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# ANALYSIS OF EFFECT OF MACROECONOMIC VARIABLES ON NON-PERFORMING LOANS IN SUBSAHARAN AFRICA

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**Abstract:**
The average non-performing loans (NPLs) ratio in Sub-Saharan Africa (SSA) is more than 10%, almost double the prudential benchmark limit of 5%. Sustainable Development Goal 8.10 is under threat, and the current situation is jeopardizing bank solvency and access to credit. But the ratios of non-performing loans vary greatly across economies. Existing evidence mainly consists of single-country studies, pooled estimators that apply common slopes, and models that overlook the fiscal channel. This study examines the long-term effects of inflation, the bank lending rate, and tax revenue (as a percentage of GDP) on NPLs in Angola, Botswana, Kenya, and Nigeria, while also comparing the specific adjustment dynamics of each country. A panel autoregressive distributed lag error-correction model is used to analyse 56 observations of annual World Bank data from 2010 to 2023. Panel unit-root tests classify NPLs, the lending rate and tax revenue as I(1) and inflation as I(0). The Hausman test ($\chi^2$ = 2.042, p = .564) does not reject long-run homogeneity, favoring the pooled mean group (PMG) estimator over the mean group estimator. Groupwise heteroskedasticity in the baseline PMG model is corrected by feasible generalized least squares re-estimation, after which all diagnostic tests are satisfied. In the final model, a one-percentage-point rise in the lending rate is associated

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with a 1.565-point rise in NPLs (p = .005) and in inflation with a 0.362-point rise (p = .046), whereas a one-point increase in tax revenue to GDP is associated with a 1.268-point fall (p = .035). Adjustment speeds differ markedly: Angola (−0.847) and Nigeria (−0.642) correct disequilibria rapidly, while adjustment in Kenya (−0.037) and Botswana (0.000) is negligible. The Central banks and financial institutions in these countries should strengthen inflation-targeting frameworks and increase foreign exchange reserve buffers; banks should increase forward-looking loan-loss provisions, stress-test loan portfolios, and expand fixed-rate and hybrid-rate lending products; and finance ministries should prioritize broadening the domestic tax base and diversifying government revenue away from oil-related revenue.

**JEL:** G21, E31, E43, H20, C23, O55

**Keywords:** non-performing loans, inflation, lending interest rates, tax revenue, Sub-Saharan Africa, macroeconomic variables, Pooled Mean Group (PMG)

## 1. Introduction

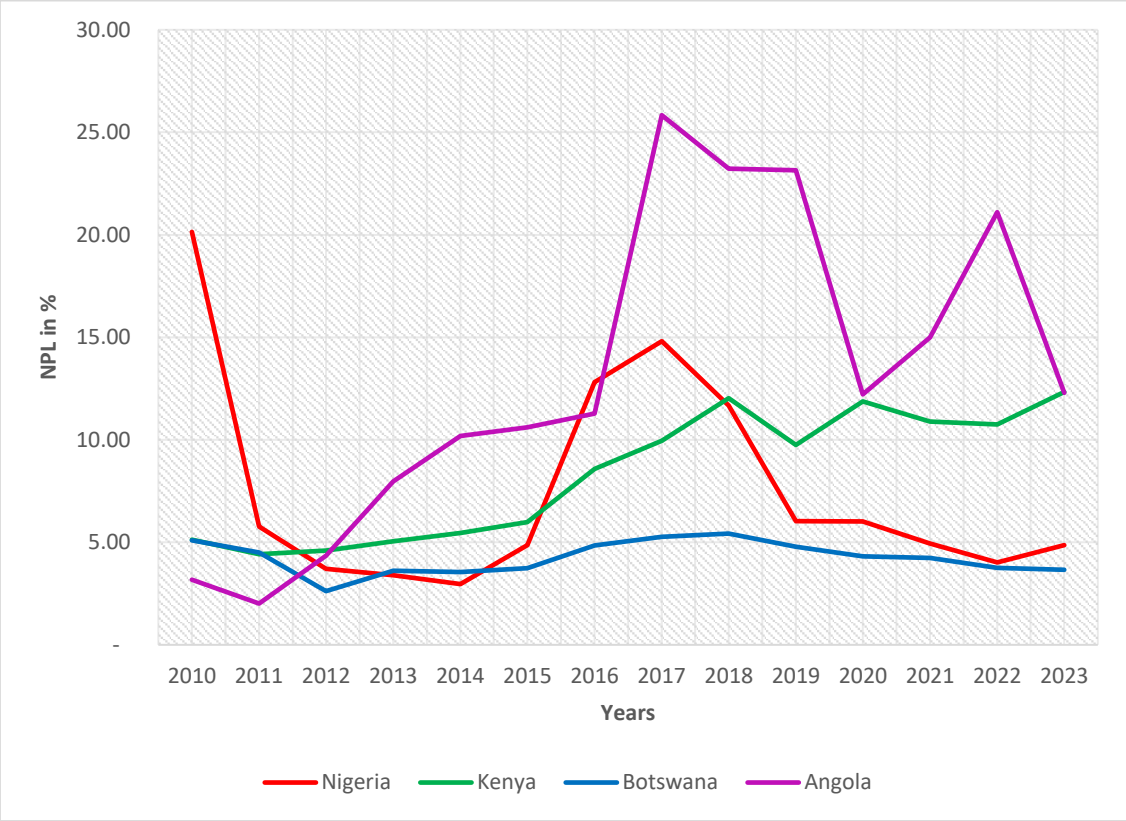
Banks mobilize domestic savings and allocate credit, and the soundness of this intermediation underpins macroeconomic stability (Banke & Yitayaw, 2022). Elevated non-performing loans (NPLs), defined as loans whose repayments are overdue beyond the contractual date (Salas *et al.*, 2024), impair that function. They erode profitability, constrain lending capacity and, in severe cases, precipitate financial crises (Al Zyood, 2022). A ratio of roughly 5 percent is conventionally regarded as prudent (IMF, 2021). Against a global ratio of 5.49 percent in 2022 (World Bank, 2023), regional dispersion is stark. OECD economies recorded 1.75 percent, whereas Sub-Saharan Africa recorded the highest regional ratio, 10.44 percent, more than twice the prudential benchmark level.

Heterogeneity is equally evident within Africa. In 2025, the WAEMU average was 8.8 percent, ranging from 3.7 percent in Benin to 28.6 percent in Niger (IMF, 2025; World Bank, 2024). Nigeria's ratio of 5.76 percent was only marginally above the reference level, whereas Ghana's reached 21.8 percent (Bank of Ghana, 2025). CEMAC averaged 16.0 percent, with Chad and Equatorial Guinea reporting ratios above 30 and 50 percent, respectively (BEAC, 2025; IMF, 2025). SADC averaged approximately 6.5 percent (IMF, 2025). In East Africa, Kenya's ratio of 15.5 percent in January 2026 contrasted with 2.5 percent in Rwanda and 3.3 percent in Tanzania (Central Bank of Kenya, 2025, 2026; National Bank of Rwanda, 2025; Bank of Tanzania, 2024). Although the empirical window ends in 2023, these recent figures show that elevated NPLs persist.

This study examines four financial systems that differ in macroeconomic structure and financial development: Kenya (East African Community), Botswana (Southern African Development Community), Nigeria (Economic Community of West African States) and Angola (Central Africa Countries). Together, they hosted 97 commercial banks in 2023 (IMF, 2025), and consistent data on NPLs and key macroeconomic

indicators are available for 2010–2023. Their trajectories diverge markedly as demonstrated in Figure 1.1.

**Figure 1.1:** Trends of Non-Performing Loans (NPLs) in Kenya, Nigeria, Botswana, and Angola (2010–2023)




**Source:** World Bank (2024). (World Development Indicators Database).

- **Botswana:** its ratio remained within about 2.5–5.5 percent, alongside cautious lending, strict provisioning requirements and currency stability.
- **Kenya:** its ratio rose from 5.1 percent in 2010–2011 to about 12 percent in 2018 and has since hovered around 10–12 percent, a period spanning the 2016 interest-rate cap and the COVID-19 shock.
- **Nigeria:** its ratio fell from about 20 percent in 2010 to roughly 6 percent in 2011 following the creation of the Asset Management Corporation of Nigeria. It rose to about 13–15 percent in 2016–2017 amid falling oil prices, recession and naira depreciation, and returned to about 5 percent by 2023.
- **Angola:** its ratio was the most volatile. From 2–4 percent in 2010–2012, it climbed to roughly 26 percent in 2017 following the oil-price collapse, recession, fiscal deficits and kwanza depreciation. It fell to about 12 percent in 2020 and rebounded to about 20 percent in 2022.

Common shocks in these regions coincide with divergent NPL responses. The pandemic, for example, coincided with a rise in Kenya in 2020 but no comparable rise elsewhere, despite IMF warnings of regional deterioration (Eyraud *et al.*, 2021). These

patterns indicate association, not causation. They suggest that the transmission from macroeconomic conditions to credit risk depends on national structure and policy regime.

Theory points to three channels. Inflation erodes real incomes where wages lag prices but may also reduce the real burden of fixed-rate debt (Fisher, 1933; Bernanke & Gertler, 1989). Higher lending rates raise debt-service costs and, through adverse selection and moral hazard, weaken loan quality (Stiglitz & Weiss, 1981). Tax revenue relative to GDP, as a proxy for fiscal capacity, may sustain demand and facilitate settlement of government arrears, lowering default risk. Existing studies, however, concentrate on single countries, impose common slopes or overlook the fiscal channel. This study therefore estimates the long-run effects of inflation, the lending rate and tax revenue on NPLs in Angola, Botswana, Kenya and Nigeria, and compares country-specific adjustment dynamics.

Non-performing loans (NPLs) undermine the financial intermediation on which Sustainable Development Goal 8.10 depends. In sub-Saharan Africa (SSA), the regional NPL ratio exceeds 10 percent, twice the 5 percent prudential benchmark, eroding bank capital and profitability and constraining credit (World Bank, 2022; Oganda *et al.*, 2019). The problem is also divergence. Over 2010–2023, Botswana's ratio remained between about 2.5 and 5.5 percent, Kenya's rose from 4.5 to 12 percent, Nigeria's fell from 20 to 5 percent, and Angola's peaked near 26 percent in 2017, despite common shocks. Macroeconomic conditions shape borrowers' repayment capacity, but their influence appears context-dependent (Paul, 2022; Kalu *et al.*, 2021).

Theory on the three channels is ambiguous. Inflation erodes real debt but squeezes real incomes (Fisher, 1933); higher lending rates raise debt-service costs and worsen adverse selection (Stiglitz & Weiss, 1981); and tax revenue may reduce disposable income or signal fiscal capacity. Empirical findings are mixed (Mpofu & Nikolaidou, 2019; Asemota *et al.*, 2023; Aliyu, 2023).

Three gaps follow. Empirically, the fiscal channel is largely untested in SSA. Contextually, single-country work concentrates on Nigeria, with few studies of Botswana and Angola and no comparison of structurally different economies. Methodologically, pooled panel's report average effects and rarely test whether long-run relationships are homogeneous or adjustment speeds differ.

The research problem is therefore the lack of comparative evidence on whether inflation, lending rates and tax revenue exert common long-run effects on NPLs across structurally different SSA economies, or whether adjustment is country-specific, leaving policy calibrated to averages that fit no individual economy.

### 1.1 Objectives of the Study

1) To determine the effect of inflation on non-performing loans in the selected sub-Saharan African economies.
2) To investigate the effect of the bank lending interest rate on non-performing loans in the selected sub-Saharan African economies.

3) To analyze the effect of tax revenue as a percentage of GDP on non-performing loans in the selected sub-Saharan African economies.

## 2. Literature Review

### 2.1 Theoretical Literature Review

#### 2.1.1 The Financial Accelerator Theory

The financial accelerator theory originates in Bernanke and Gertler (1989) and was developed into a quantitative framework by Bernanke, Gertler, and Gilchrist (1999) to explain how financial market conditions can amplify the effects of initial economic shocks on the broader economy. Its central argument is that lenders cannot costlessly observe borrowers' projects, so borrowers who need external finance pay an external finance premium that varies inversely with their net worth. A small shock that lowers borrowers' net worth therefore raises the premium, reduces borrowing and spending, and is amplified through the financial system. A macroeconomic shock, such as an increase in interest rates, raises borrowing costs and reduces disposable income, while falling asset prices reduce the value of collateral. Net worth falls, and the premium rises, so investment and consumption decline, defaults increase, and the NPL ratio rises. The resulting losses also erode bank capital and lending capacity, generating additional defaults. Inflation and taxation also operate through net worth and cash flow. The theory was developed mainly for firm balance sheets in advanced economies, and borrower net worth is not observed in aggregate data. The information problems it emphasizes are, however, pronounced in the region's banking sectors (IMF, 2021; Sacerdoti, 2005).

#### 2.1.2 Keynesian Monetary Theory

The Keynesian monetary theory was developed by John Maynard Keynes (1936). It holds that aggregate demand determines the level of economic activity and employment. In the monetary part of the theory, the interest rate is determined by liquidity preference, and together with expected returns, it governs investment. Changes in investment then change income, output and aggregate demand through the multiplier. The higher lending rate raises the cost of servicing debt and dampens investment and consumption for loan performance, thus reducing incomes and the ability to repay. This logic is applied to banks by Dymski (1988) to show that the macroeconomic environment determines credit decisions. If wages are sticky, inflation reduces the real purchasing power of households, disposable income and the ability to service debt. The importance of fiscal policy is also emphasized in the theory, where higher fiscal space, measured by higher tax revenue as a share of GDP, supports aggregate demand and income and timely settlement of obligations to private suppliers (IMF, 2024; Sacerdoti, 2005). The study expects a negative relationship between tax revenues and NPLs as an extension of the theory. The limits are the imperfect pass-through from central bank rates to commercial lending rates, sticky prices that fit imperfectly in high-inflation economies, and a largely closed-economy focus.

### 2.1.3 Credit Risk Theory (205 words)

Credit risk theory provides the foundation for helping financial institutions make informed lending decisions by measuring and mitigating the probability that a borrower fails to honor loan repayment obligations. Merton (1974) formalized the structural approach by applying option pricing techniques: the firm's equity is viewed as a call option on its assets, and default occurs when the value of the firm's assets is less than the value of its debt at maturity. Anything that lowers asset values, reduces cash flows or raises debt obligations raises the probability of default, and a bank's loan portfolio aggregates these probabilities, so the NPL ratio is the portfolio-level expression of credit risk. A second strand (Stiglitz & Weiss, 1981) stresses information problems: higher lending rates can worsen the pool of borrowers through adverse selection and encourage riskier behavior through moral hazard. Credit risk has a systematic component, driven by macroeconomic conditions, which is the focus of the study. The theory is a partial-equilibrium framework, and structural models require observable asset values and comprehensive borrower data, which are scarce where enterprises are informal and underbanked (Central Bank of Kenya, 2021; FinRegLab, 2024). The study therefore uses it as an interpretive framework at the aggregate level, complemented by Keynesian demand-side theory.

## 2.2 Empirical Literature Review

Many studies have analyzed how macroeconomic variables such as inflation, tax revenue and the bank lending rate influence non-performing loans (NPLs) globally. Understanding the relationship between these variables is necessary because they influence a country's economic growth and the stability of its financial institutions. This section reviews relevant studies' findings to offer a basic understanding of how the selected macroeconomic variables affect NPLs in Sub-Saharan Africa.

### 2.2.1 The Effect of Inflation on Non-Performing Loans

Ptasica (2019) investigated the effect of inflation on NPLs in Cyprus commercial banks. The strength and direction of the relationship were investigated by simple linear correlation. The study found that the coefficient of correlation between the changes in inflation and the NPLs of commercial banks is strongly negative (-0.710). The coefficient of determination also revealed that only 50.4% of changes in NPLs are explained by changes in inflation, thus requiring further study of the effect of other macroeconomic variables (unemployment, interest rates and taxes) on NPLs in Sub-Saharan Africa. The study is relevant for understanding the relationship between inflation and NPLs, but it assumed an exact relationship, which could lead to omitted variable bias.

Tham *et al.* (2021) studied the effect of inflation fluctuations on the non-performance of Malaysian banks' property loans in the period 2010-2015, with banks' profit determinants as intervening variables. The Johansen cointegration trace value of 53.4 from the Vector Error Correction Model was more than the critical value at 5%, indicating a long-term statistically significant relationship between inflation and

property loan non-performance. For every unit rise in inflation, NPLs were reduced by 5.60 units. The study helps in explaining the short-run and long-run relationship between inflation and NPLs, but the use of only one independent variable led to omitted variable bias, and the six years of data used in the study might make the cointegration findings less robust.

The effect of macroeconomic variables on NPLs of commercial banks in the Balkan countries for the period 2006-2020 has been studied by Rasniqi-Pervetica and Ahmeti (2022), where inflation, public debt-to-GDP ratio, unemployment and GDP are independent variables. They employed co-integration and linear regression analysis through the OLS method and found that a unit rise in inflation has a statistically significant impact on NPLs by decreasing them by 0.32 units, while a unit increase in unemployment increases NPLs by 0.095 units. But the study is limited to Balkan countries, which have more effective mechanisms for loan risk assessment in their banking sectors than in Sub-Saharan Africa, and provides a solid cross-country understanding.

Leleok and Makori (2024) conducted a study on 41 commercial banks in Kenya that were not listed on the Nairobi Stock Exchange using panel regression for the period 2013-2021. The independent variables were the interest rate on loans, exchange rate and inflation. Inflation had a positive effect on NPLs (0.1928) and was statistically significant in the short run. But in the long term, it was negative (-0.7337) and statistically not significant ($p = 0.6156$). Khan *et al.* (2023) applied the generalized method of moments to study 34 banks of Bangladesh during 2011–2022, controlling for bank-specific and macroeconomic variables. The results show that 1% increase in inflation decreases borrowers' real debt by 0.332% and, thus, reduces NPLs; a 1% increase in economic growth decreases NPLs by 0.886%, and a 1% increase in unemployment increases NPLs by 2.472%.

### 2.2.2 The Effect of Interest Rates on Non-Performing Loans

Using a descriptive research design, Kigamwa and Mutwiri (2023) undertook a study on macroeconomic factors affecting NPLs in the Kenyan banking sector using data from 2005-2021. The independent variables were commercial banks' loan interest, inflation and exchange rate changes. NPLs amounted to 9.5% of the extended loans. An increase in inflation by one unit reduces NPLs by 0.00230 units, while an increase in the loan interest of commercial banks by one unit increases NPLs by 0.00246086 units. This study provides an empirical understanding of this relationship, but it lacks econometric robustness because of the descriptive nature of the study design, which limits the application of the study findings to banking sector policy. The study aims to apply robust techniques of panel data analysis to ensure the model is stable in the long run and the findings are reliable in the formulation of policies.

Duruechi (2022) studied the effect of the Central Bank of Nigeria monetary policy actions on bank NPLs for the period of 1990–2021, using the central bank rate, quick ratio and loan-to-deposit ratio as independent variables. The Johansen trace statistic of the

central bank rate was 82.4754, which was higher than the critical value at 5% (47.8561) using the vector error correction model and Granger causality tests. This shows a stable, statistically significant long-run relationship between the central bank rate and NPLs. The study did not consider other macroeconomic determinants of NPLs such as taxes and inflation and was limited to a single country. This study is in line with the focus of the study on the effect of changes in monetary policy on the Nigerian banking sector but on a wider cross-country scope.

Basel *et al.* (2022) studied the impact of central bank intervention on NPLs in Brazil and the UK during COVID-19, applying the ordinary least squares method with the federal security interest rate, unemployment and GDP growth as independent variables. A central bank intervention of one unit reduces the prevalence of NPLs by 0.27 units significantly. The study is most useful for understanding short-term loan performance trends during economic shocks, and since the study was done in developed economies, its findings may not be relevant in Sub-Saharan Africa. The period of the present study, 2010 to 2023, includes years of regional shocks as well as normal years and thus provides a better framework for banking sector policy.

Robert and Koori (2022) studied the impact of interest rates on NPLs in Kenya using secondary data for 2016-2020, with loan size, the commercial bank lending rate and interest earned on deposits as independent variables. Their fixed-effects regression showed that a 1% increase in commercial banks' credit interest statistically significantly increased NPLs by 0.312%, that interest earned on deposits was negatively related to NPLs, and that a 1% increase in the central bank to commercial banks' lending rate statistically insignificantly increased NPLs by 0.008%.

Musimbi *et al.* (2023), using quarterly data for 2010-2021, found that a 1% increase in the central bank rate led to a 0.9666% short-run adjustment in commercial banks' lending rates and a 1.29% increase in the long run. These findings are relevant for understanding the slow short-term but full long-term adjustment of commercial banks' interest rates to the central bank rate, which is the transmission mechanism through which the central bank rate affects NPLs. This study widens the scope through cross-country analysis to understand whether Sub-Saharan African commercial banks vary loan interest rates based on the central bank rate, and its effect on NPLs in the region.

### 2.2.3 The Effect of Taxation on Non-Performing Loans

In Turkey, for the period of 2017-2021, Özen *et al.* (2022) investigated the relation between government fiscal policy measures and household NPLs and analyzed the effects of VAT laws, along with household income, GDP growth, inflation and commercial banks' loan interest as other independent variables. For their long-run results, they found that a 1% increase in VAT has significantly increased Turkish banking sector NPLs by 0.46% when using an ARDL model. This is in line with economic theory, which says that higher consumer taxes translate into higher prices of goods and services, lower income for businesses and greater difficulty in paying loans. The importance of the study is that it

gives a more holistic picture of the effect of taxes on NPLs, which has been less explored in the literature on loan performance.

Aliyu (2023) used secondary data on Nigerian banks from 1990 to 2021, adopted a descriptive research design and used an autoregressive distributed lag error correction model. The study results show that real interest rates, tax revenue and recurrent expenses can help to address NPLs of Nigerian banks in the long run, with a 1 percent increase in tax revenue causing an 11.73 percent decline in the NPL ratio.

Lin *et al.* (2021) analyzed the pass-through of US government taxes levied on financial institutions to borrowers through loan interest pricing over the period 1994-2014. They used a quasi-experimental OLS design taking advantage of the difference in tax rates between states. They showed that a 1% increase in the tax rate on banks' income increased the loan spread by 4 to 6 percentage points over the benchmark rate, thus increasing the cost of loans. However, the results may not be generalizable in the Sub-Saharan region due to structural differences in the banking sectors.

### 2.3 Research Gap

The reviewed literature leaves four gaps.

Most reviewed evidence on the macroeconomic drivers of NPLs comes from advanced and emerging economies: Cyprus (Ptasica, 2019), Malaysia (Tham *et al.*, 2021), Brazil and the United Kingdom (Basel *et al.*, 2022), the Balkans (Krasniqi-Pervetica & Ahmeti, 2022), Turkey (Özen *et al.*, 2022), Bangladesh (Khan *et al.*, 2023) and the United States (Lin *et al.*, 2021). These banking systems differ from those of sub-Saharan Africa (SSA) in credit-risk assessment, structure and exposure to commodity and exchange-rate shocks. The SSA evidence is confined to single economies, namely Kenya (Robert & Koori, 2022; Kigamwa & Mutwiri, 2023; Musimbi *et al.*, 2023; Leleok & Makori, 2024) and Nigeria (Duruechi, 2022; Aliyu, 2023). No reviewed study covers Botswana or Angola, or compares oil-exporting (Angola, Nigeria), mineral-dependent (Botswana) and diversified (Kenya) economies.

Inflation is mostly found to lower NPLs, consistent with debt erosion (Ptasica, 2019; Tham *et al.*, 2021; Krasniqi-Pervetica & Ahmeti, 2022; Khan *et al.*, 2023; Kigamwa & Mutwiri, 2023). Yet among Kenyan banks, it raises NPLs in the short run and is insignificant in the long run (Leleok & Makori, 2024). Lending-rate effects are positive (Robert & Koori, 2022; Kigamwa & Mutwiri, 2023), but the evidence on the policy rate is mixed: it has a stable long-run relationship with NPLs in Nigeria (Duruechi, 2022) and an insignificant effect in Kenya (Robert & Koori, 2022), and it passes through to lending rates only gradually (Musimbi *et al.*, 2023). Whether these divergences reflect country context, variable definition or estimation method remains unresolved.

Only three of the thirteen reviewed studies consider taxation, and their findings diverge by instrument. VAT increases raise NPLs in Turkey (Özen *et al.*, 2022), aggregate tax revenue lowers NPLs in Nigeria (Aliyu, 2023), and taxes on bank income raise loan spreads in the United States (Lin *et al.*, 2021). Aggregate tax revenue has therefore been

tested for only one SSA economy, in a single-country ARDL, and its omission elsewhere risks omitted-variable bias.

Correlation and OLS designs (Ptasica, 2019; Basel *et al.*, 2022; Krasniqi-Pervetica & Ahmeti, 2022; Lin *et al.*, 2021) cannot separate short-run dynamics from long-run relationships. Single-country VECM and ARDL studies (Tham *et al.*, 2021; Duruechi, 2022; Özen *et al.*, 2022; Aliyu, 2023) cannot compare countries, and bank-level panels within one country (Robert & Koori, 2022; Khan *et al.*, 2023; Leleok & Makori, 2024) cannot compare how macroeconomic conditions transmit across economies. Heterogeneous-panel estimators let short-run dynamics differ while testing whether long-run effects are common (Pesaran & Smith, 1995; Pesaran *et al.*, 1999). To the best of the researcher's knowledge, they have not been applied to compare NPL dynamics in these economies.

This study addresses these gaps by applying a panel autoregressive distributed lag (ARDL) pooled mean group (PMG) error correction model, with the mean group (MG) estimator as a comparator, to Angola, Botswana, Kenya and Nigeria (2010–2023). It jointly estimates the effects of inflation, the bank lending rate and tax revenue as a share of GDP on NPLs. Short-run coefficients and adjustment speeds may differ by country, and long-run homogeneity is tested.

## 3. Econometric Methodology

### 3.1 Research Design

The study adopted a panel data research design to analyze temporal and structural changes in the relationship between the selected macroeconomic variables and non-performing loans in Kenya, Botswana, Angola, and Nigeria. A panel design was chosen because it exploits both the cross-country and time-series dimensions of the data simultaneously, allowing the study to examine long-run cross-country relationships while still accommodating the short-run dynamics and structural heterogeneity that distinguish one country's banking sector from another.

### 3.2 Data Source

The study used secondary annual data for the period 2010-2023. Non-performing loan data were obtained from the World Bank's Global Financial Development Database, inflation data from the World Bank's Consumer Price Index series, and bank lending rate data from the World Bank's lending interest rate series. Tax revenue as a percentage of GDP was sourced primarily from the World Bank's tax revenue database, supplemented for Nigeria with data from the Nigeria Bureau of Statistics where World Bank coverage was incomplete.

### 3.3 Analytical Framework on Variable Selection

The study is based on the Financial Accelerator Theory, which states that the disposable income of a household or a firm affects the net worth and the ability of the household or

firm to service debts. This income is subject to inflation, credit costs and tax. The study considers three macroeconomic variables. These are inflation which reduces real disposable income, the bank lending rate which affects the cost of borrowing and taxation as a percentage of GDP which reduces disposable income and after-tax profits or increased fiscal capacity supporting aggregate demand and income. The paper tries to test the relationship between these variables and loan repayment capacity, using existing economic theory and previous empirical literature.

The three macroeconomic variables examined in this study were selected on three grounds: the availability of established economic theory linking each variable to credit performance, the existence of a body of prior empirical literature examining each variable, and each variable's relevance to macroeconomic policy in the countries studied.

Formally, non-performing loans for country i at time t, $NPL_{it}$, are modeled as a function of household disposable income, $Y_{it}$, which in turn determines household net worth, $W_{it}$:

$$NPL_{it} = f(W_{it}) \text{ where } W_{it} = f(Y_{it}) \tag{3.1}$$

$$Y_{it} = f(Taxation_{it}, LendingRate_{it}, Inflation_{i}) \tag{3.2}$$

Substituting Equation 2 into Equation 1 gives the reduced-form relationship this study estimates:

$$NPL_{it} = f(Taxation_{it}, LendingRate_{it}, Inflation_{it}) \tag{3.3}$$

where $taxation_{it}$, lending $rate_{it}$, and $inflation_{it}$ denote, respectively, tax revenue as a percentage of GDP, the bank lending rate, and the inflation rate for country i in year t.

### 3.4 Model Specification

The study used a panel autoregressive distributed lag (ARDL) error-correction model guided by the Pesaran, Shin, and Smith (1999) framework, because non-performing loans, lending rates, and tax revenue were expected to be integrated of order one, as confirmed in Chapter Four, and inflation was expected to be stationary. This error-corrected approach distinguishes between short-term dynamics and long-run equilibrium relationships expressed as follows:

$$\Delta NPL_{it} = \varphi_i(NPL_{i,t-1} - \theta_1 \cdot Inflation_{it} - \theta_2 \cdot LendingRate_{it} - \theta_3 \cdot Taxation_{it}) + \beta_{1i}\Delta Inflation_{it} + \beta_{2i}\Delta LendingRate_{it} + \beta_{3i}\Delta Taxation_{it} + \mu_i + \varepsilon_{it} \tag{3.4}$$

where:
$\Delta NPL_{it}$: is the change in the non-performing loan ratio for country i in year t;
$\varphi_i$: is the country-specific error-correction (speed-of-adjustment) coefficient, expected to be negative for a stable, mean-reverting long-run equilibrium;

$\theta_1, \theta_2, \theta_3$: are the long-run coefficients on inflation, the bank lending rate, and tax revenue, respectively;
$\beta_{1i}, \beta_{2i}, \beta_{3i}$: are the country-specific short-run coefficients on the contemporaneous change in each predictor;
$\mu_i$: is a country-specific fixed effect capturing unobserved heterogeneity and $\varepsilon_{it}$: is a white-noise error term.

The term in parentheses, $NPL_{i,t-1} - \theta_1$ $inflation_{it} - \theta_2$ $lending\ rate_{it} - \theta_3$ $taxation_{it}$, is the error-correction term: the extent to which non-performing loans deviated from their long-run equilibrium relationship with the three predictors in the previous period. A negative and significant $\varphi_i$ indicates that any such deviation is corrected over time, which is the theoretical condition required for the long-run relationship to be meaningful.

### 3.5 Model Estimation Strategy

The Mean Group (MG) estimator, following Pesaran and Smith (1995), fits Equation 3.4 separately for each of the four countries and then computes the unweighted average of the resulting long-run and short-run coefficients across countries:

$$\hat{\theta}_{MG} = \frac{1}{N}\sum_{i=1}^{N}\hat{\theta}_i\text{, for } N = 4 \text{ (Angola, Botswana, Kenya, Nigeria)} \quad (3.5)$$

The MG estimator avoids bias from enforcing artificial slope homogeneity on heterogeneous countries by allowing all long-run and short-run parameters to vary freely between countries. The cross-country average is a useful and unbiased benchmark against which to compare the more restrictive Pooled Mean Group estimator. However, MG estimates a full set of parameters separately for each country from a relatively short time series, making country-level estimates unreliable.

### 3.6 The Pooled Mean Group Estimator

The Pooled Mean Group (PMG) estimator, developed by Pesaran, Shin, and Smith (1999), combines the Mean Group estimator and a fully pooled model by constraining the long-run coefficients $\theta_1$, $\theta_2$, and $\theta_3$ to be identical across all four countries. It assumes that inflation, the lending rate, and tax revenue relate to non-performing loans through the same fundamental channels, while allowing each country to have its own intercept.

$$\hat{\theta}PMG = \theta \text{ (common across } i = 1, \dots, N); \quad (3.6)$$

$\hat{\varphi}_i, \hat{\beta}_i$ estimated separately for each country i

The PMG estimator is more efficient than MG whenever long-run coefficient homogeneity genuinely holds in the data, because it pools information across countries when estimating the long-run relationship rather than estimating it four times independently. Whether that homogeneity assumption is appropriate for this study's data is not assumed but tested directly, using the Hausman specification test described in Section 3.7.3.

### 3.7 Pre-Estimation Tests

The Levin-Lin-Chu (LLC) test was chosen in this study's small, balanced panels (N = 4, T = 14) due to its higher power, although its assumption of a consistent autoregressive coefficient across nations warrants caution. The Im-Pesaran-Shin (IPS) test allows the autoregressive coefficient to vary by country and was employed as an extra robustness check, although its power is restricted when N is as small as four. Using Maddala and Wu's combination of country-level Augmented Dickey-Fuller p-values, the Fisher-type test does not require a common lag structure across countries, making it suitable for a small, heterogeneous panel. The Hadri Lagrange Multiplier test tests the null of stationarity against a unit root alternative. Agreement between the Hadri test and the other three strengthens confidence in the conclusion, while disagreement suggests structural breaks. Finally, country-by-country Augmented Dickey-Fuller (ADF) testing revealed country-specific persistent patterns that panel-level tests from a cross-country average would miss.

**Table 3.2**: Unit Root Tests: Null Hypotheses and Decision Criteria

| Test | Null hypothesis (H0) | Alternative (H1) | Test statistic | Decision rule ($\alpha$ = 0.05) |
|---|---|---|---|---|
| LLC | Common unit root ($\rho = 1$) | Common stationarity ($\rho < 1$) | Adjusted t* | Reject H0 if $p < .05$ |
| IPS | Unit root for all i ($\rho_i = 1$) | Stationarity for at least one i | Standardized t-bar | Reject H0 if $p < .05$ |
| Fisher-ADF | Unit root for all i | Stationarity for at least one i | $\chi^2 = -2\Sigma\ln(p_i)$ | Reject H0 if $p < .05$ |
| Hadri LM | Stationarity (no unit root) | Non-stationarity (unit root) | LM statistic | Reject H0 if $p < .05$ |
| Country ADF | Unit root ($\rho_i = 1$) | Stationarity ($\rho_i < 1$) | ADF t-statistic | Reject H0 if $p < .05$ |

### 3.8 Model Estimation and Selection

The mean group and pooled mean group estimators were fully estimated. Without assumptions, the Hausman specification test was used to select the best method between the two estimation methods. The test's null hypothesis is based on the PMG assumption that long-run coefficients are comparable across countries. If not, the less efficient but more flexible MG estimator is preferred. In terms of efficiency, PMG is preferable over MG if the null cannot be rejected with a p-value greater than 0.05. When the difference between the MG and PMG coefficient covariance matrices is not positive definite in tiny panels, the test statistic is computed using the Moore-Penrose generalized inverse rather than a matrix inverse.

### 3.9 Multicollinearity

To ensure that the regression estimates were not distorted by excessive correlation among the predictors, multicollinearity was assessed using the variance inflation factor (VIF),

computed from a pooled ordinary least squares regression of non-performing loans on inflation, the lending rate, and tax revenue.

**H0:** The variance of the coefficient estimates is not substantially inflated by multicollinearity.

**H1:** The variance of the coefficient estimates is substantially inflated by multicollinearity.

A VIF value below 10 for every predictor was treated as evidence that multicollinearity does not compromise the reliability of the regression estimates; a VIF at or above 10 for any predictor would indicate that variable modification, such as dropping or transforming a variable, was required before proceeding.

### 3.10 Autocorrelation

A Wooldridge-type test for first-order serial correlation was applied to the idiosyncratic errors of the estimated model, testing H0: $\rho = 0$ (no serial correlation) against H1: $\rho \neq 0$ (an AR(1) process), evaluated at the 5 percent significance level. Serial correlation is a realistic possibility in a panel of this kind, given the fourteen-year time dimension and the persistence typically inherent in macroeconomic series, and the diagnostic testing sequence in Section 3.8 was designed to confirm formally whether it was, in fact, present, and to correct for it if so.

### 3.11 Homoskedasticity

Constant residual variance across the four countries, homoskedasticity, was tested using the Breusch-Pagan test for groupwise heteroskedasticity, applied to the residuals of the estimated Pooled Mean Group model. The null hypothesis is that the residual variance is constant across the four countries, H0: $\sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma_4^2$; the alternative is that it differs across countries. If the null hypothesis is rejected at the 5 percent level, the residuals exhibit groupwise heteroskedasticity, which means the model's standard errors, and by extension its significance tests, cannot be trusted as estimated. Rather than treat this as a problem to be patched after the fact with heteroskedasticity-robust standard errors alone, the study's approach, consistent with the principle that a final model should itself satisfy the classical regression assumptions, was to re-estimate the entire model from the ground up using feasible generalized least squares whenever the Breusch-Pagan test rejected the null. This procedure, and why it was required for the baseline model estimated in Chapter Four, is described in full in Section 3.8.

### 3.12 Cross-Sectional Dependence

The Pesaran (2004) cross-sectional dependence (CD) test was applied after model estimation to check whether the residuals were correlated across countries, testing H0: Cov $(\varepsilon_{it}, \varepsilon_{jt}) = 0$ for $i \neq j$ (no cross-sectional dependence) against H1: Cov$(\varepsilon_{it}, \varepsilon_{jt}) \neq 0$ (dependence present). The CD statistic is asymptotically standard normal, so the null hypothesis is rejected at the 5 percent level whenever $|CD|$ exceeds 1.96, which would call for Driscoll-Kraay standard errors to ensure valid inference. Failure to reject the null

supports the use of conventional standard errors, confirming that the residuals behave as though independent across the four countries.

## 4. Results and Discussion

### 4.1 Descriptive Statistics

The panel data set used in this study comprises 56 country-year observations, drawn from four Sub-Saharan African countries observed annually between 2010 and 2023. Table 4.1 presents the pooled descriptive statistics for non-performing loans and the three macroeconomic predictors, while Table 4.2 breaks these statistics down by country to reveal the substantial cross-country heterogeneity that motivates a panel, rather than a purely pooled, approach to estimation.

**Table 4.1**: Pooled Descriptive Statistics of the Study Variables (N = 56)

| Variable | Obs. | Mean | SD | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| Non-performing loans (%) | 56 | 8.273 | 5.683 | 2.010 | 25.840 | 1.368 | 4.230 |
| Inflation (%) | 56 | 10.850 | 6.854 | 1.890 | 30.690 | 1.106 | 3.660 |
| Lending rate (%) | 56 | 14.102 | 4.345 | 5.250 | 22.540 | -0.461 | 2.285 |
| Tax revenue (% of GDP) | 56 | 15.595 | 5.534 | 7.250 | 28.040 | 0.548 | 2.302 |

**Table 4.2**: Descriptive Statistics by Country: Mean (Standard Deviation)

| Country | NPL (%) | Inflation (%) | Lending rate (%) | Tax revenue (% GDP) |
|---|---|---|---|---|
| Angola | 12.93 (7.63) | 17.42 (7.72) | 18.19 (2.15) | 11.94 (3.23) |
| Botswana | 4.25 (0.80) | 5.31 (2.78) | 7.97 (2.15) | 23.38 (2.85) |
| Kenya | 8.34 (3.08) | 6.97 (2.48) | 14.63 (2.33) | 15.37 (1.38) |
| Nigeria | 7.57 (5.19) | 13.70 (4.54) | 15.62 (1.97) | 11.69 (3.59) |

Across the pooled sample, the average non-performing loan ratio stood at 8.27 percent, with considerable dispersion (SD = 5.68) and a maximum of 25.84 percent, a level that is more than twice the IMF's 5 percent stability benchmark referenced in Chapter One. The positive skewness (1.368) and elevated kurtosis (4.230) of the NPL series indicate a distribution with a longer right tail than a normal distribution would produce, consistent with the presence of occasional severe banking-sector stress episodes rather than a smoothly varying series. Angola drives much of this dispersion: its average NPL ratio of 12.93 percent, nearly three times Botswana's 4.25 percent, reflects the boom-bust pattern described in Chapter One, in which the 2015-2017 oil price collapse pushed Angolan non-performing loans as high as 26 percent. Botswana, by contrast, combines the lowest and most stable NPL ratio in the sample with the highest average tax revenue share of GDP (23.38 percent), while Kenya and Nigeria occupy an intermediate position on most indicators.

Inflation averaged 10.85 percent across the panel but ranged from a low of 1.89 percent to a high of 30.69 percent, again driven largely by Angola's episodes of currency depreciation and fiscal stress. The average lending rate of 14.10 percent and its relatively modest standard deviation (4.35) suggest less extreme cross-country variation in the cost

of credit than in inflation or non-performing loans, although Botswana's average lending rate of 7.97 percent is markedly below the sample mean. Tax revenue as a share of GDP averaged 15.60 percent, with Botswana's fiscal capacity again standing out as the strongest in the sample and Nigeria's, at 11.69 percent, the weakest, a pattern broadly consistent with Nigeria's well-documented reliance on oil revenue rather than broad-based taxation.

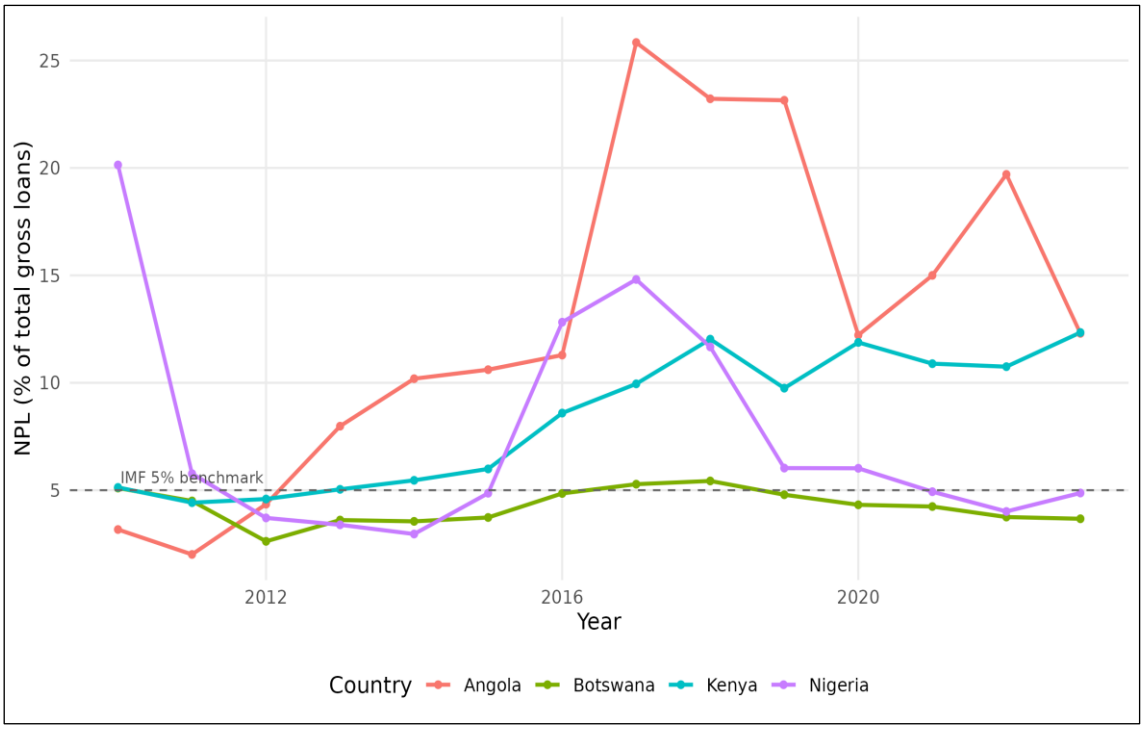



**Figure 4.1**: Trend in Non-Performing Loan Ratios by Country, 2010-2023

Figure 4.1 traces the trajectory of non-performing loans for each country over the study period. Angola's NPL ratio is visibly the most volatile of the four series, climbing sharply after 2015 in line with the oil price collapse discussed in Chapter One before beginning a gradual decline in the final years of the sample. Botswana's series is comparatively flat and low throughout, while Kenya and Nigeria show milder fluctuations that nonetheless respond to identifiable regional and global shocks, including the period surrounding the COVID-19 pandemic.

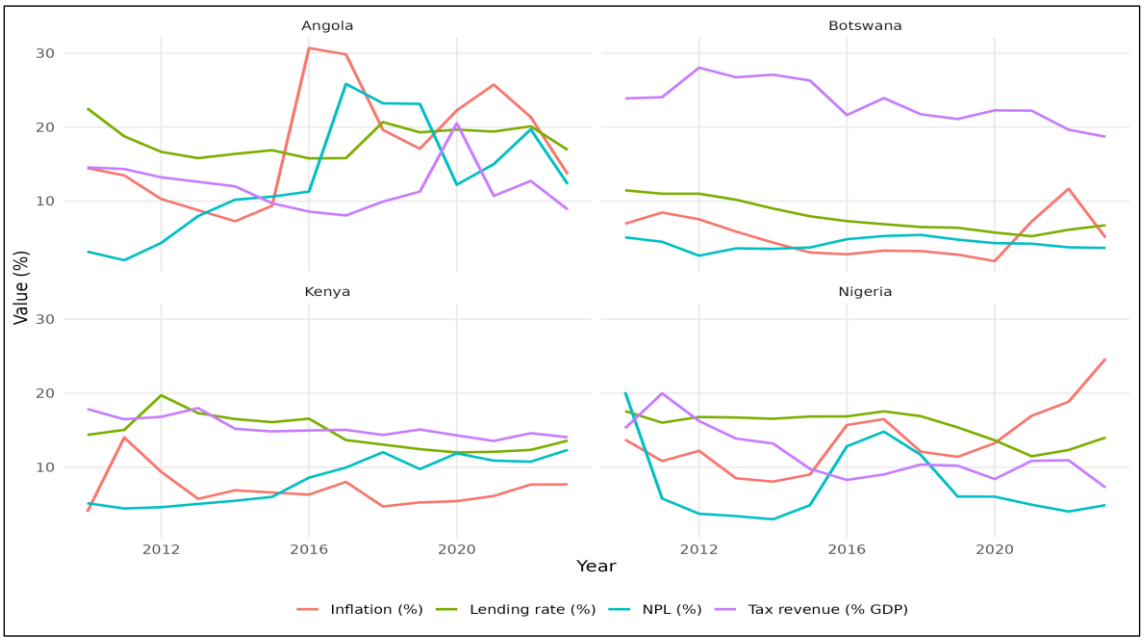



**Figure 4.2**: Trends in Inflation, Lending Rate, and Tax Revenue by Country, 2010-2023

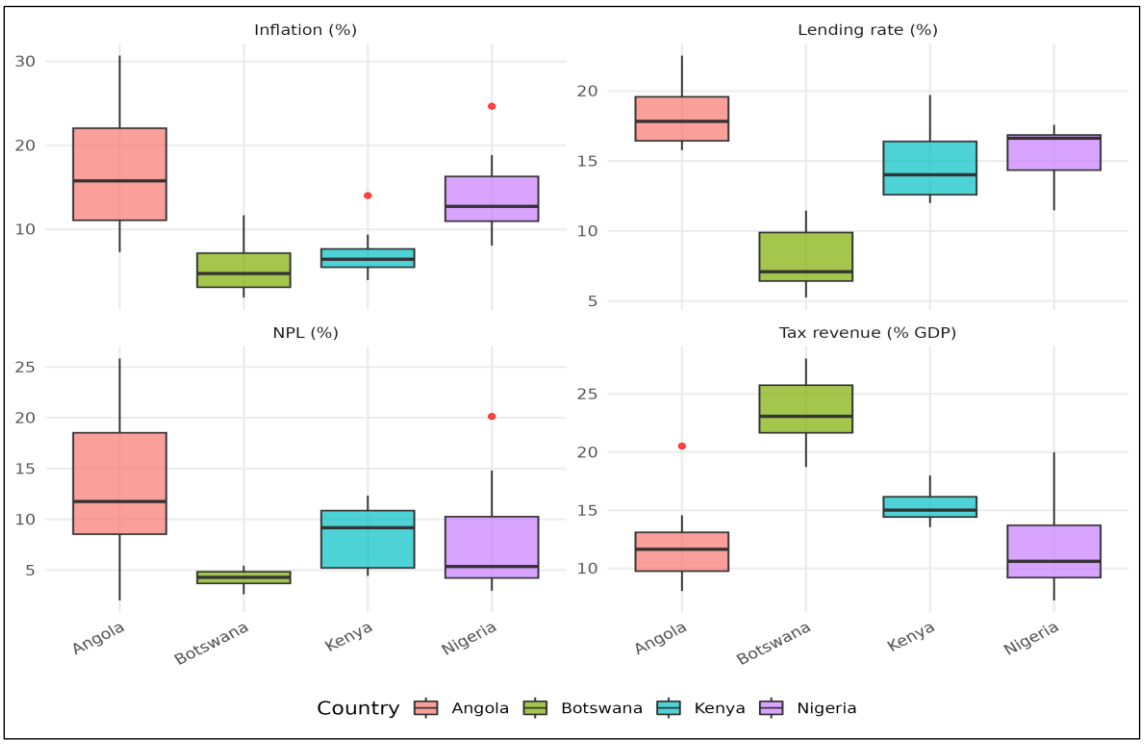



**Figure 4.3**: Distribution of Study Variables by Country

The boxplots in Figure 4.3 corroborate the summary statistics in Table 4.2: Angola's distributions for NPL, inflation, and lending rate are shifted upward and are wider than those of the other three countries, while Botswana's distributions are the most compact. This heterogeneity across countries, together with the length of the time dimension relative to the cross-sectional dimension, is precisely the setting for which the Mean Group and Pooled Mean Group estimators used later in this chapter were developed,

since both allow the short-run dynamics to differ by country while imposing a common long-run relationship only where the data support doing so.

### 4.2 Correlation Analysis

Before turning to the panel ARDL estimation, a Pearson correlation analysis was conducted to provide an initial, purely bivariate picture of how non-performing loans relate to each of the three macroeconomic variables, and of how the three predictors relate to one another. Rather than reporting the correlation coefficients in a separate table, Figure 4.4 presents the full correlation matrix as an annotated heatmap in which each cell shows the Pearson correlation coefficient together with its exact significance level, so that the strength, direction, and statistical significance of every pairwise relationship can be read directly from the figure.

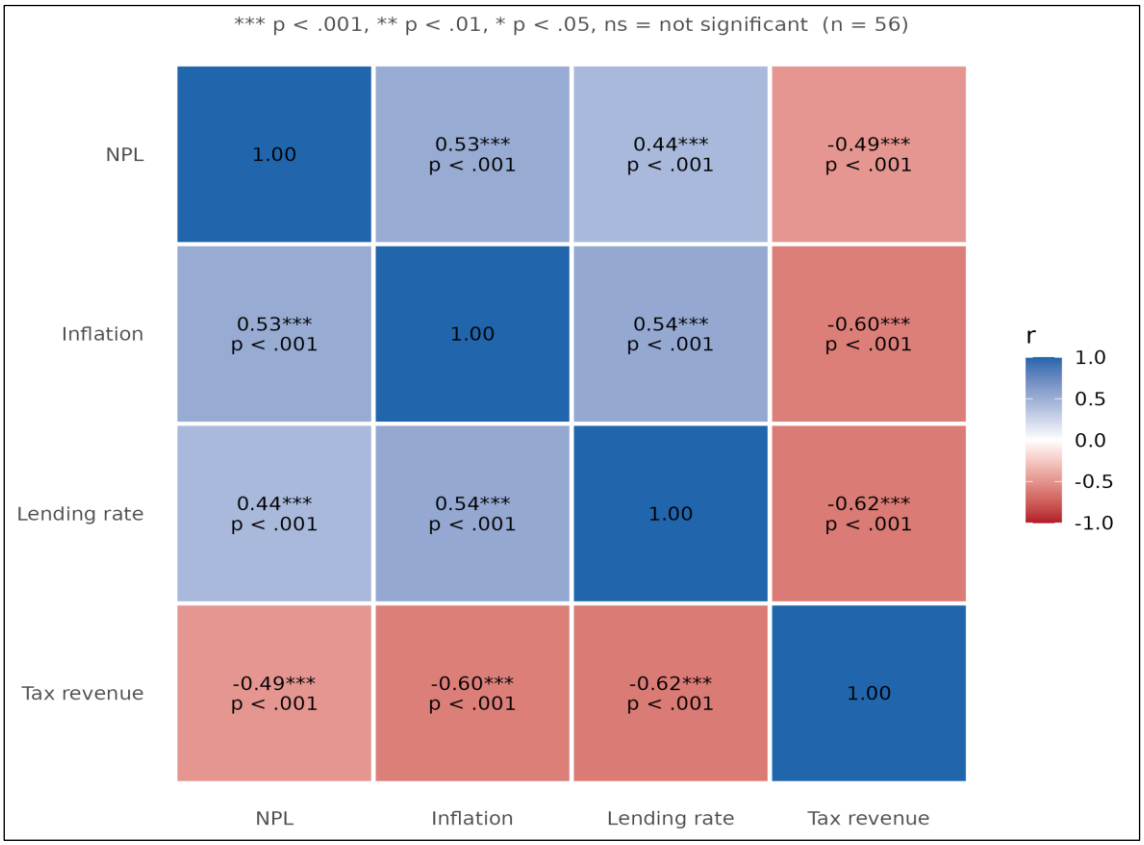



**Figure 4.4**: Pearson Correlation Matrix of Non-Performing Loans and Macroeconomic Variables, with Exact p-values (N = 56)

Every pairwise correlation shown in Figure 4.4 is statistically significant at the 1 percent level. Non-performing loans are positively and moderately correlated with inflation ($r = .528$, $t(54) = 4.568$, $p < .001$) and with the lending rate ($r = .436$, $t(54) = 3.562$, $p < .001$), and negatively correlated with tax revenue ($r = -.490$, $t(54) = -4.133$, $p < .001$). At face value, these bivariate results suggest that higher inflation and higher borrowing costs move together with a higher incidence of loan default, while stronger fiscal capacity, as proxied by tax revenue collection, moves together with a lower incidence of default.

The three predictors are themselves correlated with one another, most strongly between the lending rate and tax revenue ($r = -.618$, $p < .001$), followed by inflation and tax revenue ($r = -.600$, $p < .001$) and inflation and the lending rate ($r = .542$, $p < .001$). None of these inter-predictor correlations approaches a magnitude that would, on its own, be considered problematic (a common rule of thumb treats correlations above roughly .80 as a warning sign), but because the coefficients are not trivial either, the variance inflation factors reported later in this chapter (Table 4.6) are used to confirm formally that multicollinearity does not compromise the regression estimates. It is also worth stressing that these correlations are simple, static, contemporaneous associations; they do not distinguish short-run from long-run effects, nor do they control for the other predictors or for unobserved country-specific factors, all of which the panel ARDL model estimated later in the chapter is designed to address.

### 4.3 Panel Unit Root (Stationarity) Tests

Prior to estimation, the order of integration for each series was defined, as an autoregressive distributed lag (ARDL) error-correction framework requires no variables of order two or higher to be integrated. The Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests test the null hypothesis that the panel contains a unit root against stationarity, whereas the Fisher-type test based on Maddala and Wu's combination of country-level Augmented Dickey-Fuller p-values tests the same null. Reporting all four at both levels and beginning differences precludes a single test's assumptions (such as LLC's assumption of a common autoregressive parameter across countries, which is aided by IPS) from influencing the outcome. Table 4.3 displays the level, first-differenced, and p-values for each variable.

**Table 4.3**: Panel Unit Root Test Results: Levels and First Differences

| Variable | Form | LLC stat. (p) | IPS stat. (p) | Fisher M-W stat. (p) | Hadri LM stat. (p) |
|---|---|---|---|---|---|
| NPL | Level | -1.239 (.108) | -0.604 (.273) | 10.100 (.258) | 5.837 (< .001) |
| | 1st difference | -6.194 (< .001) | -5.407 (< .001) | 60.828 (< .001) | -0.345 (.635) |
| Inflation | Level | -2.453 (.007) | -2.042 (.021) | 27.550 (< .001) | 3.043 (.001) |
| | 1st difference | -3.849 (< .001) | -5.063 (< .001) | 63.152 (< .001) | -0.295 (.616) |
| Lending rate | Level | -2.136 (.016) | -1.184 (.118) | 13.146 (.107) | 8.746 (< .001) |
| | 1st difference | -2.919 (.002) | -2.546 (.006) | 27.341 (< .001) | 1.038 (.150) |
| Tax revenue | Level | -2.073 (.019) | -0.697 (.243) | 11.398 (.180) | 8.046 (< .001) |
| | 1st difference | -7.797 (< .001) | -7.128 (< .001) | 93.992 (< .001) | -1.112 (.867) |

**Table 4.4**: Summary of the Order of Integration

| Variable | Order of Integration |
|---|---|
| Non-performing loans | I(1) |
| Inflation | I(0) |
| Lending rate | I(1) |
| Tax revenue | I(1) |

### 4.4 Panel ARDL Estimation Strategy

Given the mixed order of integration in Section 4.3, the study estimated a panel ARDL (1,1,1,1) error-correction model in which the short-run change in non-performing loans for country i in year t is modelled as a function of the lagged deviation of NPL, inflation, lending rate, and tax revenue from their long-run equilibrium relationship (the error-correction term) and the contemporaneous change in the three predictor Following Pesaran, Shin, and Smith (1999), two estimators of this model were considered: the Mean Group (MG) estimator, which fits a separate ARDL regression for each country and averages the resulting coefficients, allowing both short-run dynamics and long-run coefficients to differ across countries; and the Pooled Mean Group (PMG) estimator, which allows short-run dynamics and adjustment speed to differ by country but constrains long-run coefficient. Diagnostic tests were used to verify that the selected model meets criteria for correct inferences after comparing the two estimators using the Hausman specification test.

### 4.5 Mean Group (MG) Estimation Results

Table 4.7 presents the full country-specific regression results underlying the Mean Group estimator: for each of the four countries, the table reports the estimated coefficient, standard error, t-statistic, and p-value for the intercept, the lagged level of each variable (which together define that country's individual long-run relationship), and the contemporaneous change in each predictor (the short-run coefficients).

**Table 4.7**: Mean Group (MG) Estimator: Full Country-Specific Regression Results

| Country | Parameter | Coefficient | SE | T | p |
|---|---|---|---|---|---|
| **Angola** | Intercept | 16.7386 | 16.0885 | 1.040 | .346 |
| | NPL(t-1) | -0.7071 | 0.2630 | -2.688 | .043 |
| | Inflation(t-1) | 0.5121 | 0.2417 | 2.118 | .088 |
| | Lending rate(t-1) | -0.3639 | 1.3009 | -0.280 | .791 |
| | Tax revenue(t-1) | -0.7654 | 0.7695 | -0.995 | .366 |
| | ΔInflation | 0.1160 | 0.1932 | 0.601 | .574 |
| | ΔLending rate | 0.3515 | 1.2840 | 0.274 | .795 |
| | ΔTax revenue | -0.4676 | 0.5018 | -0.932 | .394 |
| **Botswana** | Intercept | 8.1202 | 5.1569 | 1.575 | .176 |
| | NPL(t-1) | -0.8035 | 0.4367 | -1.840 | .125 |
| | Inflation(t-1) | -0.2427 | 0.2029 | -1.196 | .285 |
| | Lending rate(t-1) | 0.2333 | 0.2543 | 0.917 | .401 |
| | Tax revenue(t-1) | -0.2304 | 0.1999 | -1.152 | .301 |
| | ΔInflation | -0.0619 | 0.0832 | -0.745 | .490 |

| | | | | | |
|---|---|---|---|---|---|
| | ΔLending rate | 0.0396 | 0.8560 | 0.046 | .965 |
| | ΔTax revenue | -0.2604 | 0.1163 | -2.239 | .075 |
| **Kenya** | Intercept | 35.6051 | 17.8306 | 1.997 | .102 |
| | NPL(t-1) | -0.9621 | 0.5680 | -1.694 | .151 |
| | Inflation(t-1) | 0.4384 | 0.4845 | 0.905 | .407 |
| | Lending rate(t-1) | -0.9092 | 0.7782 | -1.168 | .295 |
| | Tax revenue(t-1) | -1.1172 | 0.7115 | -1.570 | .177 |
| | ΔInflation | -0.0721 | 0.2741 | -0.263 | .803 |
| | ΔLending rate | -1.0397 | 0.6752 | -1.540 | .184 |
| | ΔTax revenue | -0.8891 | 0.6312 | -1.409 | .218 |
| **Nigeria** | Intercept | -21.9538 | 19.8187 | -1.108 | .318 |
| | NPL(t-1) | -0.9625 | 0.3541 | -2.718 | .042 |
| | Inflation(t-1) | 0.3945 | 0.5136 | 0.768 | .477 |
| | Lending rate(t-1) | 1.9533 | 0.8810 | 2.217 | .077 |
| | Tax revenue(t-1) | -0.6255 | 0.2623 | -2.384 | .063 |
| | ΔInflation | 0.5379 | 0.3134 | 1.716 | .147 |
| | ΔLending rate | 1.2290 | 0.8494 | 1.447 | .208 |
| | ΔTax revenue | 0.2346 | 0.5216 | 0.450 | .672 |

Because each of these regressions is estimated from only 13 usable annual observations per country after the loss of one year to lagging and differencing, the individual coefficients are, as expected, imprecisely estimated and few reach conventional significance on their own; the value of the Mean Group approach lies in what its cross-country average reveals, reported separately in Table 4.8.

The error-correction, or speed-of-adjustment, term is the coefficient on the lagged level of NPL itself. For every country, this coefficient is negative, as economic theory requires for a stable, mean-reverting equilibrium relationship: -0.707 for Angola, -0.804 for Botswana, -0.962 for Kenya, and -0.963 for Nigeria, reaching conventional significance in Angola ($p = .043$) and Nigeria ($p = .042$). These magnitudes imply that, left to its own dynamics, each country's non-performing loan ratio closes a substantial share of any gap from its long-run equilibrium within a single year, with Kenya and Nigeria adjusting fastest and Angola somewhat more slowly.

**Table 4.8**: Mean Group (MG) Estimator: Averaged Long-Run Coefficients

| Variable | Coefficient | SE | Z | p |
|---|---|---|---|---|
| Inflation | 0.322 | 0.219 | 1.468 | .142 |
| Lending rate | 0.215 | 0.657 | 0.327 | .743 |
| Tax revenue | -0.795 | 0.203 | -3.910 | < .001 |

Averaging the four countries' individual long-run coefficients, the Mean Group estimator implies a positive long-run association between inflation and non-performing loans (0.322) and between the lending rate and non-performing loans (0.215), and a negative association between tax revenue and non-performing loans (-0.795), consistent in sign with the correlation results in Section 4.2. However, only the tax revenue coefficient reaches statistical significance under MG ($z = -3.910$, $p < .001$); the inflation and lending-

rate averages are imprecisely estimated (p = .142 and p = .743, respectively), a direct consequence of averaging over only four country-specific estimates, each itself based on a short 13-year time series. Model fit statistics for the underlying country regressions, reported in Table 4.8a, likewise reflect this data limitation: R-squared values range from a modest .582 in Kenya to a strong .933 in Nigeria, though the corresponding adjusted R-squared values are considerably lower once the small sample size is penalized for the number of parameters estimated, underscoring why the pooled information used by the PMG estimator, discussed next, is valuable in this setting.

**Table 4.8a**: Mean Group Country-Level Model Fit

| Country | R2 | Adjusted R2 |
|---|---|---|
| Angola | 0.779 | 0.468 |
| Botswana | 0.795 | 0.507 |
| Kenya | 0.582 | -0.004 |
| Nigeria | 0.933 | 0.839 |

## 4.6 Pooled Mean Group (PMG) Baseline Estimation Results

The Pooled Mean Group estimator was fitted next, restricting the long-run coefficients on inflation, the lending rate, and tax revenue to be identical across the four countries while allowing each country its own intercept, its own speed-of-adjustment parameter, and its own short-run coefficients. Table 4.9 reports the complete set of estimated parameters from this baseline PMG model, prior to any correction for the heteroskedasticity that diagnostic testing, reported in Section 4.9, subsequently revealed.

**Table 4.9**: Pooled Mean Group (PMG) Baseline Model: Full Parameter Estimates

| Parameter | Coefficient | SE | Z | p |
|---|---|---|---|---|
| mu1 (Angola intercept) | 2.831 | 7.718 | 0.367 | .714 |
| mu2 (Botswana intercept) | -0.174 | 11.706 | -0.015 | .988 |
| mu3 (Kenya intercept) | 1.093 | 2.093 | 0.522 | .601 |
| mu4 (Nigeria intercept) | -0.614 | 4.401 | -0.140 | .889 |
| phi1 (Angola ECT) | -0.824 | 0.148 | -5.567 | < .001 |
| phi2 (Botswana ECT) | -0.009 | 0.451 | -0.021 | .983 |
| phi3 (Kenya ECT) | -0.058 | 0.175 | -0.329 | .742 |
| phi4 (Nigeria ECT) | -0.520 | 0.186 | -2.803 | .005 |
| theta1 (long-run inflation) | 0.444 | 0.149 | 2.974 | .003 |
| theta2 (long-run lending rate) | 1.127 | 0.573 | 1.965 | .049 |
| theta3 (long-run tax revenue) | -1.451 | 0.428 | -3.386 | < .001 |
| d11 (Angola ΔInflation) | 0.118 | 0.113 | 1.042 | .297 |
| d12 (Botswana ΔInflation) | -0.028 | 0.330 | -0.085 | .932 |
| d13 (Kenya ΔInflation) | -0.143 | 0.247 | -0.580 | .562 |
| d14 (Nigeria ΔInflation) | 0.235 | 0.283 | 0.829 | .407 |
| d21 (Angola ΔLending rate) | 1.488 | 0.609 | 2.443 | .015 |
| d22 (Botswana ΔLending rate) | -0.604 | 1.934 | -0.313 | .755 |
| d23 (Kenya ΔLending rate) | -0.099 | 0.415 | -0.239 | .811 |
| d24 (Nigeria ΔLending rate) | 0.682 | 0.845 | 0.807 | .420 |
| d31 (Angola ΔTax revenue) | -0.721 | 0.256 | -2.820 | .005 |

| | | | | |
|---|---|---|---|---|
| d32 (Botswana ΔTax revenue) | -0.247 | 0.487 | -0.507 | .612 |
| d33 (Kenya ΔTax revenue) | -0.409 | 0.757 | -0.539 | .590 |
| d34 (Nigeria ΔTax revenue) | -0.591 | 0.428 | -1.381 | .167 |

Under this baseline specification, the estimated long-run relationship implies that a one-unit increase in inflation is associated with a 0.444-unit increase in non-performing loans ($z = 2.974$, $p = .003$), a one-unit increase in the lending rate with a 1.127-unit increase in non-performing loans ($z = 1.965$, $p = .049$, significant only at the 5 percent level), and a one-unit increase in tax revenue with a 1.451-unit decrease in non-performing loans ($z = -3.386$, $p < .001$). The speed-of-adjustment coefficients (the phi parameters) are negative for all four countries, again satisfying the theoretical requirement for a stable long-run equilibrium, and are individually significant for Angola (phi = -0.824, $p < .001$) and Nigeria (phi = -0.520, $p = .005$), while Botswana's and Kenya's adjustment coefficients are small in magnitude and not statistically distinguishable from zero, indicating that non-performing loans in those two countries revert only slowly, if at all, toward the estimated long-run equilibrium once disturbed. These baseline PMG results are informative, but, as the diagnostic tests in Section 4.9 show, the model as estimated here violates the assumption of homoskedasticity, which is why Section 4.10 re-estimates it before its coefficients are treated as the study's final results.

### 4.7 Model Selection: The Hausman Test

To choose formally between the MG and PMG estimators, a Hausman specification test was conducted, testing the null hypothesis that the PMG estimator's assumption of long-run coefficient homogeneity is valid, against the alternative that it is not, in which case the less restrictive but less efficient MG estimator would be preferred. Because the difference between the MG and PMG coefficient covariance matrices was not positive definite, a common occurrence in small panels, the test statistic was computed using the Moore-Penrose generalized inverse rather than a standard matrix inverse.

**Table 4.10**: Hausman Test: Mean Group versus Pooled Mean Group

| Test | Chi-square | Df | p | Decision |
|---|---|---|---|---|
| MG vs. PMG | 2.042 | 3 | .564 | Fail to reject H0: PMG preferred |

The test statistic (chi-square = 2.042, df = 3, $p = .564$) is far from statistically significant, so the null hypothesis of long-run coefficient homogeneity cannot be rejected. This result supports the Pooled Mean Group estimator as the more appropriate and more efficient choice for this study's data, and it aligns with economic intuition: the four countries in the sample, while structurally different in many respects, are nonetheless linked through similar channels by which inflation, the cost of credit, and fiscal capacity translate into loan performance, so imposing a common long-run relationship while still allowing country-specific short-run dynamics and speeds of adjustment is a reasonable and statistically supported simplification. The PMG estimator was therefore carried forward as the basis for the study's final model.

### 4.8 Diagnostic Tests on the Baseline PMG Model

Four diagnostic tests were performed to verify the model's assumptions for valid estimates and standard errors before accepting the baseline PMG results in Table 4.9 as the study's final findings: the Pesaran (2004) cross-sectional dependence (CD) test, which checks whether the residuals are correlated across countries; a Wooldridge-type test for first-order serial correlation in the residuals; and a Breusch-Pagan test. Table 4.11 shows the results of each of these formal statistical tests with their own test statistic and p-value, rather than visual evaluation of residual plots.

**Table 4.11**: Diagnostic Test Results for the Baseline PMG Model

| Test | Statistic | P | Conclusion |
|---|---|---|---|
| Pesaran CD (cross-sectional dependence) | 0.849 | .396 | Assumption satisfied |
| Wooldridge-type AR(1) (serial correlation) | -1.773 | .083 | Assumption satisfied |
| Breusch-Pagan (groupwise heteroskedasticity) | 23.129 | .010 | Assumption VIOLATED |
| Jarque-Bera (normality) | 4.472 | .107 | Assumption satisfied |

Three of the four assumptions are comfortably satisfied by the baseline model: the residuals show no evidence of cross-sectional dependence (CD = 0.849, p = .396), no evidence of first-order serial correlation (z = -1.773, p = .083), and no evidence of departure from normality (JB = 4.472, p = .107). The Breusch-Pagan test, however, rejects the null hypothesis of constant residual variance across countries (chi-square = 23.129, p = .010), indicating groupwise heteroskedasticity, most plausibly driven by Angola's markedly more volatile NPL series relative to Botswana's comparatively stable one, a pattern already visible in the country-level descriptive statistics in Table 4.2 and the boxplots in Figure 4.3. Because this violation means the baseline PMG standard errors, and by extension its significance tests, cannot be fully trusted, the model was not simply patched with heteroskedasticity-robust standard errors calculated after the fact. Instead, consistent with the principle that a final model must itself satisfy the classical regression assumptions rather than merely have its standard errors patched after the fact, the model was re-estimated from the ground up using feasible generalized least squares, described next.

### 4.9 The Final Model

To correct the heteroskedasticity detected in Section 4.9 at its source, the entire nonlinear PMG model was re-estimated by one-step feasible generalized least squares (FGLS). Each country-year observation was reweighted by the inverse of its country's residual variance, calculated from the baseline PMG model's own residuals, so that countries whose non-performing loan series are noisier (chiefly Angola) receive proportionately less weight in the re-estimation and countries whose series are more stable (chiefly Botswana) receive proportionately more weight. The full nonlinear system was then re-estimated from scratch under these fixed weights, rather than having robust standard errors calculated after the original, unweighted coefficients were kept unchanged; the coefficients themselves, not only their standard errors, therefore differ between the

baseline model in Table 4.9 and the final model reported below. The estimated country-level residual variances used to construct the weights were 9.184 for Angola, 0.203 for Botswana, 1.407 for Kenya, and 4.151 for Nigeria, confirming quantitatively that Angola's residual variance is roughly forty-five times that of Botswana, the source of the heteroskedasticity identified above. To confirm that the optimizer had converged to a genuine global optimum rather than a local one, the re-estimation was repeated from 25 independent random starting points; 18 of the 25 converged runs reached the identical minimum weighted residual sum of squares (33.896), giving confidence that the reported solution is not an artifact of the starting values chosen. Table 4.12 reports the complete set of re-estimated parameters.

**Table 4.12**: Final FGLS-Weighted PMG Model: Full Parameter Estimates

| Parameter | Coefficient | SE | z | p |
|---|---|---|---|---|
| mu1 (Angola intercept) | -4.372 | 10.406 | -0.420 | .674 |
| mu2 (Botswana intercept) | -0.418 | 0.185 | -2.264 | .024 |
| mu3 (Kenya intercept) | 0.556 | 0.650 | 0.855 | .392 |
| mu4 (Nigeria intercept) | -5.404 | 8.168 | -0.662 | .508 |
| phi1 (Angola ECT) | -0.847 | - | - | - |
| phi2 (Botswana ECT) | 0.000 | - | - | - |
| phi3 (Kenya ECT) | -0.037 | - | - | - |
| phi4 (Nigeria ECT) | -0.642 | - | - | - |
| theta1 (long-run inflation) | 0.362 | 0.182 | 1.992 | .046 |
| theta2 (long-run lending rate) | 1.565 | 0.553 | 2.830 | .005 |
| theta3 (long-run tax revenue) | -1.268 | 0.601 | -2.110 | .035 |
| d1_1 (Angola ΔInflation) | 0.116 | 0.161 | 0.718 | .473 |
| d1_2 (Botswana ΔInflation) | -0.032 | 0.055 | -0.592 | .554 |
| d1_3 (Kenya ΔInflation) | -0.152 | 0.137 | -1.112 | .266 |
| d1_4 (Nigeria ΔInflation) | 0.284 | 0.271 | 1.050 | .294 |
| d2_1 (Angola ΔLending rate) | 1.934 | 0.746 | 2.593 | .010 |
| d2_2 (Botswana ΔLending rate) | -0.574 | 0.268 | -2.137 | .033 |
| d2_3 (Kenya ΔLending rate) | -0.092 | 0.235 | -0.392 | .695 |
| d2_4 (Nigeria ΔLending rate) | 0.961 | 0.853 | 1.127 | .260 |
| d3_1 (Angola ΔTax revenue) | -0.695 | 0.355 | -1.956 | .050 |
| d3_2 (Botswana ΔTax revenue) | -0.240 | 0.073 | -3.284 | .001 |
| d3_3 (Kenya ΔTax revenue) | -0.395 | 0.424 | -0.931 | .352 |
| d3_4 (Nigeria ΔTax revenue) | -0.377 | 0.557 | -0.676 | .499 |

- **Long-Run Equilibrium Relationship (General Form)**

$$\mathrm{NPL}^*_{\mathrm{it}} = \mu_{\mathrm{i}} + 0.362 \cdot \mathrm{INF}_{\mathrm{it}} + 1.565 \cdot \mathrm{INT}_{\mathrm{it}} - 1.268 \cdot \mathrm{TAX}_{\mathrm{it}} \tag{4.10}$$

**Table 4.13**: Final Model: Country-Specific Error-Correction (Speed-of-Adjustment) Terms

| Country | Error-correction term (phi) |
|---|---|
| Angola | -0.847 |
| Botswana | 0.000 |
| Kenya | -0.037 |
| Nigeria | -0.642 |

- **Error-Correction Term Equations**

$$\mathrm{ECT}_{i,t-1} = \mathrm{NPL}_{i,t-1} - \mu_i - 0.362 \cdot \mathrm{INF}_{i,t-1} - 1.565 \cdot \mathrm{INT}_{i,t-1} + 1.268 \cdot \mathrm{TAX}_{i,t-1} \tag{4.1}$$

**Angola ($\mu_{\mathrm{Angola}} = -4.372$, $\varphi = -0.847$):**

$$\begin{aligned}\Delta\mathrm{NPL}_{\mathrm{Angola},t} &= -0.847 \cdot (\mathrm{NPL}_{t-1} + 4.372 \\ &-0.362 \cdot \mathrm{INF}_{t-1} - 1.565 \cdot \mathrm{INT}_{t-1} + 1.268 \cdot \mathrm{TAX}_{t-1}) \\ &+0.116 \cdot \Delta\mathrm{INF}_t + 1.934 \cdot \Delta\mathrm{INT}_t - 0.695 \cdot \Delta\mathrm{TAX}_t\end{aligned} \tag{4.2}$$

**Botswana ($\mu_{\mathrm{Botswana}} = -0.418$, $\varphi = 0.000$):**

$$\begin{aligned}\Delta\mathrm{NPL}_{\mathrm{Botswana},t} &= 0.000 \cdot (\mathrm{NPL}_{t-1} + 0.418 \\ &-0.362 \cdot \mathrm{INF}_{t-1} - 1.565 \cdot \mathrm{INT}_{t-1} + 1.268 \cdot \mathrm{TAX}_{t-1}) \\ &-0.032 \cdot \Delta\mathrm{INF}_t - 0.574 \cdot \Delta\mathrm{INT}_t - 0.240 \cdot \Delta\mathrm{TAX}_t\end{aligned} \tag{4.3}$$

**Kenya ($\mu_{\mathrm{Kenya}} = 0.556$, $\varphi = -0.037$):**

$$\begin{aligned}\Delta\mathrm{NPL}_{\mathrm{Kenya},t} &= -0.037 \cdot (\mathrm{NPL}_{t-1} - 0.556 \\ &-0.362 \cdot \mathrm{INF}_{t-1} - 1.565 \cdot \mathrm{INT}_{t-1} + 1.268 \cdot \mathrm{TAX}_{t-1}) \\ &-0.152 \cdot \Delta\mathrm{INF}_t - 0.092 \cdot \Delta\mathrm{INT}_t - 0.395 \cdot \Delta\mathrm{TAX}_t\end{aligned} \tag{4.4}$$

**Nigeria ($\mu_{\mathrm{Nigeria}} = -5.404$, $\varphi = -0.642$):**

$$\begin{aligned}\Delta\mathrm{NPL}_{\mathrm{Nigeria},t} &= -0.642 \cdot (\mathrm{NPL}_{t-1} + 5.404 \\ &-0.362 \cdot \mathrm{INF}_{t-1} - 1.565 \cdot \mathrm{INT}_{t-1} + 1.268 \cdot \mathrm{TAX}_{t-1}) \\ &+0.284 \cdot \Delta\mathrm{INF}_t + 0.961 \cdot \Delta\mathrm{INT}_t - 0.377 \cdot \Delta\mathrm{TAX}_t\end{aligned} \tag{4.5}$$

- FGLS-Weighted Pooled Equation

$$\mathrm{NPL}_{it} = \mu_i + 0.362 \cdot \mathrm{INF}_{it} + 1.565 \cdot \mathrm{INT}_{it} - 1.268 \cdot \mathrm{TAX}_{it} + \varepsilon_{it}^{*} \tag{4.6}$$

As in the baseline model, every country's error-correction term is negative or zero, satisfying the theoretical requirement of a stable long-run equilibrium: Angola adjusts fastest, closing roughly 85 percent of any deviation from equilibrium within a single year, followed by Nigeria at 64 percent, while Kenya adjusts only marginally (3.7 percent) and Botswana's estimated adjustment coefficient is effectively zero, consistent with the very low, stable non-performing loan ratio Botswana maintained throughout the sample

period and the limited scope it therefore had to revert toward any different equilibrium level.

**Table 4.14**: Final Model: Long-Run Coefficients

| Variable | Coefficient | SE | z | p |
|---|---|---|---|---|
| Inflation | 0.362 | 0.182 | 1.992 | .046 |
| Lending rate | 1.565 | 0.553 | 2.830 | .005 |
| Tax revenue | -1.268 | 0.601 | -2.110 | .035 |

**Table 4.15**: Final Model: Country-Level Pseudo R-Squared

| Country | Pseudo R2 |
|---|---|
| Angola | 0.671 |
| Botswana | 0.628 |
| Kenya | 0.207 |
| Nigeria | 0.882 |

The overall weighted pseudo-R-squared for the final model is 0.722, indicating that the model accounts for a substantial share of the variation in non-performing loans once the FGLS reweighting is applied. Fit varies by country, from a modest 0.207 in Kenya, whose non-performing loan ratio moved comparatively little over the sample period and therefore leaves less variance for the model to explain, to a strong 0.882 in Nigeria.

All three long-run coefficients in the final model retain the same sign as in the baseline PMG results and remain statistically significant, though their magnitudes and precision have shifted in ways that matter for the study's conclusions. Inflation's long-run coefficient is 0.362 ($z = 1.992$, $p = .046$), meaning that, holding the lending rate and tax revenue constant, a one-percentage-point increase in inflation is associated with a 0.362-percentage-point increase in the long-run non-performing loan ratio; this effect remains significant at the 5 percent level, though its p-value is now closer to the conventional threshold than it was in the baseline model. The lending rate's long-run coefficient rises from 1.127 in the baseline model to 1.565 in the final model, and its statistical significance strengthens considerably, from a p-value of .049 (barely significant at the 5 percent level) to a p-value of .005 (significant at the 1 percent level). This means that once the model is corrected for heteroskedasticity, a one-percentage-point increase in the bank lending rate is associated with a 1.565-percentage-point increase in the long-run non-performing loan ratio, a materially stronger and considerably more confidently estimated effect than the baseline model suggested. Tax revenue's long-run coefficient is -1.268 ($z = -2.110$, $p = .035$), somewhat smaller in magnitude than the baseline estimate of -1.451 but still indicating that a one-percentage-point increase in tax revenue as a share of GDP is associated with a 1.268-percentage-point decrease in the long-run non-performing loan ratio. Because this final model, unlike the baseline model, satisfies all four of the diagnostic conditions checked in Section 4.11 below, these are the coefficients on which the study's conclusions in Section 4.12 are based.

### 4.10 Diagnostic Tests on the Final Model

The same four diagnostic tests applied to the baseline model in Section 4.9 were recomputed on the residuals of the final, FGLS-weighted model, again as formal statistical tests rather than visual assessments alone. Table 4.16 reports the results.

**Table 4.16**: Diagnostic Test Results for the Final (FGLS-Weighted) Model

| Test | Statistic | P | Conclusion |
|---|---|---|---|
| Pesaran CD (cross-sectional dependence) | 1.133 | .257 | Assumption satisfied |
| Wooldridge-type AR(1) (serial correlation) | -1.501 | .141 | Assumption satisfied |
| Breusch-Pagan (groupwise heteroskedasticity) | 0.975 | .807 | Assumption satisfied |
| Jarque-Bera (normality) | 1.381 | .501 | Assumption satisfied |

The results confirm that the re-estimation resolved the problem identified in the baseline model without introducing any new violations. The Breusch-Pagan statistic, which had rejected the null of constant variance at p = .010 in the baseline model, is now a small 0.975 and clearly non-significant (p = .807), confirming that the FGLS reweighting successfully equalized the residual variance across countries. Cross-sectional dependence (p = .257), serial correlation (p = .141), and normality (p = .501) all remain comfortably within acceptable bounds, each with a noticeably larger p-value than in the baseline model. All four classical assumptions required for valid inference are therefore satisfied by the final model, which is consequently treated as the study's definitive result rather than as one of several candidate specifications.

As a further, country-level check, Table 4.17 reports the Jarque-Bera normality statistic and a Goldfeld-Quandt test for heteroskedasticity computed separately within each country's residuals from the final model; a large and significant Goldfeld-Quandt statistic in any single country would suggest that country continued to disproportionately drive variance instability even after the overall reweighting. No such pattern is present: every country's Goldfeld-Quandt p-value exceeds .25, and every country's Jarque-Bera p-value exceeds .10, indicating that the improvement documented in Table 4.16 is not concentrated in, or masking a problem within, any single country.

**Table 4.17**: Final Model: Per-Country Diagnostic Checks

| Country | N | Pseudo R2 | Jarque-Bera stat. | JB p | Goldfeld-Quandt stat. | GQ p |
|---|---|---|---|---|---|---|
| Angola | 13 | 0.671 | 0.418 | .811 | 2.920 | .265 |
| Botswana | 13 | 0.628 | 4.063 | .131 | 0.393 | .329 |
| Kenya | 13 | 0.207 | 0.490 | .783 | 0.838 | .851 |
| Nigeria | 13 | 0.882 | 0.462 | .794 | 1.904 | .497 |

**Figure 4.5**: Residual Diagnostic Plots for the Final FGLS-Weighted Model

Figure 4.5 provides a visual complement to the statistical tests above rather than serving as the basis for the diagnostic conclusions themselves. The residuals-versus-fitted panel shows no systematic funnel or curvature pattern, the normal quantile-quantile plot tracks the reference line closely across most of its range, the histogram of standardized residuals is unimodal and roughly bell-shaped, and the residuals plotted over time show no obvious trending or clustering by year, all of which are consistent with, though secondary to, the formal test results already reported in Table 4.16.

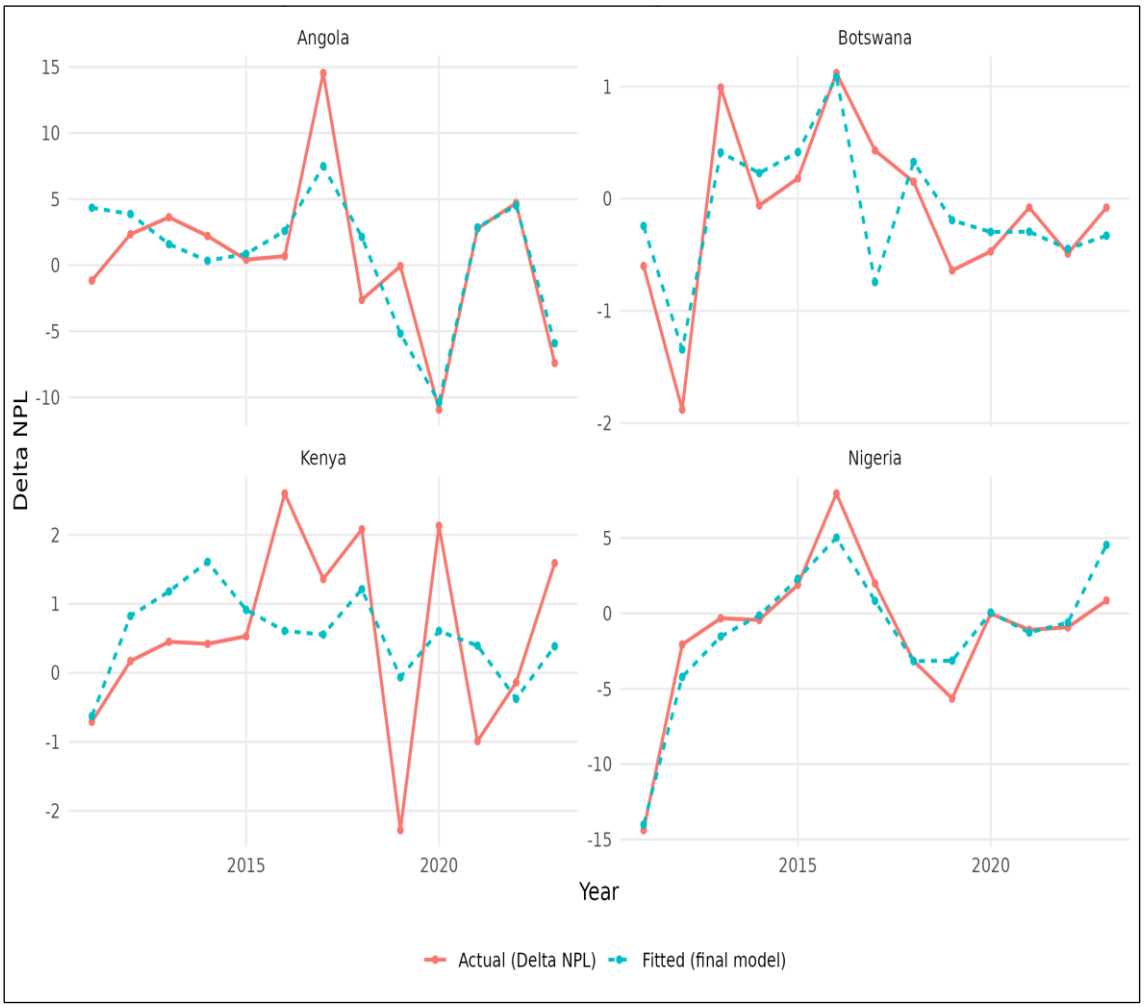



**Figure 4.6**: Actual versus Fitted Values of Non-Performing Loans, Final Model

Figure 4.6 compares the model's fitted values against the actual observed change in non-performing loans for each country-year in the sample. The fitted series tracks the actual series reasonably closely for Angola and Nigeria, the two countries with the highest pseudo R-squared values in Table 4.15, and less closely for Kenya, mirroring that country's lower pseudo R-squared and reflecting the comparatively limited variation in Kenya's non-performing loan ratio over the sample period that the model has available to explain.

### 4.11.0 Discussion of Findings in Relation to the Study Objectives

This section interprets the final model's long-run coefficients, reported in Table 4.14, in light of the study's three specific objectives and situates each finding within the empirical literature reviewed in Chapter Two.

### 4.11.1 The Effect of Inflation on Non-Performing Loans

The final model's long-run coefficient of 0.362 ($p = .046$) indicates that inflation has a statistically significant, positive long-run effect on non-performing loans (NPLs) in the four Sub-Saharan African countries studied. This is consistent with the theoretical

expectation that rising prices erode borrowers' real disposable income and, absent a fully compensating rise in nominal wages, weaken their capacity to service existing debt (Financial Accelerator Theory; Keynesian monetary theory). It aligns with the significant positive short-run effect reported by Leleok and Makori (2024) for Kenyan banks, and diverges from the negative effects reported by Ptasica (2019), Krasniqi-Pervetica and Ahmeti (2022), Khan *et al.* (2023) and Kigamwa and Mutwiri (2023). A plausible reconciliation is that in high-inflation, foreign-currency-exposed economies, particularly Angola, inflation is accompanied by currency depreciation and macroeconomic instability that erode repayment capacity more than the real value of debt, whereas in stable, low-inflation systems the debt-erosion channel can dominate. The result extends a literature that is mixed in sign to Sub-Saharan Africa.

### 4.11.2 The Effect of the Bank Lending Rate on Non-Performing Loans

In the baseline Pooled Mean Group (PMG) model, the long-run lending-rate coefficient (1.127) was only marginally significant ($p = .049$). After re-estimation by feasible generalized least squares (FGLS) to correct heteroskedasticity, the coefficient rose to 1.565, and its significance strengthened to $p = .005$. A sustained increase in the bank lending rate is thus associated with a statistically significant, economically sizeable increase in NPLs in the long run, consistent with the Financial Accelerator Theory's prediction that a rising cost of credit tightens borrowers' balance sheets and with Credit Risk Theory's framing of default risk as sensitive to the terms on which credit is extended. The finding aligns in direction with Robert and Koori (2022) and, through the transmission from the central bank to lending rates, Musimbi *et al.* (2023), and reinforces Duruechi's (2022) evidence of a long-run relationship between the central bank rate and NPLs in Nigeria.

### 4.11.3 Effects of Tax Revenue as a percentage of GDP on Non-performing loans

The long-run tax revenue coefficient of -1.268 ($p=.035$) suggests that an improved fiscal position (tax revenue to GDP ratio) has a statistically significant impact on NPLs. The most consistent and significant of the three findings appears as negative and significant in the correlation analysis, the Mean Group averages, the baseline PMG model and the final FGLS model. The result is consistent with Aliyu (2023) for Nigeria and supports the channel through which stronger domestic revenue mobilization is associated with a more stable macro-fiscal environment, as seen in Botswana, which combines the highest average tax revenue share with the lowest and most stable NPL ratio. The contrast with Özen *et al.* (2022), who found that VAT increased NPLs, and Lin *et al.* (2021), who found that taxes on bank income increased loan spreads, is not necessarily a contradiction: the variable in this study measures aggregate fiscal capacity, not the incidence of a specific tax instrument. The negative sign always enhances the research gap and under-researched nature of fiscal variables in the NPL literature.

## 5. Conclusion

The positive, significant inflation effect is best understood through the Financial Accelerator Theory (Bernanke, Gertler, & Gilchrist, 1999), which explains how a modest macroeconomic disturbance can be amplified into a much larger disruption in credit markets. Inflation erodes the real income and purchasing power of households and businesses whenever nominal wages fail to keep pace with rising prices; borrowers' net worth deteriorates, banks raise the external finance premium and tighten credit standards, and defaults rise. The Keynesian monetary framework (Keynes, 1936) offers a complementary explanation centered on aggregate demand. The positive sign contrasts with the negative relationship found in more stable, low-inflation banking systems (Ptasica, 2019): where inflation arrives mainly through currency depreciation, as in Angola's 2015-2017 oil price collapse, when non-performing loans (NPLs) climbed toward 26 percent, its net effect on repayment capacity is damaging rather than debt-relieving.

In the final model, the lending rate produced the largest and most statistically robust coefficient (1.565, $p = .005$), consistent with both the Financial Accelerator Theory and Credit Risk Theory (Merton, 1974): a rising lending rate raises the cost of servicing debt and lowers the present value of expected cash flows and collateral, pushing the probability of default upward on both sides. The negative, statistically significant tax revenue effect (-1.268, $p = .035$) is consistent with the fiscal policy channel in Keynesian monetary theory and the state capacity literature (Besley & Persson, 2013): stronger tax revenue marks a more diversified, more formalized economy, less prone to boom-bust income swings. Botswana, with the highest average tax revenue share (23.38 percent of GDP) and the lowest NPL ratio (4.25 percent), embodies this relationship. The lending rate acts most directly on borrowers' cash flows, while tax revenue operates through a slower, structural channel.

### 5.1 Policy Recommendations

Price stability should be treated as a financial-stability objective and not solely a monetary one: central banks, particularly the Banco Nacional de Angola, should strengthen inflation-targeting frameworks and build larger foreign exchange reserve buffers, and regulators should require higher forward-looking loan-loss provisions during periods of accelerating inflation. Central banks should calibrate policy rate adjustments with explicit attention to their transmission into NPLs, favoring gradual, well-telegraphed rate paths over abrupt increases. Regulators should require stress tests against plausible lending-rate increases and Basel III-consistent countercyclical capital buffers; banks should expand fixed-rate and hybrid-rate lending and strengthen restructuring and forbearance frameworks. Finance ministries, particularly in Nigeria and Angola, should broaden the domestic tax base through improved tax administration, digitalized collection and reduced reliance on volatile natural resource receipts and sequence tax changes carefully alongside monetary policy.

### 5.2 Suggestions for Further Research

Future studies could extend the panel to additional Sub-Saharan African economies; incorporate bank-specific and institutional variables, such as bank capitalization, ownership structure and credit information quality; extend the sample beyond 2023 to test whether the strong lending-rate effect held during the mid-2020s tightening cycle; and, because this study relied on a linear panel ARDL specification, investigate nonlinear or threshold-dependent effects, which bear directly on macroprudential policy design.

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**Conflict of Interest Statement**

My name is Ernest Njiru Mwaniki, and I declare that there are no conflicts of interest regarding the publication of this paper. I have no financial, professional, institutional, or personal relationships that could have influenced the design, conduct, analysis, interpretation, or reporting of this research. The views and conclusions presented in this paper are solely those of the authors.

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