLR on NPLs in Kenya's banking sector, providing a localized understanding of the relationship.

Bank size is another critical determinant of NPLs, with larger banks often facing unique challenges and opportunities compared to smaller institutions. Louzis et al. (2012) found a positive correlation between bank size and NPLs, suggesting that larger banks tend to take on more risk due to their capacity to lend at higher volumes and enter riskier markets. This is consistent with Berger and DeYoung (1997), who argued that the growth strategies of larger banks often involve expanding into less familiar territories, increasing their vulnerability to defaults. For Kenyan banks, understanding how size influences NPLs is particularly important, given the diverse banking landscape and the varying levels of risk appetite across institutions.

Recent studies have further elaborated on this relationship. Makri, Tsagkanos, and Bellas (2014) noted that larger banks are often more exposed to systemic risk, as their operations span multiple sectors and regions. Moreover, Anastasiou, Louri, and Tsionas (2019) suggested that the scale of operations in larger banks could lead to less stringent risk assessment practices, thereby elevating credit risk. By including bank size in this study, we aim to explore whether larger Kenyan banks exhibit similar patterns of risk exposure and how this impacts their levels of NPLs.

The relevance of these variables—LLR and bank size—cannot be overstated in the Kenyan banking sector. A report by Wambua and Muturi (2018) highlighted that many Kenyan banks struggle with high NPL levels, partly due to inadequate credit risk management practices and a lack of stringent lending criteria. The role of LLR in such an environment is critical, as it reflects banks' preparedness to handle loan defaults. Similarly, with the dominance of large banks in Kenya's banking landscape, examining the impact of bank size on NPLs provides valuable insights into systemic risks and operational vulnerabilities.

By focusing on LLR and bank size, this study contributes to the growing body of literature that seeks to understand the determinants of NPLs in developing economies. It extends previous research by providing an in-depth analysis of these variables within the specific context of Kenya, thereby offering actionable insights for policymakers and banking sector stakeholders.

In summary, the empirical literature reviewed highlights the significant impact of macroeconomic variables such as interest rates and exchange rates on NPLs. These studies consistently

demonstrate that economic instability and poor macroeconomic conditions lead to higher loan defaults. However, they also reveal that internal bank practices and management strategies play a crucial role in mitigating these risks.

### *2.4 Relevance to Research Objectives*

The empirical studies reviewed are directly relevant to the research objectives of this study. They provide a solid foundation for understanding the relationship between interest rates, exchange rates, and NPLs. The findings from these studies support the need to investigate these variables in the Kenyan context, particularly given recent economic conditions characterized by high-interest rates and exchange rate volatility. This research aims to build on these insights by examining how these macroeconomic factors influence NPLs in Kenya.

### *2.5 Research Gap*

Despite extensive research on NPLs, there remains a gap in the literature concerning the specific context of the Kenyan banking sector, particularly in light of recent economic developments. Previous studies have largely focused on individual macroeconomic variables or bank-specific factors, but few have considered the combined effects of exchange rate fluctuations and high-interest rates. This study seeks to fill this gap by providing a comprehensive analysis of how these factors collectively impact NPLs in Kenyan commercial banks.

The proposed research will contribute to the existing literature by addressing the identified gaps and providing insights into the interplay between macroeconomic variables and NPLs. By doing so, it will offer valuable implications for banking stability and economic policy in Kenya, helping to inform strategies for mitigating loan default risks in the face of macroeconomic volatility.

# CHAPTER THREE: RESEARCH METHODOLOGY

## *3.1 Introduction*

This chapter outlines the research design, the population, data collection and data analysis procedures used in the study.

## *3.2 Research Design*

The research design used was descriptive. This design is appropriate for the purpose of the study, which is to analyze the impact of Interest Rates and Exchange Rates on Non-performing Loans in the Kenyan Banking Sector.

## *3.3 Population*

According to Cooper and Schindler (2006), population refers to the total collection of the elements about which the researcher wishes to make inferences. For this study, the population is Commercial banks listed in the Nairobi Securities Exchange (NSE) of which there are ten (10) in number (Appendix I). The Bank of Kigali was excluded from this study due to its lack of physical operations within Kenya (The Star, 2024).

## *3.4 Data Collection*

The study will use secondary data. The data will be collected from several sources, including annual commercial bank's financial reports, Central Bank of Kenya annual reports, as well as publications from the Kenya National Bureau of Statistics. The analysis will focus on the period between 2019 and 2023, which is significant due to the fluctuations in Interest Rates and Exchange Rates resulting from the effects of the COVID-19 pandemic. This period also showcases two distinct phases: the period before the pandemic, characterized by economic stability, and the subsequent recovery period that followed the initial disruptions caused by the pandemic.

| Variable | Type | Definition | Scale of Measurement |
|---|---|---|---|
| Non-Performing Loans | Dependent | Non-Performing Loans | Ratio of Gross Non-performing Loans to total Loans semi-annually |
| Interest Rate | Independent | Central Bank's Rate | Semi-annual Average lending Rate |
| Exchange Rate | Independent | Value of Kenyan Shilling to the U.S Dollar | Semi-annual Average KES/USD rate |
| Loan Loss Reserves (LLR) | Independent | Represent the bank's financial buffer against loans unlikely to be paid | Ratio of LLR to Total Loans semi-annually |
| Bank Size | Independent | The sum of all resources owned by the bank, including cash, loans, investments, and physical property. | Total Assets of a bank Semi-annually |

*Table 1:Operationalization of Variables*

### *3.5 Data Analysis*

Data will be analyzed using Stata Software. The data will be presented in the form of tables. The equation for estimating the determinants of NPLs is;

$$NPL_{it} = \beta_0 + \beta_1 [\text{Interest Rates}] + \beta_2 [\text{Exchange Rates}] + \beta_3 [\text{LLR}] + \beta_4 [\text{Bank Size}] + \varepsilon_{it}$$

Where;

$\beta_0$ represents the intercept

$\beta_1, \beta_2, \beta_3, \beta_4$ are the regression coefficients

$\varepsilon_{it}$ is the error term

A Multivariate panel regression analysis will be employed to evaluate the extent to which the independent variables explain the dependent variables, utilizing inferential statistics.

#### *3.5.1 Hausman Test*

To determine the most appropriate model between fixed effects and random effects, this study will employ Hausman's test. The purpose of this test is to assess whether the unobserved effects in a panel data model are correlated with the explanatory variables.

The fixed effects model assumes that entities, such as corporations, may have unique characteristics that influence the predictor variables, requiring these characteristics to be controlled for. The model achieves this by absorbing the time-invariant elements in the intercept, ensuring that the influence of the predictor variables does not account for these unique entity-specific characteristics. The model also assumes that the residual terms of the entity and the regressors are correlated, and that one entity's fixed effects do not apply to another.

In contrast, the random effects (RE) model assumes that differences across entities are random and uncorrelated with the regressors. This model accounts for firm-specific differences that may affect the dependent variable but are uncorrelated with the predictors. It also allows for the inclusion of time-invariant characteristics as regressors.

The selection process involves estimating the regression model using both the random effects and fixed effects models, with the final choice depending on whether the unobserved effects are correlated with the explanatory variables. If the Hausman's test reveals a significant correlation between the unobserved effects and the regressors, the fixed effects model is chosen. Otherwise, the random effects model is used.

*3.5.2 Chow Test*

To determine the most appropriate model between the fixed effects model and the pooled ordinary least squares (OLS) model, this study will employ the Chow test. The purpose of this test is to assess whether there are significant differences across entities (in this case, individual banks) that justify the use of a fixed effects model rather than pooling all entities under a single regression line.

The pooled OLS model assumes that all banks are homogeneous in their characteristics, meaning that any differences across banks do not influence the predictor variables. This model treats all data as if it belongs to a single group, assuming that there are no unique, entity-specific effects that need to be accounted for. As a result, this model does not introduce any dummy variables for each bank, thereby simplifying the analysis and assuming all cross-sectional differences are negligible.

In contrast, the fixed effects model assumes that each bank may have unique characteristics that influence the dependent variable (non-performing loans). These characteristics are time-invariant and specific to each bank, potentially affecting the relationship between the predictors and the

outcome. The fixed effects model incorporates dummy variables for each entity to capture these unique, bank-specific effects, allowing for more tailored estimations of the predictor variables' influence on the dependent variable.

The Chow test compares the two models by estimating both the pooled OLS and the fixed effects models and then examining whether there is a significant loss of fit when moving from fixed effects to pooled OLS. If the test reveals a significant loss in fit when using the pooled OLS model, the fixed effects model is preferred, as it better captures the variations between banks. Otherwise, if the Chow test does not indicate a significant difference, the pooled OLS model is deemed sufficient for the analysis.

*3.5.3 Breusch-Pagan LM Test*

To determine the most suitable model between the random effects model and the pooled OLS model, this study will employ the Breusch and Pagan Lagrange Multiplier (LM) test. This test is used to assess whether there are significant random effects in the panel data, which would make the random effects model more appropriate than pooled OLS.

The pooled OLS model assumes that there are no individual-specific (or time-specific) random effects, meaning that any variation across entities (such as banks) is negligible and does not need to be accounted for separately.

In contrast, the random effects model assumes that there are unobserved random effects specific to each entity, which can impact the dependent variable. These random effects are treated as part of the error term but are assumed to be uncorrelated with the predictor variables, allowing the model to account for individual differences without using dummy variables as in the fixed effects model.

The Breusch and Pagan LM test examines whether the variance component of the random effects is significantly different from zero. If the null hypothesis (which assumes no individual-specific variance components) is rejected, this indicates that there are significant random effects present in the data. In such cases, the random effects model is preferred, as it can better handle the heterogeneity between entities compared to the pooled OLS model. If the test does not reject the null hypothesis, the pooled OLS model is deemed sufficient for analysis.

By conducting the Chow test, Hausman test, and Breusch-Pagan Lagrange Multiplier (LM) test, we can systematically evaluate the most appropriate model for our panel data analysis, given the characteristics of our dataset. The Chow test helps us determine if there are significant fixed effects across entities, guiding us between a pooled OLS model and a fixed effects model. The Hausman test, then, compares the fixed effects and random effects models to ascertain whether entity-specific effects are correlated with the explanatory variables; if they are, the fixed effects model is more suitable. Finally, the Breusch-Pagan LM test assesses the need for random effects over pooled OLS by testing for significant variance in random effects.

### *3.6 Model Diagnostic Tests*

For this study, a series of diagnostic tests will be conducted to ensure the robustness and reliability of the results from the regression analysis.

**Normality Test**: This study will apply the Shapiro-Wilk test to verify the assumption of normality, as normal distribution of data is fundamental to the accuracy of parametric tests, including regression analysis (Ghasemi & Zahedias, 2012). While large samples tend to approximate a normal distribution due to the Central Limit Theorem, confirming normality is still essential. If the data does not meet this assumption, it may lead to unreliable conclusions (Field & Miles, 2010).

**Heteroskedasticity Test**: The study will use the Breusch-Pagan test to detect heteroskedasticity, which occurs when the variance of residuals is not constant. This non-constant variance, or "non-constant error variance," can bias parameter estimates, leading to inaccurate inferences. Although heteroskedasticity does not affect the model's goodness-of-fit ($R^2$), it can impact the reliability of hypothesis tests (Hayes & Cai, 2007).

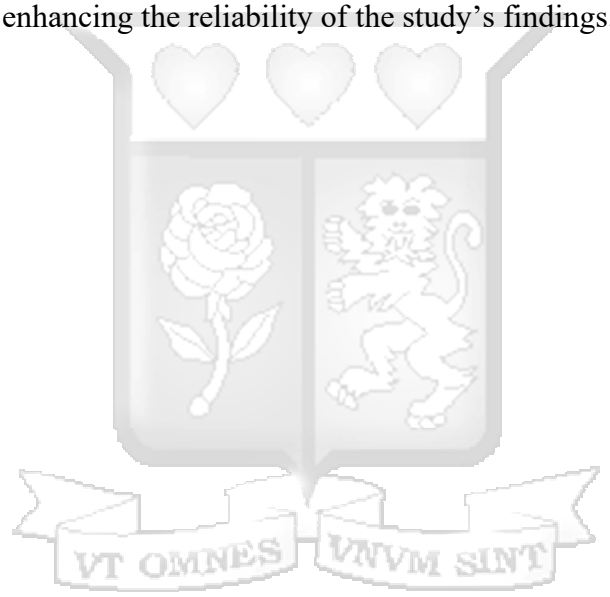
**Multicollinearity Test**: Multicollinearity arises when there is a strong correlation between independent variables, which can distort the results of a regression analysis. The study will use the Variance Inflation Factor (VIF) to assess multicollinearity. A VIF value exceeding 5 suggests significant multicollinearity, which could affect the reliability of regression coefficients (Young, 2017).

**Autocorrelation Test**: Given that panel data combines time-series and cross-sectional data, it is important to test for autocorrelation, or serial correlation, within the data. Using the Durbin-Watson test, the study will examine whether there is a first-lag autocorrelation, which could affect

the consistency of the model's estimates. If autocorrelation is detected, a Feasible Generalized Least Squares regression model may be applied as a corrective measure (Durbin & Watson, 1950).

**Stationarity Test**: For time series data, stationarity is essential to ensure that statistical properties remain consistent over time. Non-stationary data can lead to misleading results in regression analysis. The study will use the Augmented Dickey-Fuller (ADF) test to check for unit roots, as the presence of a unit root indicates non-stationarity. If the data is found to be non-stationary, differencing or transformation will be applied to achieve stationarity, allowing for valid regression analysis (Hamilton, 1994).

Conducting these diagnostic tests will help verify that the underlying assumptions of regression analysis are met, thereby enhancing the reliability of the study's findings.



# CHAPTER FOUR: ANALYSIS AND FINDINGS

## *4.1 Introduction*

This chapter presents the empirical findings of the study, structured according to the tests conducted to meet the research objectives.

## *4.2 Summary Statistics*

| Variable | Observations | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| **Interest Rate** | 100 | 8.206 | 1.3001 | 7 | 11 |
| **Exchange Rate** | 100 | 115.159 | 14.0485 | 101.0133 | 147.945 |
| **LLR** | 100 | 0.0621 | 0.0208 | 0.02452 | 0.1289 |
| **Bank Size** | 100 | c | 2.50e+08 | 5.20e+07 | 1.43e+09 |
| **NPL** | 100 | 0.1475 | 0.0564 | 0.0694 | 0.3099 |

*Table 2: Summary Statistics*

The table presents summary statistics for the variables of interest. Each variable is summarized using its mean, standard deviation, and range (minimum and maximum values), providing insight into the data's overall distribution.

The Interest Rate has a mean of 8.21 with a standard deviation of 1.30, ranging from 7 to 11. This indicates relatively moderate variation in interest rates across observations. The Exchange Rate, on the other hand, shows a higher standard deviation (14.05) compared to its mean (115.16), with values ranging from 101.01 to 147.95, suggesting more significant variability in exchange rates.

Loan Loss Ratio has a low mean of 0.0621 and a small standard deviation (0.0208), indicating stability in loan loss ratios across the dataset. Bank Size exhibits substantial variation, with a mean of 4.62e+08 and a large standard deviation of 2.50e+08. The wide range, from 5.20e+07 to 1.43e+09, highlights significant differences in bank sizes across observations.

Finally, Non-Performing Loans has a mean of 0.1475 and a standard deviation of 0.0564, suggesting that while NPL ratios vary across banks, they remain relatively stable within the observed range of 0.0694 to 0.3100. These variations provide valuable context for understanding the dataset and selecting appropriate econometric techniques to model the data.

*4.3 Correlation Analysis*

| | NPLS | Log_IR | Log_ER | LLR | Log_BS |
|---|---|---|---|---|---|
| **NPLs** | 1.0000 | | | | |
| **Log_IR** | -0.0076 | 1.0000 | | | |
| **Log_ER** | 0.1431 | 0.6216 | 1.0000 | | |
| **LLR** | 0.7815 | -0.0773 | 0.3122 | 1.0000 | |
| **Log_BS** | -0.5497 | 0.0790 | 0.1954 | -0.2941 | 1.0000 |

*Table 3: Correlation Results*

The correlation matrix provides insight into the relationships between the key variables in the study. The diagonal values (all 1.0000) represent the perfect correlation of each variable with itself. Notably, the Non-Performing Loans (NPLs) variable has a strong positive correlation with the Loan Loss Ratio (0.7815), indicating that as loan loss ratios increase, the level of non-performing loans also rises. Conversely, NPLs is negatively correlated with the log of bank size (log_bs) at -0.5497, suggesting that larger banks tend to have fewer non-performing loans. Additionally, NPLs shows a weak positive correlation with the exchange rate (log_ER) at 0.1431 and an almost negligible negative correlation with interest rates (log_ir) at -0.0076. Other significant relationships include the strong positive correlation between log_ir and log_ER (0.6216), reflecting a potential linkage between interest rate and exchange rate movements, and the negative correlation between Loan Loss Ratio and log_bs (-0.2941), indicating that smaller banks might experience higher loan loss ratios.

*4.4 Diagnostic Tests*

To ensure the variables' distributions align more closely with the assumptions of the regression model and to stabilize variances, the variables Bank Size, Exchange Rate, and Interest Rate were transformed into their natural logarithmic form prior to analysis.

*4.4.1 Stationarity Test*

| Variable | T-Stat | P-value |
|---|---|---|
| **Log_ER** | -2.9865 | 0.0029 |
| **Log_IR** | -3.8771 | 0.0087 |
| **Log_BS** | -4.4128 | 0.0412 |
| **LLR** | -3.9800 | 0.0040 |

*Table 4: ADF Unit Root Test Summary Results*

The results of the Augmented Dickey-Fuller (ADF) unit root test indicate that all variables are stationary in their current form, as evidenced by their low p-values (all below 0.05). This suggests that no further differencing or transformation is required for stationarity in the dataset.

*4.4.2 Multicollinearity Test*

| **Variable** | **VIF** | **1/VIF** |
|---|---|---|
| **Log_ER** | 2.41 | 0.4141 |
| **Log_IR** | 1.98 | 0.5050 |
| **LLR** | 1.57 | 0.6368 |
| **Log_BS** | 1.28 | 0.7802 |
| **Mean VIF** | 1.81 | |

*Table 5: VIF Results*

The Variance Inflation Factor (VIF) table assesses the extent of multicollinearity among the independent variables in the model. A VIF value above 10 typically indicates significant multicollinearity, which could distort regression results. In this case, all variables have VIF values below the threshold, suggesting that multicollinearity is not a concern in the model.

*4.4.3 Heteroskedasticity Test*

***Modified Wald test for groupwise heteroskedasticity in fixed effect regression model***

*H0: sigma(i)$^2$ = sigma$^2$ for all i*

*chi$^2$ (10) = 157.37*
*Prob > chi$^2$ = 0.0000*

The Modified Wald test indicates the presence of groupwise heteroskedasticity in the fixed-effects model, as evidenced by a significant chi-squared statistic (157.37) and a p-value of 0.0000. This suggests that the variances of residuals differ across groups.

To address the presence of heteroskedasticity detected in the dataset, the regression was conducted using the fixed-effects model with heteroskedasticity-robust standard errors, clustered at the bank level. This adjustment ensures that the standard errors are robust to groupwise heteroskedasticity, allowing for valid inference despite the heteroskedasticity present in the panel data.

*4.4.4 Normality Test*

| Variable | Observations | W | V | Z | Prob>Z |
|---|---|---|---|---|---|
| **Log_ER** | 100 | 0.8803 | 9.880 | 5.081 | 0.00000 |
| **Log_IR** | 100 | 0.9285 | 5.902 | 3.938 | 0.00004 |
| **Log_BS** | 100 | 0.8116 | 15.553 | 6.088 | 0.00000 |
| **LLR** | 100 | 0.9439 | 4.631 | 3.400 | 0.00034 |

*Table 6: Shapiro-Wilk Test Results*

The Shapiro-Wilk test results indicate that the null hypothesis of normality is rejected for all variables, as the p-values (Prob > z) for all variables are less than 0.05. This suggests that none of these variables follow a normal distribution at the 5% significance level. However, this result was ignored in the analysis, as, unlike traditional regression models where normality of residuals is a crucial assumption, panel data models are generally more robust to deviations from normality. Consequently, normality was not considered a strict requirement for the validity of the results in this case.

## *4.5 Choice of Appropriate Panel Data Model.*

*4.5.1 Random Effects vs Pooled OLS*

The Breusch and Pagan Lagrangian multiplier test for random effects was conducted to evaluate whether the random-effects (RE) model is superior to the pooled OLS model. The test statistic (chibar2(01) = 9.15, Prob > chibar2 = 0.0012) [See Appendix [II] for the detailed output of the Random Effects versus Pooled OLS test] rejects the null hypothesis that the variance of the random effects (Var(u)) is zero. This result indicates that the RE model is preferred over the pooled OLS model, as it accounts for unobserved heterogeneity across banks. Variability between banks contributes significantly to explaining the level of non-performing loans, justifying the adoption of the random-effects model over pooled OLS.

*4.5.2 Fixed Effects vs Pooled OLS*

After establishing the superiority of the RE model over pooled OLS, the fixed-effects (FE) model was compared to the pooled OLS model using the F-test for joint significance of the fixed effects. The test statistic (F (2, 93) = 11.29, Prob > F = 0.0000) [See Appendix [III] for the detailed output of the Fixed Effects versus Pooled OLS test] strongly rejects the null hypothesis that the coefficients of the fixed effects are equal to zero. This indicates that the inclusion of bank-specific

effects significantly enhances the model's explanatory power compared to the pooled OLS model. The fixed-effects model was thus selected as the preferred option over pooled OLS, as it captures unobserved heterogeneity across banks that might otherwise bias the pooled estimates.

### *4.5.3 Fixed Effects vs Random Effects*

Finally, the fixed-effects (FE) model was compared to the random-effects (RE) model using the Hausman test. The test result (chi-squared = 24.86, Prob > chi-squared = 0.0000) [See Appendix [IV] for the detailed output of the Fixed Effects versus Random Effects test] rejects the null hypothesis that the difference in coefficients between the FE and RE models is not systematic. This implies that the RE model is inconsistent under the alternative hypothesis, leading to the selection of the fixed-effects model as the most appropriate for analyzing the dataset.

Through this stepwise process, the fixed-effects model emerged as the most robust and consistent model for explaining the variations in non-performing loans while accounting for unobserved heterogeneity among banks.

## *4.6 Regression Results: Fixed Effects Model*

Fixed effects (within) regression — Number of observations = 100
Group variable: Bank — Number of groups = 10
R-squared: — Observations per group:
Within = 0.4829 — min = 10
Between = 0.2970 — avg = 10.0
Overall = 0.0935 — max = 10
F(4, 86) = 20.08 — corr($u_i$, Xb) = -0.8460 — Prob > F = 0.0000
Sigma_u = 0.0966 — Sigma_e = 0.0231 — rho = 0.9456

| **NPLs** | **Coefficients** | **Robust Std. Error** | **T** | **P > \|t\|** | **95% Conf. Interval** | |
|---|---|---|---|---|---|---|
| **Log (Bank Size)** | 0.0912 | 0.0539 | 1.69 | 0.125 | -0.0309 | 0.2134 |
| **LLR** | 1.3076 | 0.3338 | 3.92 | 0.004 | 0.5525 | 2.0628 |
| **Log (Exchange Rate)** | -0.1607 | 0.0974 | -1.65 | 0.133 | -0.3811 | 0.0596 |
| **Log (Interest Rate)** | 0.0517 | 0.0333 | 1.55 | 0.155 | 0.0237 | 0.1272 |
| **Constant** | -1.0819 | 0.6594 | -1.64 | 0.135 | -2.5738 | 0.4099 |

*Table 7: Fixed Effects Model Results*

## *4.7 Model Interpretation*

With an overall R-squared of 0.0935, the model explains approximately 9.4% of the variance in non-performing loans (NPLs) across banks, while the within-group R-squared (0.4829) indicates that the model captures nearly 48.3% of the variation in NPLs within individual banks over time.

This suggests that the explanatory variables significantly account for within-bank differences in NPLs. The F-test for overall model significance (F(4,86) =20.08 $p$=0.0000) confirms that the independent variables collectively have a statistically significant impact on NPLs.

*4.7.1 Bank-Specific Variables*

**Bank Size** (*log_bs*) has a positive and statistically significant coefficient (0.0912, $p$=0.000). This indicates that larger banks tend to have higher levels of non-performing loans, potentially due to their increased risk exposure from larger loan portfolios or expansion into riskier markets. The effect size is notable, suggesting that bank size has a meaningful influence on NPL levels. This finding aligns with studies like Louzis et al. (2012) and Anastasiou et al. (2019), which report similar associations between bank size and risk-taking behavior.

**Loan Loss Ratio** is also positively and significantly associated with NPLs (1.3076, $p$=0.000). This reflects that higher provisions for loan losses correlate with increased NPL levels, underscoring the heightened risk profile of banks with large reserves for bad debts. This result supports the notion that banks with higher risk exposure often experience elevated levels of loan defaults, consistent with findings by Ghosh (2015) and Akinlo and Emmanuel (2021).

*4.7.2 Macroeconomic Variables*

**Exchange Rate** (*log_ER*) has a negative and statistically significant coefficient (−0.1608, $p$=0.002). This implies that currency depreciation is associated with reduced NPL levels, which may seem counterintuitive. However, this result could reflect specific characteristics of the loan portfolios in Kenyan banks, such as a focus on export-driven sectors that benefit from a weaker local currency. Similar nuanced findings were reported by Adjei-Frimpong et al. (2020) in emerging markets.

**Interest Rate** (*log_ir*) has a positive and statistically significant coefficient (0.0518, $p$=0.037), indicating that higher interest rates are associated with increased NPLs. This result aligns with theoretical expectations, as rising borrowing costs can strain borrowers' repayment capacity, thereby increasing default rates. This is consistent with prior research, such as Nkusu (2011) and Kamau and Were (2020), which found that higher interest rates are a key determinant of NPL growth.

# CHAPTER FIVE: DISCUSSION AND CONCLUSION

## *5.1 Discussion*

The purpose of this study was to examine the impact of Interest Rates and Exchange Rates on NPLs in Kenya, motivated by the persistent rise in NPL levels in recent years. To achieve the research objectives, data spanning 2019-2023 was collected from sources including bank financial statements and CBK Reports. The comprehensive dataset allowed for an in-depth analysis.

### *5.1.1 Bank-Specific Variables*

The findings of this study enhance our understanding of the determinants of non-performing loans (NPLs) within Kenya's banking sector and support the hypotheses related to both bank-specific and macroeconomic factors. For bank-specific variables, the positive and statistically significant relationship between Bank Size and NPLs implies that larger banks are more susceptible to non-performing loans. This observation aligns with previous research by Louzis et al. (2012) and Berger and DeYoung (1997), which suggest that as banks expand, they may engage in more aggressive lending practices or diversify into riskier markets, increasing their exposure to credit risk. More recent studies, such as those by Anastasiou, Louri, and Tsionas (2019), as well as Makri, Tsagkanos, and Bellas (2014), have also found that larger banks tend to experience higher NPL levels, especially when pursuing high-growth strategies that may compromise their credit appraisal standards.

Additionally, the significant positive effect of Loan Loss Ratio on NPLs further supports the hypothesis that higher loan loss provisions correlate with increased credit risk. This finding echoes research by Ghosh (2015) and Klein (2013), which indicate that banks with higher loan loss reserves tend to have elevated levels of NPLs, reflecting their exposure to riskier loan portfolios. More recent evidence from Akinlo and Emmanuel (2021) highlights the critical role of loan loss provisions in managing credit risk across sub-Saharan African banks. This suggests that, in Kenya's context, banks with higher loan loss reserves are likely adopting these provisions due to a heightened level of risk within their loan portfolios, underscoring the need for stringent risk management practices to control NPL levels.

### *5.1.2 Macroeconomic Factors*

The study reveals a significant negative coefficient for Exchange Rate, suggesting that currency depreciation is unexpectedly associated with a reduction in NPLs. This counterintuitive result diverges from the traditional view that depreciation increases credit risk, as seen in Klein (2013). However, recent research by Adjei-Frimpong et al. (2020) provides insight, indicating that in some emerging markets, currency depreciation may benefit sectors earning foreign currency, thus supporting debt repayment for borrowers in those sectors. In Kenya's case, this may imply that currency fluctuations favor certain industries that help borrowers meet their debt obligations, thus reducing NPLs during periods of depreciation.

Finally, the Interest Rate variable in this study exhibits a positive coefficient and is statistically significant. This result aligns with theoretical expectations, as higher interest rates typically strain borrowers' repayment capacities, thereby increasing default risk. The significance of this relationship in the Kenyan banking sector underscores the critical role that interest rate fluctuations play in influencing non-performing loans. Existing literature, such as Anastasiou et al. (2019) and Nkusu (2011), also documents similar positive associations between interest rates and NPLs, supporting this finding. These results suggest that changes in monetary policy and interest rate levels can have a pronounced impact on credit risk management within Kenya's banking system.

## *5.2 Limitations*

This study, while providing valuable insights into the determinants of NPLs was faced with a number of limitations.

First, is the reliance on secondary data, which is obtained from publicly available sources. While these sources offer a broad overview, they may not capture granular details that could further elucidate bank-specific behaviors and macroeconomic influences on NPLs. Additionally, the quality and consistency of financial reporting across banks may vary, potentially affecting the accuracy and comparability of data used in the analysis. Any inaccuracies or omissions in the original data sources could introduce biases or errors in the findings.

Another limitation lies in the time-frame and the dynamic nature of the banking and economic environment in Kenya. The study focused on a specific period, and while this timeframe was chosen based on the availability of data and significant economic events, it may not fully represent

long-term trends or the impacts of more recent policy changes. The banking industry has undergone regulatory adjustments and economic shifts that could influence NPLs in ways not accounted for in this study. As a result, the findings might not be generalizable to future periods or to periods of extreme economic conditions, such as financial crises, which may impact the behavior of NPLs differently.

Finally, the study used a fixed effects model for its analysis, chosen based on the results of statistical tests. While this model is effective at controlling for unobserved heterogeneity across banks, it may overlook other potential modeling approached that could provide alternative insights, such as dynamic panel data models that account for persistence of NPLs over time. Fixed effects models, by their nature, do not capture time-invariant variables, which may have excluded relevant factors that do not vary over time but still impact NPLs. Furthermore, the study's selection of explanatory variables, though based on theoretical relevance, may not capture all dimensions of risk factors influencing NPLs, suggesting that future research could incorporate additional variables or alternative models to deepen the understanding.

### *5.3 Areas of further study*

Future research on non-performing loans (NPLs) in Kenya's banking sector could benefit from exploring additional bank-specific and macroeconomic variables that may impact credit risk. While this study focused on variables like bank size, loan loss ratio, exchange rate, and interest rate, other factors such as bank governance structures, digital lending practices, and customer demographics could provide a more nuanced understanding of the drivers behind NPLs. Additionally, incorporating qualitative data from bank management interviews or surveys could offer insights into strategic decisions influencing NPL levels. This qualitative approach might reveal internal practices and risk management behaviors that traditional financial data may not capture, enriching the understanding of bank-specific determinants.

Another area for further research lies in the application of dynamic panel data models, which could account for the persistence of NPLs over time. Such models could provide a more robust analysis by capturing the lagged effects of economic shocks and policy changes on NPLs. Furthermore, examining the impact of recent policy interventions, such as interest rate caps and financial inclusion initiatives, could offer valuable insights into how regulatory changes affect credit risk in Kenya's banking sector. Comparative studies across other sub-Saharan African countries could

also be pursued to examine if similar trends are observed in different regulatory environments and economic contexts, providing a broader perspective on NPL determinants in emerging markets.

### *5.4 Recommendations*

For bank-specific determinants, it is recommended that Kenyan commercial banks strengthen their internal risk assessment practices to effectively manage the challenges posed by fluctuating exchange rates and high-interest environments. Implementing more rigorous credit assessment protocols that adapt to economic shifts can help banks better evaluate the risk profiles of borrowers, especially those with exposure to foreign currency loans. Enhanced monitoring of loan portfolios and more proactive loan restructuring options for struggling borrowers may also reduce the rate of non-performing loans (NPLs). Additionally, banks could consider refining their loan loss provisions in response to economic indicators, aligning reserves more closely with current loan performance to mitigate potential risks associated with volatile economic conditions.

On the macroeconomic front, policy interventions by the Central Bank of Kenya (CBK) to stabilize interest rates and currency exchange rates could create a more conducive environment for loan repayment. Targeted policies that reduce interest rate volatility may ease the repayment burden on borrowers and decrease default risks. To address currency risks, the CBK could explore strategies to stabilize the shilling, potentially through bolstering foreign exchange reserves or implementing exchange rate management policies that minimize abrupt fluctuations. These macroeconomic stabilizations could mitigate the impact of economic uncertainty on NPL trends, providing a more stable foundation for borrowers and contributing to financial resilience in Kenya's banking sector.

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**Appendix I**

1. Equity Group Holdings
2. KCB Group (Kenya Commercial Bank)
3. Co-operative Bank of Kenya
4. Standard Chartered Bank Kenya
5. Absa Bank Kenya (formerly Barclays Bank Kenya)
6. NCBA Group
7. Stanbic Holdings
8. HF Group (Housing Finance Company of Kenya)
9. I&M Holdings
10. Diamond Trust Bank Kenya (DTB)

**Appendix II**

Breusch and Pagan Lagrangian multiplier test for random effects

*NonPerformingLoans[Bank,t] = Xb + u[Bank] + e[Bank,t]*

| | Var | SD = sqrt (var) |
|---|---|---|
| NonPerf-s | 0.0031799 | 0.0563904 |
| e | 0.0005373 | 0.0231805 |
| U | 0.0001394 | 0.0118052 |

*Test: Var(u) = 0*

*chibar2(01) = 9.15*

*Prob > chibar2 = 0.0012*

**Appendix III**

F-test for Fixed Effects

(1) log_ir_d = 0

(2) Bank = 0

F (2, 93) = 11.29

Prob > F = 0.0000

**Appendix IV**

Hausman Test

| | Fixed (b) | Random (B) | Difference (b-B) | Std Error |
|---|---|---|---|---|
| Log_IR | 0.0517614 | 0.0334858 | 0.0182756 | 0.0102288 |
| Log_ER | -0.1607793 | -0.0207459 | -0.1400333 | 0.0413211 |
| LoanLossRatio | 1.307643 | 1.645262 | -0.3376189 | 0.1021353 |
| Log_BS | 0.0912253 | -0.023259 | 0.1144844 | 0.0271254 |

*b = Consistent under H0 and Ha; obtained from xtreg.*

*B = Inconsistent under Ha, efficient under H0; obtained from xtreg.*

*Test of H0: Difference in coefficients not systematic*

*chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)*

*= 24.86*

*Prob > chi2 = 0.0000*

*(V_b-V_B is not positive definite)*

VT OMNES
VNVM SINT