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Effect of Monetary Policy on Non-Performing Loans in Sub-Saharan Africa: A Panel Vector Autoregressive Approach

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Abstract: Banks play a vital role in a country's financial system through their intermediation activities, which support economic development. However, the rise in non-performing loans (NPLs) has jeopardized the performance of banks in Sub-Saharan Africa (SSA). Moreover, the behavior of key macroeconomic factors and shocks to monetary policy are closely linked to this issue. This study examines the impact of monetary policy on NPLs in SSA using a panel vector autoregressive model, based on quarterly data from 23 countries spanning 2008Q1 to 2023Q4. The findings reveal that monetary policy shocks significantly affect NPL levels in SSA. Additionally, excessive domestic and external borrowing, inflationary pressures, and exchange rate volatility have substantial consequences for NPL accumulation. This study offers valuable insights into how macroeconomic factors interact to create banking stress and fragility, ultimately undermining financial stability in the region. It recommends that monetary authorities and governments implement credible monetary policies and maintain a stable macroeconomic environment to safeguard the financial sector.

Keywords: Monetary policy, Non-performing loan, Sub-Saharan Africa, Panel vector autoregression, PVAR.

JEL Classification: G21, G32, E20, E52, E58, O16.

1. Introduction

Because banks are essential to transferring capital from capital-surplus agents to capital-deficient actors within an economy, the stability of the banking system is a fundamental prerequisite for economic growth in every society (Radivojević et al., 2019; Fukuda & Dahalan, 2012). However, Radivojević et al. (2019) noted that the deregulation and internationalization of banking operations, alongside structural changes in the global financial system during the late 20th century, intensified competition among banks. This heightened competitiveness has increased credit risk and deteriorated lending quality, thereby raising the rate of non-performing loans (NPLs). NPLs are defined as loans and advances overdue by 90 days or more from the due date (Reinhart & Rogoff, 2011). As Pandey (2024) noted, high levels of NPLs undermine banks' capacity to issue new loans, restricting investment and job creation. Thus, widespread NPLs can adversely affect the broader economy.

According to Schumpeter and Opie (1995), a robust financial system promotes economic progress, whereas a fragile one burdened by NPLs and weak capital can hinder growth. Consequently, NPLs lie at the core of credit market frictions (Pandey, 2024; Bernanke & Gertler, 1989; Guerrieri & Lorenzoni, 2017). Zeng (2012) referred to NPLs as a form of "financial pollution" that diminishes social utility. Therefore, deteriorating loan quality poses a systemic threat to the financial system, with NPLs serving as a key metric for evaluating loan performance (Us, 2020).

Reinhart and Rogoff (2011) argued that rising NPLs can signal the onset of a banking crisis. Similarly, Sorge (2004) suggested that NPLs can serve as a proxy for assessing the vulnerability of the financial system. Moreover, the global economy continues to face severe disruptions due to the COVID-19 pandemic and the Russia–Ukraine conflict (Bacchiocchi et al., 2022). Bacchiocchi et al. further argued that asymmetric effects have materialized across economic sectors in developed countries, ultimately reaching Sub-Saharan Africa (SSA), despite the relatively uniform decline in the global gross domestic product (GDP) caused by governmental stabilization measures. These impacts extend beyond consumption and production and also affect the functioning of financial and banking institutions.

The evolution of NPLs is shaped by macroeconomic conditions, bank-specific factors, and regulatory frameworks (Alnabulsi et al., 2022; Gashi et al., 2022; Radivojević et al., 2019). Elevated NPL levels restrict banks' lending capacity, thereby impeding economic expansion and amplifying financial instability. Although numerous studies have examined the determinants of NPLs, most focused on developed and emerging markets (Pandey, 2024; Bacchiocchi et al., 2022; Karadima & Louri, 2020; Arham et al., 2020; Bayar, 2019; Makri et al., 2014), with comparatively few empirical investigations centered on SSA economies (Akuoko-Konadu & Mahmud, 2024; Jimoh et al., 2024; Mpofu & Nikolaidou, 2018).

To address the challenge of rising NPLs, monetary policy remains a critical instrument for central banks to steer economic activity by regulating interest rates and managing the money supply. In SSA, where financial markets are often underdeveloped and exposed to external shocks, the efficacy of monetary policy can vary considerably. Expansionary monetary policy, typically involving lower interest rates, is expected to stimulate borrowing and reduce NPLs by making credit more accessible. In contrast, contractionary policy may increase NPLs, as higher rates can impair borrowers' repayment capacity during downturns. Therefore, the central objective of this study is to examine how monetary policy influences NPLs in SSA.

It is thus vital to investigate the effect of monetary policy on NPLs in SSA, given the region's distinct economic vulnerabilities and ongoing efforts to promote financial inclusion and system resilience. However, despite the topic's importance, a significant gap remains in the literature regarding the use of advanced econometric methods (i.e., panel vector autoregression (PVAR) approaches) to assess these dynamics in the SSA context. This study seeks to address that gap by applying a PVAR framework to explore the dynamic interplay between monetary policy variables and NPLs across multiple SSA nations. The research aims to generate evidence-based insights into the capacity of monetary policy to reduce NPL risk and enhance banking sector stability.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature; Section 3 outlines the methodology; Section 4 presents the results and discusses the findings; and the final section offers conclusions and policy recommendations.

2. Literature review

This section reviews relevant studies to help integrate the current research into the broader body of literature, thereby laying the foundation for developing a theoretical framework to examine the variables under study. It specifically presents an overview of NPLs in SSA, the relationship between monetary policy and NPLs, theoretical underpinnings, and empirical evidence related to this research topic.

Overview of non-performing loans in SSA

NPL research has grown steadily over time, as financial vulnerability, banking collapses, and financial crises in developed and developing nations are frequently linked to the phenomenon (Alnabulsi et al., 2022; Konstantakis et al., 2016). In many African countries, NPLs pose a severe threat to the stability of banking systems. They can trigger bank failures and contagion effects, where the collapse of one institution precipitates systemic crises across the sector (Nwonye et al., 2023). Moreover, banking crises are often marked by elevated NPL levels (Ari et al., 2019), as high NPL ratios impair bank balance sheets, constrain credit growth, and delay economic recovery (IMF, 2016; Aiyar et al., 2015; Kalemli-Ozcan et al., 2015). This persistent threat to financial institution stability is a major economic challenge across SSA.

SSA has experienced considerable economic volatility for several decades, which has complicated the effectiveness of monetary policy. Banks across the region increasingly view NPLs as a critical threat to both economic growth and financial stability (Akuoko-Konadu & Mahmud, 2024; Eyraud et al., 2021; Yahaya et al., 2021). For example, in 2018, the median NPL ratio in SSA was 11.7%—more than double that of other global regions (Eyraud et al., 2021). The prevalence of high NPLs across both lower-middle-income and low-income countries reflects the depth of the issue. Using financial soundness indicators for 25 SSA countries, Eyraud et al. (2021) reported that NPLs totaled $34.8 billion in 2018, amounting to a median of nearly 2% of SSA's GDP.

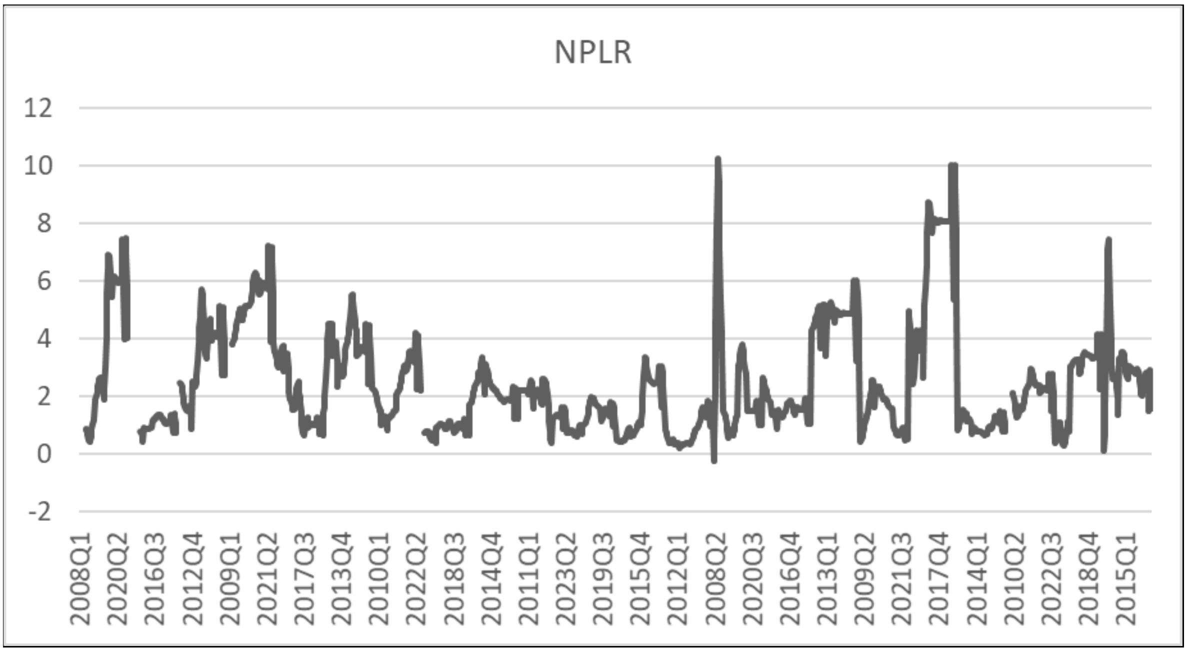
The region also exhibited the largest spread between minimum and maximum NPL ratios (i.e., 12.1% from 2005 to 2018), indicating that SSA has experienced more extreme fluctuations in NPL levels than other regions. Average NPL volatility in SSA was more than three times that of North America and roughly twice the levels seen in Europe and Central Asia (6.3%), South Asia (6.0%), and the Middle East and North Africa (MENA; 5.6%). NPLs were especially high in currency union members, fragile states, and commodity exporters. For instance, the median NPL ratio for these SSA countries stood at 12.4% in 2018, with Ghana and the Central African Republic reporting the highest levels. Although NPLs are a widespread issue in SSA, their distribution varies across country groups. In contrast, commodity importers in SSA had a median NPL ratio of 9.3%, while fragile states recorded a median of 13.8%, with the Central African Republic, Guinea–Bissau, Chad, and São Tomé and Príncipe among the most affected (Eyraud et al., 2021).

Eyraud et al. (2021) also observed that non-fragile SSA states had a median NPL ratio of 10.4% in 2018. By comparison, a 9.3% median was seen in unitary nations in the SSA (i.e., Central African Economic and Monetary Community (CEMAC), while West African Economic and Monetary Union (WAEMU)) recorded a significantly higher median of 16.3%. Within CEMAC, countries like Equatorial Guinea, Chad, and the Central African Republic had the highest NPL levels. In WAEMU, Guinea–Bissau and Togo reported the highest ratios. Notably, five SSA currency union members (i.e., Senegal and Côte d'Ivoire (pre-2010), Mali (2007–2013), the Central African Republic, and Sierra Leone (post-2013)) consistently registered the highest NPL ratios.

El-Rehim (2021) reported that African banks hold about $60 billion in NPLs, compared with $600 billion held by European banks. In 2020, approximately $12.6 billion—equivalent to 6.22% of South African bank loans—were classified as problem loans. In 2019, Moroccan banks reported an NPL ratio of 9.13%; Nigerian banks, 7.7%; Kenyan and Ghanaian banks, just over 10%; and Egyptian banks, 4.2% (El-Rehim, 2021). The persistence of NPLs in SSA is largely attributed to high levels of macroeconomic instability exacerbated by exogenous shocks (Mpofu & Nikolaidou, 2018). Figure 1 illustrates the trends in NPLs across SSA from 2008Q1 to

2023Q4, revealing persistent volatility, particularly evident in 2008Q1, between 2012Q1 and 2018Q3, and from 2019Q1 to 2022Q3.

Figure 1: Trends in non-performing loans in Sub-Saharan Africa



Source: Authors' computation based on the World Bank`s World Development Indicators, Global Financial Development Indicators, Sustainable Development Goals Indicators, and central bank databases

The financial environment in SSA is shaped by a complex interaction between economic growth, monetary policy, and institutional stability (Zanfack et al., 2024). NPLs have become a key concern for banks in the region, threatening both financial and economic stability. As central banks work to implement effective monetary policies aimed at stimulating growth and preserving price stability, it becomes imperative to understand how these policies influence NPLs. Zanfack et al. emphasized that the current global financial crisis and subsequent economic slowdown have prompted economists worldwide to reconsider the effectiveness of monetary policy. Elsayed et al. (2023) further noted that persistently low interest rates may incentivize excessive risk-taking by banks, potentially destabilizing the financial system. Nonetheless, the essential role of central banks in safeguarding financial stability is consistently reinforced in the current literature, although findings on this issue remain mixed in the case of SSA.

Monetary policy and NPLs

A central issue in the current monetary policy debate is whether, in addition to their profit-making charter, central banks should also be responsible for promoting financial stability (Brancaccio et al., 2020). Akerlof et al. (2014), Blanchard et al. (2010), Claessens and Habermeier (2013), and Yellen (2015) explored this issue from multiple perspectives. According to Brancaccio et al. (2020), the debate has focused analytically on whether the monetary policy "rules" typically used to evaluate central bank actions can also serve the objective of financial stability. One such rule is the Taylor rule (Taylor, 1993), which describes how a central bank adjusts interest rates based on deviations of output and inflation from their respective equilibrium levels. The aim is to close these gaps during the business cycle (i.e., the lower the output and inflation relative to equilibrium, the lower the interest rate required to stimulate them, and vice versa; Brancaccio et al., 2020).

From this perspective, monetary policy can potentially stabilize not only inflation and output but also financial systems. Moreover, monetary policy dynamics can influence NPL levels. For instance, Louzis et al. (2012) used dynamic panel regression to investigate macroeconomic and bank-specific factors contributing to NPLs in Greece across mortgage, business, and consumer loans for 2003Q1–2009Q3. The study found that NPLs are negatively associated with economic growth, and positively associated with unemployment, lending interest rates, public debt, and poor bank management.

Theoretical framework

This section presents the theoretical underpinnings of our empirical model used to investigate the relationship between monetary policy and NPLs. They align with the empirical framework developed by Brancaccio et al. (2020), who adopted a conventional Taylor rule and incorporated an additional term representing the level of NPLs as a proxy for business solvency. The model assumes full employment and equilibrium values for interest rates, inflation, and output, which are derived using the Taylor rule. The core objective is to demonstrate how monetary policy dynamics shape these variables and influence the stability of the financial system.

Following Brancaccio et al. (2020), the relationship between monetary policy and NPLs can be illustrated using variables i_t, π_t, y_t, and NPL_t, representing the current interest rate, inflation, output, and non-performing loan values, respectively. Here, $i_t - \pi_t$ denotes the current real interest rate, and π_{t-1} indicates the previous period's inflation rate. Variables r^*, π^*, y^*, and NPL^* represent their respective equilibrium or target levels. Parameters α, β, γ, $\in$, ω, σ, ρ, and z are the associated coefficients.

The system of equations proposed by Blanchard and Brancaccio (2019) and Brancaccio et al. (2020) is as follows:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y^*) + \gamma(\text{NPL}_t - \text{NPL}^*), \tag{1}$$

$$\text{NPL}_t = \text{NPL}^* + \in [(i_t - \pi_t - y_t) - (r^* - y^*)], \tag{2}$$

$$y_t = y^* + \sigma - \omega(i_t - \pi_t), \tag{3}$$

$$\pi_t = \pi_{t-1} + z + \rho(y_t - y^*). \tag{4}$$

As noted by Brancaccio et al. (2020), Eq. (1) represents both an augmented Taylor rule and a normal solvency rule. Hence, NPLs are treated either as a macroprudential indicator of financial stability or as a measure of systemic solvency. Equation (2) models NPLs as a function of the deviation between actual and equilibrium outputs and the gap between real interest rates and their equilibrium levels. The underlying assumption is that higher output and inflation relative to interest rates boost nominal borrower income relative to debt costs, thereby reducing NPLs. Conversely, deteriorating macro conditions elevate NPL levels. Equation (3) describes output as a function of the real interest rate and an exogenous component of aggregate demand.

Equation (4) models the current inflation rate based on past inflation, π_{t-1}, a cost-push factor, z, and an output gap, $y_t - y^*$. In this system, i_t, π_t, y_t, and NPL_t are endogenous variables. Whereas γ may take on positive or negative values, parameters α, β, $\in$, σ, and z are assumed to be positive. The system captures the causal mechanisms embedded in the original and extended Taylor rules, depending on the sign and magnitude of γ, assuming that ω and ρ are positive.

Under the standard Taylor rule, i_t, π_t, and y_t are determined simultaneously by Eqs. (1), (3), and (4), with NPL_t computed residually using Eq. (2). In contrast, the solvency rule alignment occurs when ω and ρ are negligible or zero and γ is negative. In this case, Eq. (3) determines y_t, Eq. (4) determines π_t, and Eqs. (1) and (2) jointly determine i_t and NPL_t (Brancaccio et al., 2020). This framework forms the theoretical basis for the empirical model used in this study, which may be extended with additional explanatory variables.

Empirical evidence

Numerous empirical studies have examined how macroeconomic, institutional, and bank-specific factors influence NPLs. However, studies focusing specifically on the interaction between monetary policy and NPLs remain limited within the context of SSA. For instance, Pandey (2024) investigated the effects of inflation, real GDP growth, and the Nepal Rastra Bank's (NRB) policy rate on NPL levels in Nepal using an autoregressive distributed lag (ARDL) regression model based on quarterly data from 2007/08 Q2 to 2022/23 Q1. The results showed that although the NRB policy rate has a significant positive effect on NPLs, inflation exerts a significant negative impact.

Using the Driscoll–Kraay technique and ordinary least squares (OLS), Zanfack et al. (2024) analyzed the effects of monetary policy on financial stability in SSA from 2000 to 2021, finding that monetary policy operating through domestic credit and money supply enhances financial stability in the region. Similarly, Asemota et al. (2023) examined how commercial banks' NPLs respond to financial, environmental, and economic factors in SSA using dynamic generalized method-of-moments (GMM), system, and system seemingly-unrelated regression models based on annual data from 2012 to 2021. The study concluded that bank quality, monetary policy, and bank operations are significant determinants of NPLs in the region.

Bacchiocchi et al. (2022) explored the relationship between NPLs and monetary policy rules in the United States using a structural vector autoregressive model based on quarterly data from 1988 to 2016. Their findings revealed that monetary policy instruments respond contemporaneously to changes in NPLs and that the federal funds rate has a positive and significant causal relationship with NPL levels. Using annual data from 2000 to 2019, Gashi et al. (2022) applied GMM, fixed effects, and random effects models to examine how macroeconomic conditions influence NPLs in the Western Balkans. The results showed significant relationships between NPLs and GDP growth, government consumption, real interest rates, domestic savings, and unemployment rates.

Similarly, Alnabulsi et al. (2022) employed a two-stage system GMM estimator to evaluate the drivers of NPLs during financial and health crises in the MENA region from 2005 to 2020. Covering 74 banks across 11 countries, the study found that both institutional quality and macroeconomic conditions have a substantial impact on NPL volumes. Syed and Aidyngul (2022) examined macroeconomic and bank-specific influences on NPLs in both developed and developing countries using the GMM approach covering 1995–2019. Their results identified growth rate, inflation, interest rate, capital adequacy ratio, deposit-to-deposit ratio, and private-sector lending as key explanatory variables in both contexts.

Using data from 2005 to 2016, Kjosevski and Petkovski (2021) assessed macroeconomic factors affecting NPLs in 21 commercial banks across the Baltic States, finding that GDP growth, public debt, inflation, and unemployment were the most significant variables. Similarly, Arham et al. (2020) used a panel regression approach to investigate how national governance and macroeconomic cycles affect bank NPLs in emerging Asian economies. The results indicated that both real interest rates and unemployment rates significantly and positively affect NPLs in these economies.

Anita et al. (2020) used annual data from 2008 to 2019 to explore macroeconomic determinants of NPLs for a panel of eight South Asian Association for Regional Cooperation countries. Applying OLS, fixed effects, and random effects models, they found a significant inverse relationship between NPLs and money supply, GDP, sovereign debt, and inflation. Likewise, Nyabakora et al. (2020) applied a panel approach to analyze 27 listed firms in Tanzania from 2013 to 2019. Their results showed that interest rates and exchange rates have a positive impact on NPLs, while inflation, money supply, and GDP growth exerted a negative influence.

Zheng et al. (2019) employed an ARDL model to examine macroeconomic and sector-specific drivers of NPLs in Bangladesh's banking system from 1979 to 2018, confirming their findings using a vector error correction (VEC) model. Their results indicated that domestic credit and exchange rates were positively associated with NPLs. Additionally, bank liquidity and lending interest rates were found to exert upward pressure on NPL levels.

However, Radivojević et al. (2019) investigated the determinants of NPLs in Latin American emerging markets using difference and system GMM estimators. The study found no statistically significant relationship between lending interest rates and NPLs. In another study, Kuzucu and Kuzucu (2019) analyzed NPL drivers across emerging and advanced economies during the pre- and post-global financial crisis periods using dynamic panel methods. They found that exchange rates and foreign direct investments had statistically significant impacts on NPL ratios in emerging markets after the crisis.

Finally, using dynamic panel data from 2000 to 2016, Mpofu and Nikolaidou (2018) examined the macroeconomic factors influencing credit risk in banking systems across 22 SSA countries. Using pooled OLS, fixed effects, and both two-step difference and system GMMs, they found that credit risk increases as macroeconomic conditions deteriorate. Konstantakis et al. (2016) similarly assessed the determinants of NPLs in Greece using quarterly data from 2001 to 2015. Employing a VAR model, specifically a VEC approach, the study found that macroeconomic and financial indicators significantly affect NPL levels.

Empirical strategy

The theoretical model describing the relationship between the non-performing loan ratio and monetary policy, including control variables, follows the literature (Pandey, 2024; Akuoko-Konadu & Mahmud, 2024; Jimoh et al., 2024; Asemota et al., 2023; Bacchiocchi et al., 2022; Karadima & Louri, 2020; Arham et al., 2020; Bayar, 2019; Makri et al., 2014; Mpofu & Nikolaidou, 2018). The theoretical functional form is expressed as

$$\text{NPLR} = f\left(\text{INTR,INFL,EXR,M2,PD}, D_{\text{COVID19}}, D_{\text{FR\_MR}}, D_{\text{IMF}}\right), \tag{5}$$

From Eq. (5), the empirical panel specification can be written as

$$\text{NPLR}_{it} = \beta_0 + \beta_1\text{INTR}_{it} + \beta_2\text{INFL}_{it} + \beta_3\text{EXR}_{it} + \beta_4\text{M2}_{it} + \beta_5\text{PD}_{it} + \gamma_1 D_{\text{COVID19}_{it}} + \gamma_2 D_{\text{FR\_MR}_{it}} + \gamma_3 D_{\text{IMF}_{it}} + v_{it}, \tag{6}$$

where NPLR_{it} is the non-performing loan ratio, INTR_{it} is the interest rate, INFL_{it} is the inflation rate, EXR_{it} is the exchange rate, M2_{it} is broad money, and PD_{it} represents public debt. The following dummy variables capture exogenous shocks: $D_{\text{COVID19}_{it}}$ for COVID-19, $D_{\text{FR\_MR}_{it}}$ for pegged exchange rate regimes, and $D_{\text{IMF}_{it}}$ for International Monetary Fund (IMF)-related funding. β_0 is the constant term, v_{it} is the error term, i denotes countries, t denotes time, and coefficients β_1 to β_5 and γ_1 to γ_3 capture marginal effects. The expected signs are $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 < 0$, $\beta_5 > 0$.

3. Data and methods

Data source

The study adopted a PVAR model to assess how monetary policy shocks affect the NPL ratio across SSA. Although the region comprises 48 countries, data limitations reduced the sample to 23, including Angola, Botswana, Burundi, Comoros, Ethiopia, The Gambia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Nigeria, Namibia, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania, Uganda, and Zambia.

All data were obtained from secondary sources, including the World Bank's World Development Indicators, Global Financial Development Indicators, Sustainable Development Goals Indicators, and national central bank databases. The study covered the period from 2008Q1 to 2023Q4, using quarterly panel data. The variables include: non-performing loan ratio (NPLR), interest rate (INTR), inflation rate (INFL), exchange rate (EXR), broad money (M2), and public debt (PD). A dummy variable for COVID-19 (D_{COVID19}) captures pandemic-related shocks. These variables were drawn from the literature cited above, and their operational definitions are detailed in Table A1.

The study estimated a PVAR model based on the structure developed by Canova and Ciccarelli (2013). The general form of the model is as follows

$$Y_{it} = A_{0i}(t) + A_i(\ell)Y_{it-1} + Z_i(\ell)W_t + \varepsilon_{it}, \tag{7}$$

where $A_i(\ell)$ is a polynomial in the lag operator, ℓ, where restrictions on the coefficient matrices ensure that the variance of Y_{it} remains bounded. The vector, W_t, represents exogenous or predetermined variables common to all cross-sectional units, i. The existence of the inverse polynomial, $A(\ell)^{-1}$, is guaranteed by ensuring no roots lie on or inside the unit circle. This condition confirms the stability of the model and allows for the interpretation of Y_{it} as a vector moving average of infinite order (Lütkepohl, 2005).

This PVAR model was chosen for its ability to capture dynamic interdependencies among endogenous variables across countries and over time, including spillover effects (Jouida, 2018). In this context, all variables were treated as endogenous, with dynamic and static feedback effects and a cross-sectional component.

Let $Y_i(t)$ be the vector of endogenous variables for country i at time t, where $t = 1, \dots, T$ and $i = 1, \dots, N$. Its stacked representation is Y_{it}. The optimal lag length is selected based on the minimum value among the Bayesian information criterion, Akaike information criterion (AIC), and Hannan–Quinn criterion (HQ).

To investigate long-run relationships, the structural form with Blanchard–Quah (1989) long-term restrictions is expressed as

$$Y_{it} = \sum A_p^s Y_{it-p} + F_i W_t + B\mu_{it}, \text{ where } \varepsilon_{it} = A^{-1}B\mu_{it} \text{ and } S = A^{-1}B. \tag{8}$$

This form enables identification of structural shocks and their cumulative long-term impact through matrix S.

Here, F_i denotes the autoregression coefficient matrix of size $(N \times N)$, and the error term vector, $\varepsilon_t = (\mu_{1t}, \dots, \mu_{kt})$, follows a Gaussian distribution with dimension $(N \times 1)$, where $\varepsilon_t \sim \left(0, E(\mu_t \mu_t')\right)$ and the covariance matrix is positive definite.

The F matrix indicating the shock is introduced in Eq. (9). From Eq. (9), the cumulative long-term impact of the shock is assumed to be zero. The term ψ represents the long-term multiplier, satisfying the condition, $F = \psi S$, where

$$\left(I - A_1 - \cdots - A_p\right)^{-1} \varepsilon_t = \Psi \varepsilon_t = F u_t. \quad (9)$$

The structure of the F matrix captures long-term dynamics, assuming that each variable is affected by a shock, and the final variable in the sequence is only influenced by its own shock. This structure, as detailed in Eq. (10), is derived from the theoretical model:

$$F = \begin{bmatrix} INTR \\ EXR \\ INFL \\ PD \\ M2 \\ NPLR \end{bmatrix} = \begin{bmatrix} f11 & 0 & 0 & 0 & 0 & 0 \\ f21 & f22 & 0 & 0 & 0 & 0 \\ f31 & f32 & f33 & 0 & 0 & 0 \\ f41 & f42 & f43 & f44 & 0 & 0 \\ f51 & f52 & f53 & f54 & f55 & 0 \\ f61 & f62 & f63 & f64 & f65 & f66 \end{bmatrix} \text{, and } S = \begin{bmatrix} f11 & f12 & f13 & f14 & f15 & f16 \\ f21 & f22 & f23 & f24 & f25 & f26 \\ f31 & f32 & f33 & f34 & f35 & f36 \\ f41 & f42 & f43 & f44 & f45 & f46 \\ f51 & f52 & f53 & f54 & f55 & f56 \\ f61 & f62 & f63 & f64 & f65 & f66 \end{bmatrix} \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \\ \epsilon_{4t} \\ \epsilon_{5t} \\ \epsilon_{6t} \end{bmatrix}. \quad (10)$$

Thus, Eq. (10) defines the long-run structure under the assumption that each variable experiences shocks, with the last variable affected only by its own innovations.

It should be noted that the PVAR model is not without limitations. A primary limitation is the assumption of time-invariant coefficients, which implies that the relationships among variables remain constant over time for all cross-sectional units. In practice, however, these relationships may change due to evolving economic conditions, policy adjustments, or structural shifts. Another limitation is the model's need for many observations to yield reliable estimates. Nonetheless, the PVAR model remains suitable for the present study.

4. Results and discussion

This section presents the results and discussion based on the analyzed data and aligns with the study's objectives. The analysis proceeds in the following order: stationarity testing, lag selection, and estimation of the PVAR model.

Panel unit root test

To assess the stationarity properties of the variables, the Levin et al. (LLC, 2002) and Im et al. (IPS, 2003) unit root tests were applied. The LLC test assumes cross-sectional homogeneity, whereas the IPS test allows for heterogeneity across panels. The results, shown in Table 1, indicate mixed outcomes. Specifically, NPLR, INTR, INFL, and M2 were stationary at level, that is, integrated of order zero $I(0)$. However, EXR and PD were non-stationary at level, indicating the presence of a unit root, and became stationary after first differencing, that is, $I(1)$.

Table 1: Panel unit root test

Test	NPLR	INTR	INFL	EXR	M2	PD
LLC	-3.834 (0.000)*	-3.992 (0.000)*	-6.432 (0.000)*	-19.624 (0.000)*	-6.902 (0.000)*	-15.506 (0.000)*
IPS	-4.651 (0.000)*	-7.359 (0.000)*	-7.987 (0.000)*	-11.161 (0.000)*	-9.341 (0.000)*	-11.201 (0.000)*

Source: Authors' computation

Optimal lag length selection

To analyze the data using the PVAR procedure, selecting the appropriate lag length is crucial. Based on the PFE, AIC, and HQ criteria, a lag length of four was selected, as shown in Table 2. Consequently, the PVAR model was deemed applicable.

Table 2: Lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-10464.74	NA	12258.82	26.44126	26.47668	26.45487
1	-2168.013	16446.80	1.07e-05	5.580840	5.828733	5.676114
2	-1842.266	640.7992	5.14e-06	4.849157	5.309530*	5.026095
3	-1823.844	35.96105	5.38e-06	4.893545	5.566398	5.152147
4	-1614.321	405.8176*	3.47e-06*	4.455356*	5.340690	4.795623*

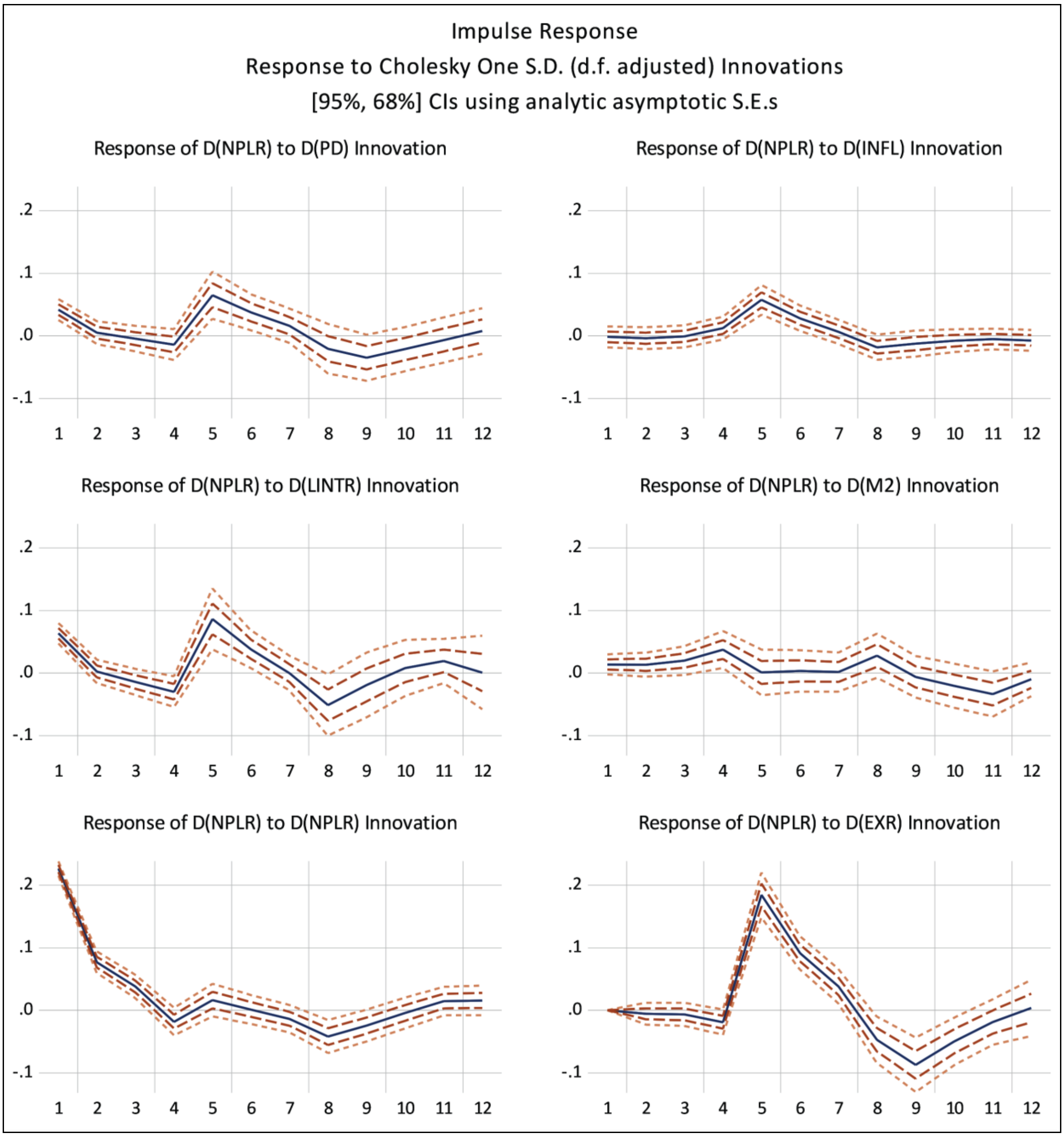
Source: Authors' computation

Monetary policy and non-performing loans (short-run Cholesky recursive model)

This section presents the results of impulse response functions and forecast error variance decomposition, illustrating how NPLs respond to short-run contemporaneous shocks from exogenous variables, as shown in Fig. 2 and Table 3.

The NPLR exhibited a positive response to its own shock from the first to the third quarter, with the mean lying within the critical bounds of the standard errors. Additionally, NPLR responded negatively to its own shock during the fourth to fifth and seventh to ninth quarters, followed by positive responses in the 11th and 12th quarters. A shock to the INTR led to a positive effect on NPLR from the first to second and fourth to sixth quarters. Negative responses were observed between the seventh and ninth quarters. These alternating effects persisted in the long run but eventually dissipate. These results align with the findings of Pandey (2024), Akuoko-Konadu and Mahmud (2024), Jimoh et al. (2024), Asemota et al. (2023), Bacchiocchi et al. (2022), and Zheng et al. (2019).

Figure 2: Impulse response functions among the variables



Source: Authors' Computation

Among all variables, the exchange rate (EXR) exerted the most significant influence on NPLs in SSA, as shown in Fig. 2. A shock to EXR produced a positive response in NPLR between the fourth and seventh quarters, followed by negative responses between the 8th and 11th quarters. These findings are consistent with Asemota et al. (2023), Alnabulsi et al. (2022), Kjosevski and Petkovski (2021), Zheng et al. (2019), and Kuzucu and Kuzucu (2019).

Similarly, a sudden increase in public debt led to a rise in NPLR during the first to second and fourth to sixth quarters. Conversely, negative effects were observed between the eighth and ninth quarters. This supports the conclusions of Arham et al. (2020), Bayar (2019), and Makri et al. (2014).

Additionally, inflation (INFL) shocks produced positive effects on NPLR during the fourth to sixth quarters and negative effects from the seventh to ninth quarters. However, these shocks dissipated in the long run. These results are consistent with the studies of Pandey (2024), Bacchiocchi et al. (2022), Karadima and Louri (2020), and Konstantakis et al. (2016).

Finally, a sudden shock to broad money supply (M2) led to a short-run increase in NPLR between the first and fourth quarters and again between the seventh and ninth quarters. A negative response was observed between the 11^{th} and 12^{th} quarters. These dynamics suggest that monetary policy shocks have long-run effects on the NPLR. The findings corroborate those of Zanfack et al. (2024), Asemota et al. (2023), Anita et al. (2022), Alnabulsi et al. (2022), and Mpofu and Nikolaidou (2018).

Furthermore, Table 3 helps explain how innovations in NPLR are influenced by innovations in the independent variables. The variance decomposition covers 12 periods and confirms the implications of Fig. 2. Specifically, Table 3 shows that the exchange rate (EXR) is the primary variable explaining innovations in NPLR across the periods. However, the largest share of the variance in NPLR was initially explained by its own past values (1^{st} to 12^{th} period), but this influence diminishes over time.

For example, in the early periods, approximately 89% to 39% of the innovations in NPLR were attributed to its own historical values, but this share declined over time. As shown in Table 3, by the 12^{th} period, the contribution fell from 89% to approximately 39.8%. Notably, the influence of EXR on NPLR became more pronounced from the 5^{th} to 12^{th} quarter, rising from 29.15% to 36.42%, surpassing all other explanatory variables. These results are consistent with Asemota et al. (2023), Alnabulsi et al. (2022), Kjosevski and Petkovski (2021), and Kuzucu and Kuzucu (2019).

Table 3: Forecast error variance decomposition

Period	S.E.	D(PD)	D(INFL)	D(INTR)	D(M2)	D(NPLR)	D(EXR)
1	0.24	3.06	0.00	7.04	0.33	89.56	0.00
2	0.25	2.80	0.03	6.37	0.57	90.17	0.05
3	0.26	2.74	0.03	6.48	1.15	89.48	0.11
4	0.26	2.90	0.25	7.45	3.14	85.62	0.63
5	0.34	5.25	2.94	10.68	1.83	50.15	29.15
6	0.36	5.85	3.27	10.79	1.67	45.53	32.89
7	0.36	5.95	3.25	10.64	1.65	45.00	33.51
8	0.37	5.91	3.30	11.89	2.11	43.64	33.14
9	0.39	6.33	3.19	11.34	2.00	41.14	36.01
10	0.39	6.48	3.15	11.13	2.22	40.22	36.80
11	0.39	6.42	3.13	11.21	2.91	39.80	36.52
12	0.40	6.44	3.15	11.18	2.97	39.84	36.42

Source: Authors' Computation

In addition to EXR, the INTR was the second most influential factor, explaining between 10.68% and 11.18% of innovations in NPLR, although its influence diminished over time. These findings reinforce earlier results, which showed that shocks to INTR have a substantial impact on NPLR, as supported by Pandey (2024), Akuoko-Konadu and Mahmud (2024), Jimoh et al. (2024), Asemota et al. (2023), and Bacchiocchi et al. (2022).

Public debt is the next most significant variable in explaining innovations in NPLR, demonstrating how shocks to public debt affect banking stability in SSA. This supports the findings of Arham et al. (2020), Bayar (2019), and Makri et al. (2014). INFL also contributed to explaining innovations in NPLR after interest, although its effects fluctuated across quarters. For instance, inflation explains 3.27% of the variance in Q6 and 3.30% in Q8, with similar variations continuing throughout the periods. These findings align with Akuoko-Konadu and Mahmud (2024), Jimoh et al. (2024), and Arham et al. (2020).

Finally, broad money supply (M2) also explains a portion of the innovations in NPLR, although its influence diminished over time. For example, M2 accounted for 3.14% of the variance in the fourth period, dropping to 2.97% by the 12th period. These results are consistent with those reported by Zanfack et al. (2024), Asemota et al. (2023), Anita et al. (2022), Alnabulsi et al. (2022), and Mpofu and Nikolaidou (2018).

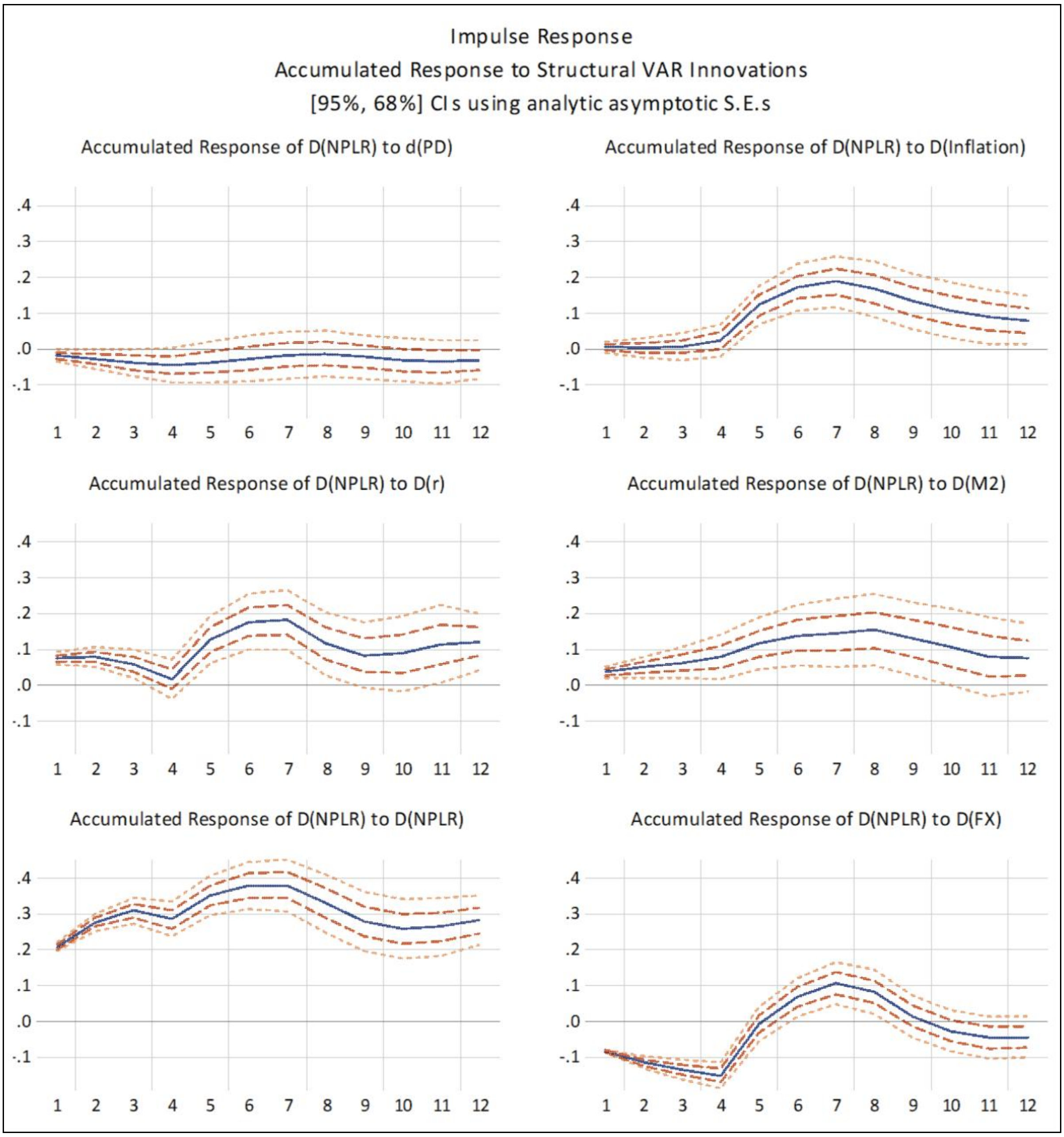
Monetary policy and non-performing loans (Blanchard–Quah's long-effect structural model)

As a robustness check, this section presents results from impulse response functions and forecast error variance decomposition, assessing how NPLR responds to long-run shocks from exogenous variables, as shown in Fig. 3 and Table 2. According to Fig. 3, NPLR responded positively to its own shocks throughout all 12 quarters, with the mean remaining within the standard error bounds. This contrasts with the short-run results and is specific to the SSA context.

A shock to INTR resulted in a sustained positive impact on NPLR from the first to the third quarter and again from the fourth to the eighth quarter, with continued positive responses from the ninth to twelfth quarters. This suggests that in the long run, shocks to INTR exert a prolonged upward influence on NPLR, in contrast to the short-run dynamics. These long-run findings align with those of Pandey (2024), Akuoko-Konadu and Mahmud (2024), Jimoh et al. (2024), Asemota et al. (2023), Bacchiocchi et al. (2022), and Zheng et al. (2019).

EXR remained the most influential variable in the long run as well. For example, a shock to EXR resulted in a negative effect on NPLR from the first to the fifth quarter, which contrasts with the positive effects observed in the short run. This was expected in the SSA context, as currency depreciation in the region typically leads to higher non-performing loan rates. These findings are consistent with those of Asemota et al. (2023), Alnabulsi et al. (2022), Kjosevski and Petkovski (2021), Zheng et al. (2019), and Kuzucu and Kuzucu (2019).

Figure 3: Impulse response functions among the variables



Source: Authors' Computation

Furthermore, a shock to the exchange rate led to positive effects on NPLR from the sixth to ninth quarters and negative effects between the eleventh and twelfth quarters. Moreover, a sudden shock to public debt resulted in a negative effect on NPLR from the first to fourth quarters, unlike the short-run scenario, where the effect was positive. It also became insignificant in the later periods. This suggests that a public debt shock (i.e., an increase) leads to a reduction in NPLR in the context of SSA. These results align with the findings of Bayar (2019) and Makri et al. (2014).

Furthermore, the effect of inflation on NPLR in the long run is notable. Although the impact was insignificant in the early periods (i.e., first to fourth quarters), the response became positive from the fifth to twelfth quarters. This pattern contrasts with the short-run behavior. Nonetheless, these results are consistent with Pandey (2024), Bacchiocchi et al. (2022), Karadima and Louri (2020), and Konstantakis et al. (2016).

Finally, an interesting trend emerges in the case of M2, where a sudden shock led to a positive effect on NPLR in the long run, spanning from the first to tenth quarters. This suggests that a monetary policy shock significantly influences NPLR over time. However, in the context of SSA, the result contradicted the expected theoretical relationship, in which money supply typically exhibits an inverse correlation with NPLR. Although these findings were supported by Zanfack et al. (2024), Asemota et al. (2023), Anita et al. (2022), Alnabulsi et al. (2022), and Mpofu and Nikolaidou (2018), they contradict Nyabakora et al. (2020), who reported a negative relationship in Tanzania.

Additionally, Table 4 presents the results of the forecast error variance decomposition, showing how innovations in NPLR are explained by innovations in the independent variables over the long run. This analysis, which spanned 12 periods, generally confirmed the results shown in Fig. 3, with the exception of public debt, which is no longer significant in this model. As with Table 3, Table 4 demonstrates that the exchange rate is the dominant variable explaining innovations in NPLR across all periods in SSA.

Table 4: Forecast error variance decomposition

Period	S.E.	D(PD)	D(INFL)	D(INTR)	D(M2)	D(NPLR)	D(EXR)
1	0.24	0.56	0.05	9.91	2.28	75.11	12.10
2	0.25	0.70	0.04	8.96	2.36	75.35	12.59
3	0.26	0.83	0.05	9.19	2.54	74.58	12.81
4	0.26	0.84	0.47	11.50	2.81	71.80	12.58
5	0.34	0.53	8.57	17.16	2.84	45.63	25.26
6	0.36	0.57	9.71	17.51	2.93	42.03	27.25
7	0.36	0.65	9.76	17.28	2.92	41.42	27.98
8	0.37	0.62	9.50	19.45	2.81	40.82	26.81
9	0.39	0.62	9.66	18.83	2.99	39.84	28.06
10	0.39	0.66	9.86	18.42	3.28	39.26	28.52
11	0.39	0.67	9.96	18.58	3.71	38.74	28.34
12	0.40	0.68	9.97	18.55	3.70	38.83	28.26

Source: Authors' Computation

Nevertheless, a substantial share of the variance in NPLR can be explained by its own past values, from the first to twelfth period, although this influence declines over time. For instance, in the initial periods, approximately 75% to 38.8% of the innovations in NPLR were self-explained, but the contribution diminished with each subsequent period. Compared with the short-run results, the long-run self-contribution was lower. As shown in Table 4, the contribution fell from 75% in the first period to around 38.8% by the twelfth period.

Moreover, exchange rate shocks remained the most significant external influence on NPLR from the first to twelfth quarter, with contributions ranging from 12.10% to 28.26%. Notably, the explanatory power of exchange rate shocks in the long run was higher than in the short run. These results are consistent with Asemota et al. (2023), Alnabulsi et al. (2022), Kjosevski and Petkovski (2021), and Kuzucu and Kuzucu (2019).

Apart from the exchange rate, the INTR was the next most influential variable in explaining innovations in NPLR. However, its explanatory power diminished over time. As observed in the previous analysis, INTR shocks continued to have a substantial impact on NPLR in SSA. This was expected, given that financial systems in developing countries are often underdeveloped. The findings are supported by Pandey (2024), Jimoh et al. (2024), and Bacchiocchi et al. (2022).

In contrast, public debt did not appear to significantly influence NPLR in the long-run model. Inflation, however, remained an explanatory variable. Its shocks began in the fifth quarter and fluctuated throughout the observed periods, similar to the short-run case, with alternating increases and decreases. Despite these fluctuations, a shock to inflation exhibited a significant long-run effect on NPLR in SSA, consistent with Jimoh et al. (2024) and Arham et al. (2020).

Finally, innovations in NPLR could also explained by shocks to M2, although the effect weakened over time. The influence of M2 followed a pattern like the one observed in the short run, with alternating periods of increase and decrease. These results continue to align with Zanfack et al. (2024), Asemota et al. (2023), Anita et al. (2022), Alnabulsi et al. (2022), and Mpofu and Nikolaidou (2018).

5. Conclusion and policy recommendations

This study found that financial institutions play a crucial role in economic development, particularly through their capacity to extend credit to economic agents. This credit provision is significantly influenced by the macroeconomic environment in which these institutions operate. Recent global financial and economic crises have distorted financial markets and the banking sector in developing regions, especially in SSA, contributing to elevated levels of NPLs.

Owing to the limited scope of fiscal policy interventions, monetary policy has emerged as a critical tool for monetary authorities in these economies. The conduct of monetary policy has direct implications not only for the broader economy but also for the banking sector specifically. As such, monetary policy decisions affect financial institutions throughout SSA. This study examined the relationship between monetary policy and NPLs in SSA by applying a PVAR methodology using quarterly data from 23 countries spanning from 2008 to 2023.

To assess how the NPLR responds to monetary policy shocks and other exogenous variables, two models were constructed in addition to the general specification. The first was a short-run Cholesky recursive model, and the second was the Blanchard–Quah long-run structural model. These models help determine the distinct impacts of various macroeconomic factors on NPLR for policy guidance. The impulse response analysis from the short-run model revealed that, in the early periods, fluctuations in NPLR were largely driven by its own shocks, followed by contributions from exogenous variables.

Specifically, among individual exogenous shocks, the most influential was the exchange rate, followed by INTR, public debt, inflation, and finally broad money supply. The forecast error variance decomposition supports these findings, showing that a large proportion of innovations in NPLR can be attributed to exchange rate shocks, followed in sequence by INTR, public debt, inflation, and money supply.

In the long-run model, the impulse response functions again showed that NPLR was initially driven by its own shocks, which diminished over time. However, the magnitude of these self-driven shocks was smaller than in the short-run model. Beyond its own shocks, exchange rate shocks remained the primary driver, followed by INTR, inflation, money supply, and public debt. The forecast error variance decomposition further confirms these results, with innovations in NPLR predominantly explained by exchange rate shocks, then INTR, inflation, and money supply. Notably, public debt was found to be statistically insignificant in the long-run.

This study presents several practical implications. First, it highlights the importance of monetary policy and macroeconomic conditions in shaping the performance of the banking sector in SSA, offering valuable insights for monetary authorities and policymakers. Second, governments and central banks across SSA can reduce NPLs by adopting sound and consistent monetary policy strategies, thereby mitigating distortions in money and financial markets.

Third, excessive domestic and external borrowing, elevated interest rates, inflationary pressures, fluctuations in broad money supply, and exchange rate volatility contribute to rising NPLs in SSA economies. As a result, it is recommended that governments and monetary authorities in SSA pursue credible and transparent monetary policy aimed at fostering a stable macroeconomic environment. Such efforts will help strengthen financial sector operations and reduce loan defaults across the region.

This study also has limitations. Chief among them was data unavailability for some countries, which limited the analysis to 23 SSA nations. Moreover, studies on this topic remain relatively scarce in the SSA context. However, this limitation does not affect the quality or generalizability of the findings. Finally, while this study examined the influence of monetary policy on NPLR in SSA as a region, future research could explore country-specific time-series data to support the formulation of tailored national-level policies.

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Appendix 1

Table A1: Description of variables and source of data

Variable	Explanation	Data source
Exchange rate	This is measured as using the bilateral rate against the US Dollar.	World Development Indicators and Central Banks' Databases 2008-2023
Inflation	Measured as using the consumer price index.	World Development Indicators 2008-2023
Non-Performing Loans ratio	This is measured as the banks' non-performing loans to total gross loans.	Global Financial Development, World Bank Dataset 2008-2023
Public Debt	This is measured as the public debt as a percentage of GDP.	World Development Indicators 2008 to 2023
M2	This is measured as broad money as a percentage of GDP.	World Development Indicators 2008 to 2023
Lending interest rate	This is the bank rate charged by financial institutions that meets the financial needs of the private sector.	World Development Indicators and Central Banks' Databases 2008-2023

Source: Authors' construction