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Determinants of Non Performing Loans and Its Feedback Effects on Macroeconomic Performance: The Case of Rwanda

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Abstract

This paper investigates the determinants of non-performing loans (NPLs) in the Rwandan banking sector for the period 2012Q1 to 2022Q1. The study uses the bias-corrected fixed effects (BCFE) for the dynamic panel data. The findings reveal that the level of NPLs is explained by macroeconomic conditions such as credit growth, Real Gross Domestic Product (RGDP) growth, and real effective exchange rate. However, inflation is not significant for BCFE, but it is for fixed effect (FE) used as a benchmark. Banks' specific characteristics, namely real interest rate, growth of loans, size, capital adequacy ratio, operating efficiency, and income diversification, were found to be important determinants of NPLs in Rwanda. The study also affirms the robust feedback mechanisms originating from the banking sector via non-performing loans, exerting a tangible influence on the real economy. The main implication from the findings is that the National Bank of Rwanda should continue ensuring macroeconomic stability while reinforcing banking sector supervision, putting in place policies to ensure that the banks avoid excessive lending by maintaining solid credit standards so as to prevent a sharp buildup of NPLs.

Keywords: Non-performing loans, Bias-corrected fixed effects and Panel VAR

JEL Classification: G21, G32, E44, C23

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1 Introduction

Banks are generally exposed to a diversity of risks, such as credit, financial, operational and strategic, and macroeconomic risks. The main activity of banks is to finance the economy by giving out loans to different economic agents. These loans constitute the largest share of banks' total assets, and consequently, credit risk becomes the key risk for banks Marcucci & Quagliariello (2009). In Rwanda, the ratio of bank loans to total assets of the banking sector averaged 56.9 percent in the last decade. While the level of NPLs signals the degree of crystallization of key risks, elevated NPLs can be dangerous for macro-financial stability. It is widely believed that rising NPLs are often precursors to financial crises and bank failures. For example, the financial crisis of 2007/2008 was attributed to the rapid default of the United States subprime mortgage. Therefore, assessing the determinants of NPLs becomes an important empirical enterprise worldwide, particularly in Rwanda, where credit risk is more prevalent than other risks that the banking sector faces.

Elevated NPLs impedes not only the growth of the banking sector but also economic growth. As Klein (2013) observes, an increase in NPLs diminishes liquidity, reduces banks' profitability, limits credit growth to viable economic entities, and restrains economies to low growth as the real sector slows down, causing an increase in unemployment. Although the classification of NPLs differs across countries, IMF (2019) and regulation No 12/2017 of 23rd November 2017 of the National Bank of Rwanda on credit classification and provisioning, classify a loan as non-performing if payments (principal and/or interest) due have not been paid for at least 90 days.

Since financial liberalization began in 1995, the Rwandan financial sector has undergone profound changes characterized by the deregulation of interest rates, abolition of credit ceilings, market determination of interest and exchange rates, and the adoption of indirect monetary policy instruments. There has been the enhancement of regulatory framework and financial sector supervision aimed at developing the financial market and increasing competition between banks in a bid to achieve efficient financial intermediation. Consequently, the number of banks grew from seven (7) in 1995 to fifteen (15) by the end of 2022. Among these banks, subsidiaries of foreign banks constitute the majority. In this regard, lending activities grew at a higher pace after the liberalization and increased risk-taking as evidenced by Tonell et al. (2004) who stipulate that though financial liberalization is positively linked to growth, it also ignites a lending boom.

Given the importance of NPLs as far as their determinants and macroeconomic effects are concerned, many researchers around the world continue to focus attention on them. Part of the literature has concentrated on the determinants of NPLs using macroeconomic factors and bank-level data Glogowski (2008), while the remaining part of the literature explored the feedback effect of NPLs on the macroeconomic performance after assessing the determinants of NPLs Klein (2013); Espinoza & Prasad (2010)). It is in this last strand of the literature that this study is classified.

However, the existing literature is scanty, especially in Rwanda, where NPLs had trended upward over time before converging to the 5 percent target recently in 2018. To the best of our knowledge, only one paper by Karuhanga K. et al. (2018) attempted to examine the determinants of NPLs in Rwanda with much emphasis on macroeconomic variables and limited focus on bank-specific data over the period 2012Q1 to 2017Q2 by using dynamic panel data techniques.

The objective of this paper, therefore, is to assess the determinants of NPLs in the Rwandan banking sector and their feedback on the real economy spanning the period 2012Q1 to 2022Q1. The latter sample period does not include all quarters of 2022 because of two banks which merged in April 2022, and the study was seeking to include them separately before they became one. The contribution of this paper to the existing literature is the assessment of the determinants of NPLs and their macroeconomic effects by exploring other key variables not considered by previous works, especially bank-specific variables, as well as using a novel estimation technique. In this regard, the paper aims to correct the fixed effect (FE)[1] used by Karuhanga K. et al. (2018) with the use of a bias-corrected alternative. Another contribution of this paper to the existing literature is the assessment of the feedback effect from the NPLs on the selected macroeconomic variables by using a panel VAR. The empirical literature review suggests that no previous paper has attempted to assess NPLs via this angle.

The findings reveal that both macroeconomic and bank-level variables exert a significant impact on NPLs. Specifically, economic growth represented by RGDP improves NPLs. Conversely, increases in inflation (INFL) and the depreciation of the real effective exchange (REER) deteriorate the asset quality of banks. In the case of bank-level data, a rise in real lending rate (RIR) increases the burden of borrowers in terms of servicing their debt and, therefore, raises the NPLs ratio. Another important finding is that NPLs are positively related to bank size, implying that the higher the bank size, the higher the NPLs ratio. This finding is consistent with the literature, which suggests a possible moral hazard problem emanating from the "too big to failure" argument whereby big banks usually think that they will be covered by the government in case of financial failures, leading them to take higher risks in their lending activities. We also found a negative relationship between Capital Adequacy Ratio (CAR), Income Diversification (ID), and Bank Operating Efficiency (BOE) with NPLs, as expected.

The evaluation of the feedback effects places significant emphasis on the potent interplay between macroeconomics and finance. This analysis, which leverages on the panel Vector Autoregression (VAR) model and impulse response functions, unequivocally validates the existence of this feedback mechanism. Specifically, when a shock to the NPLs occurs, it triggers a notable reduction in credit expansion, and real GDP growth, while inflation has an expected direction but is not statistically significant. These findings underscore macro-financial linkages in the Rwandan economy and

[1]The FE estimators are biased for small panels, specifically when the number of cross sections is small.

the need for policies to forestall financial instability and its potential spillover to the macroeconomy.

The rest of this study is organized as follows. Section 2 describes the dynamics of non-performing loans in the Rwandan banking sector. Section 3 presents the literature review. Section 4 outlines the analytical procedure and model specifications and data, while Section 5 reports the empirical results and Section 6 contains the conclusion.

2 Dynamics of Non-Performing Loans in the Rwandan Banking Sector

2.1 Structure of the banking sector

Since financial liberalization began in 1995, the Rwandan financial sector has undergone significant changes, such as the use of indirect monetary policy instruments following the abolition of credit ceilings and other direct control measures, and the market determination of interest rates and exchange rates. The regulatory framework and financial sector supervision have witnessed improvements aimed at developing the financial market and increasing competition between banks in a bid to achieve efficient financial intermediation. The number of banks operating in the Rwandan financial sector has since increased to 15 banks after Banque Populaire du Rwanda PLC and Kenya Commercial Bank Rwanda PLC merged in April 2022, compared to 13 banks by the end of 2012 and 7 banks by the end of 1995. The latter period coincided with the resumption of economic activities after the end of the genocide against the Tutsi and moderate Hutus in July 1994. Among the 15 banks currently operating in Rwanda, 10 are commercial banks, 3 microfinance banks, 1 development bank, and 1 cooperative bank. 10 banks out of the 15 banks are subsidiaries of foreign banks, equivalent to 53.9 percent of the banking sector's market share in terms of total assets. The banking sector plays an important role in the Rwandan economy since it constitutes a major source of financing for the private sector.

2.2 The performance of the banking sector

The balance sheet of the banks has increased substantially in recent times despite the challenging economic conditions. Indeed, the total assets of the banking sector grew by 123.2 percent to FRW 5,993 billion as of the end of December 2022, from the end-2017 position. The high growth in banks' assets mostly emanated from the rise in loans as banks' deposits and capital base increased over the past five years. Lending to the private sector remains the main risk faced by Rwandan banks. By the end of December 2022, net loans accounted for 52.2 percent of the total assets of banks, whereas Government securities constituted 21.1 percent of the total assets of banks.

During the same period, the reserves at the NBR amounted to 8.6 percent, placements in domestic banks (8.5 percent), placements in foreign banks (2.9 percent), fixed assets (2.9 percent), other assets (2.3 percent), and cash (1.6 percent). With this balance sheet structure, interest income on loans and advances is the primary source of income for banks, accounting for approximately 59.2 percent of the total revenues of banks. The balance sheet of banks is funded mainly by short-term customer deposits. As of the end of December 2022, customer deposits represented 72.2 percent of the total liabilities of banks versus 78.6 percent recorded during the last 8 years.

The financing of the economy by banks remains good, with the increase of outstanding loans by 21.0 percent to FRW 4,160.3 billion by the end of December 2022 compared to the growth of 15.9 percent on average in the last five years. In terms of sectoral lending, banks continue to carry out credit diversification strategies to mitigate credit risks that could arise from sectoral loan concentration. Nonetheless, loans have been historically concentrated in mortgage industries, trade and hotels. The share of loans in those sectors to total loans has been declining at the expense of an increased share of transport warehousing and communication, manufacturing activities, service sector, and water and energy.

	Dec-12	Dec-17	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22
% share							
Personal loan	24.9	8.9	8.8	8.1	8.6	8.3	8.8
Agricultural,fisheries& livestock	2.8	0.9	0.9	0.7	0.7	0.7	0.5
Mining activities	0.0	0.2	0.2	0.2	0.2	0.0	0.0
Manufacturing activities	3.2	8.6	8.8	12.1	12.2	10.4	11.2
Water & energy activities	1.1	2.5	2.8	4.5	3.8	3.4	4.2
Mortgage industries	31.1	39.4	37.8	37.9	34.6	33.6	30.7
Commercial & hotel	27.4	26.3	24.2	21.2	24.0	26.1	23.4
Transport; warehousing & communication	6.8	9.5	12.8	11.8	11.0	11.5	11.5
OFI & insurance	0.7	1.3	1.0	0.9	0.8	0.3	0.7
Service sector	2.0	2.5	2.7	2.6	4.2	5.7	9.0
% change							
Total credit growth	38.6	12.3	12.4	5.4	33.9	15.6	21.0

Table 1: **Sectoral distribution of credit in % Share (NBR, 2023)**

2.3 Soundness of the banking sector

The banking sector remains sufficiently capitalized, reflecting banks' increased ability to absorb losses. The capital adequacy ratio (CAR) stood at 23.0 percent on average in the last decade, higher than the minimum requirement of 15 percent. Liquidity risks remain marginal as bank funding conditions remain steady while key measures of core liquidity such as Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR) remained above the minimum prudential requirement from June 2018 to December 2022. By complying with these two indicators, banks ensure they are resilient to funding shocks over the short- and longer-term horizons while continuing to support lending activities. The LCR ensures that banks hold a sufficient reserve of High-Quality Liquid Assets (HQLA) to allow them to resist a period of significant liquidity stress for a period of 30 calendar days. The consolidated LCR of banks, by considering all currencies, reached 263.8 percent on average between June 2018 and December 2022 versus the minimum requirement of 100 percent, indicating the resilience of banks to short-term outflow of funds. However, the NSFR ensures funding resilience over a longer time horizon than the LCR, requiring banks to fund long-term assets with long-term liabilities and hence limit the degree of maturity mismatch. Precisely, the NSFR gauges the availability of stable funding of the banks over a one-year horizon. This ratio averaged 162.9 percent between June 2018 and December 2022 against the 100 percent minimum regulatory requirement.

Banks remain profitable, and their excess reserves continue to increase their capital buffers. The aggregate net profits of banks grew by 134.1 percent to FRW 1,198.2 billion between 2018 and 2022 compared with 199.1 percent recorded between 2013 and 2017. The Return on Assets (ROA) averaged 2.1 percent between 2018 and 2022, which is the same level reached in the preceding five years, while the Return on Equity (ROE) stood at 12.3 percent on average, higher than the 10.6 percent recorded during the same period. Within the context of stability, enhanced profitability increases the resilience of banks against shocks through internally generated capital buffers, thus plays a role in capital and liquidity funding role. Fx loans to gross loan ratio have been increasing from an average of 3.8 percent between 2012 and 2016 to 10.5 percent between 2017 and 2022. This reflects the impact of the exchange rate on loan repayment, especially for borrowers who do not earn foreign currency.

	Dec-12	Dec-17	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22
Capital Adequacy Ratio	21.4	21.4	25.5	24.1	21.5	21.6	21.7
LCR(min 100%)	-	-	637.0	191.8	254.7	268.9	215.9
NSFR (min 100%)	-	-	222.0	129.3	161.4	147.1	136.8
FX loans/Gross loans	0.9	11.8	10.7	11.4	9.7	8.3	9.0
NPLs/Gross loans	7.1	7.6	5.0	4.5	4.5	4.6	3.1
Provision/NPLs	45.3	46.7	68.2	83.6	106.3	119.8	141.9
Return on Assets(RoA)	2.2	1.1	1.9	2.2	2.0	2.5	3.0
Return on Equity(RoE)	10.4	6.2	11.2	12.5	11.8	15.0	17.8
Growth of loans	38.6	12.3	12.4	5.4	33.9	15.6	21.0

Table 2: **Key financial soundness indicators for banks (percent) (NBR, 2023)**

2.3.1 Development in Non-Performing Loans (NPLs)

NPLs declined steadily to converge to the benchmark of 5 percent in 2018. The outstanding NPLs in the banking sector recently reduced by 0.5 percent on average between the end of December 2018 and the end of December 2022. This reflects a decline in the NPLs ratio during that period (4.3 percent) compared to the rise of 15.7 percent in outstanding NPLs on average between the end of December 2011 and the end of December 2017, which corresponds with NPLs of 7.1 percent during the same period. Though the increase in NPLs during the 2011-2017 period was still above the minimum requirement of 5 percent, it was moderate compared to the period prior to 2011 when NPLs were in double digits, averaging 12.8 percent between 2007 and 2010.

In order to achieve the above-mentioned decline in NPLs from double-digit to single-digit, NBR introduced measures to reinforce the prudential and regulatory frameworks and put in place banks' internal credit policies as follows. The NBR enhanced its supervisory role and obliged banks to write off bad loans that were overdue for a long time. Moreover, NBR introduced a credit reference bureau in July 2010 in a bid to reduce the information asymmetry that existed between creditors and borrowers in Rwanda. Several regulations were enacted in different periods to improve the asset quality of banks. Among others, the regulation in 2011 on credit classification and provisioning with the objective of ensuring that banks promptly identify their NPLs and undertake adequate correction measures.

Briefly, NPLs were above the regulatory minimum requirement from 2006 up to 2017 before

converging to the minimum requirement of 5 percent in 2018. This reduction in the NPLs ratio was due to several measures undertaken by the National Bank of Rwanda and idiosyncratic reforms by the banks mentioned above, the robust economic performance, which enables banks' clients to service their loans, and increased write-offs of legacy bad loans.

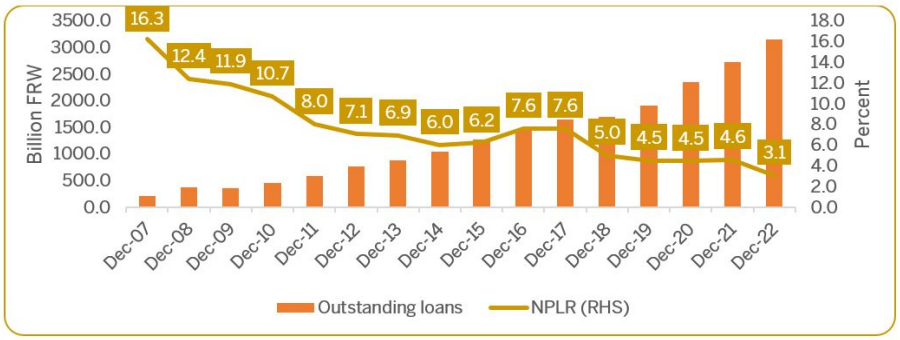


Figure 1: **Outstanding Non-Performing Loans Developments(NBR, 2023)**

2.3.2 Macro-financial linkages in Rwanda

The figure below shows the trend in the NPL ratio associated with the trend in real interest rate and economic activities. Globally, the trends in RGDP growth and real interest rate are negatively and positively linked to NPL ratio, respectively. For instance, between 2009 and 2015, the NPL ratio was declining though it was still above the target of 5 percent, while the real GDP growth and real interest rate in many episodes were expanding and decreasing, respectively. From 2018 up to 2022, the NPL ratio continued reducing until it converged to the target of 5 percent due to improvements in economic conditions and a decline in real interest rates, especially in 2018, 2019, and 2021.

However, in 2020 RGDP contracted by 3.4 percent, mainly due to the outbreak of Covid-19. In 2022, RGDP growth decelerated to 8.2 percent from 10.9 percent in 2021 owing to climate changes that affected agriculture production, while industry sector production also contracted mainly due to bad performance of the construction subsector resulting from the completion of large infrastructure projects that supported the economic recovery in 2021. Despite this declining trend in RGDP in 2020 and 2022, the NPL ratio kept decreasing as the real interest rate was reducing.

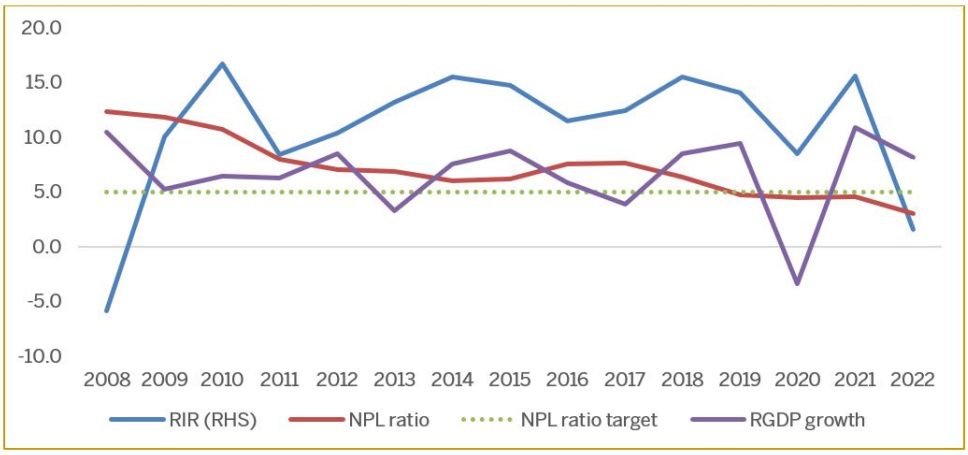


Figure 2: **Macro-financial linkages in Rwanda (NBR and NISR, 2023)**

2.3.3 NPLs by Economic Sector

From a sectoral viewpoint, compared to the end of December 2016, the NPLs ratio declined in most sectors from the end of December 2017 up to the end of December 2022. The diminution in the NPLs ratio was mainly attributed to the growth of outstanding loans, write-offs, and recoveries for loan loss in some sectors.

All these factors that eased NPLs, have been enabled by different credit policies undertaken by NBR, as mentioned above. However, the NPLs for personal loans and the agriculture sector, on average, stood at 6.4 percent and 7.3 percent, respectively, between the end of December 2016 and the end of December 2022, which is above the minimum requirement of 5 percent.

Regarding the agriculture sector, the surge in NPLs may reflect the poor performance of the sector on account of unfavourable weather conditions and changes in the prices of fertilizers. However, the impact of credit defaults in agriculture on the stability of banks is low due to the low financing of that sector by banks (on average 1 percent of total outstanding loans of banks). On the other side, the high NPLs in personal loans are associated with the fact that those loans are highly risky as they are mainly unsecured, and the recovery rate is low.

Economic sectors	Dec-16	Dec-17	Dec-18	***Dec-19***	Dec-20	Dec-21	Dec-22
Personal loan	6.6	5.8	6.3	6.9	5.9	8.0	5.4
Agricultural, fisheries& livestock	16.0	8.8	8.6	6.3	4.1	4.1	3.3
Mining activities	0.0	0.0	0.0	0.0	0.0	0.6	0.1
Manufacturing activities	0.4	0.1	0.1	0.1	0.1	0.1	0.1
Water & energy activities	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Mortgage industries	3.6	2.8	3.4	2.2	1.5	2.9	1.7
Trade	4.2	4.4	4.5	4.3	2.5	3.3	1.1
Restaurant & hotel	3.4	1.8	1.9	0.7	0.2	0.8	0.2
Transport; warehousing & communication	1.3	0.8	0.7	0.6	0.8	0.5	0.4
OFI &Insurance	0.1	0.0	0.6	0.4	0.2	0.4	0.0
Service sector	0.2	0. 3	0.4	0.1	0.0	0.0	0.0

Table 3: **Non-Performing Loans ratio by economic sector (percent)(NBR, 2023)**

3 Literature Review

NPLs constitute one of the major risks that banks face, which can lead to financial and macroeconomic instability in the country. NPLs have been the origin of financial crises in different countries. The recent global financial crisis of 2007 /2008 was, for instance, attributed to the rapid default in the subprime mortgage market of the United States. Since then, the determinants of NPLs and their feedback on macroeconomic performance at both cross-country and specific-country levels have become topics of interest in the literature.

According to IMF (2019) and regulation No. 12/2017 of 23rd November 2017 of the National Bank of Rwanda on credit classification and provisioning, a loan is classified as non-performing if payments (principal and/or interest) due have not been paid for at least 90 days. With the outbreak of the recent global financial crisis, many researchers have analyzed the determinants of NPLs to better understand the dynamic behaviour of NPLs. Results from such empirical works have broadly identified domestic macroeconomic factors, global factors such as fluctuations in external financing and economic conditions, and, more recently, bank-level factors. The first strand of the empirical literature relates macroeconomic factors and bank-level data to NPLs and covers all regions, such as advanced, emerging, and developing countries. Key macroeconomic variables explored in the investigation of the causal factors of NPLs include economic growth, unemployment rate, inflation, interest rate, credit growth, exchange rate depreciation, housing prices and stock exchange indices (Marcucci & Quagliariello (2009); Glogowski (2008)).

Using Italian data, Marcucci & Quagliariello (2009) evaluated the cyclical behaviour of default rate in the banks of Italy. By using a panel data model with a single threshold variable and multiple

regimes, their findings reveal that the level of NPLs reduces in good macroeconomic conditions and rises during downturns. Another study on the determinants of NPLs in Italian banks was undertaken by Quagliariello (2006) for the period spanning 1985 to 2002. By using panel data, NPLs and loan loss provision (LLP) [both expressed as a percentage of loan portfolio] are considered as dependent variables in different models. Both static and dynamic models reveal that an increase in NPLs is caused by a decline in GDP growth, an increase in long-term interest rates and a rise in the spread between deposit and lending rates, while loan growth at the bank level negatively affects NPLs with a one-year lag, as loan growth reflects good business conditions. With regards to new LLP increases, they are explained by a slowdown in GDP growth, a rise in long-term interest rates, a reduction in the stock market index (a proxy for the business cycle and probably the value of corporations' assets which could serve as collateral), an increase in interest rate spread, a rise in new NPLs and bank profitability measured by ROA.

Glogowski (2008) analyzed the determinants of Polish banks' loan losses. He examined the links between business cycle variables and loan losses of Polish commercial banks by using a panel approach in order to make maximum use of available supervisory data and to capture the impact of bank profiles on loan losses. Loan loss provisions were used as a proxy for loan losses in Poland. The findings reveal that a reduction in real GDP growth, a rise in real interest rate and an increase in the unemployment rate have a significant influence on loan losses. However, the influence of the exchange rate was inconclusive despite the high share of FX loans to households.

Fofack (2005) explored the leading causes of non-performing loans in Sub-Saharan Africa in the 1990s, using causality and pseudo-panel models. The results show that at the macroeconomic level, inflation, real interest rate, and growth rate of GDP per capita, are Granger-causal to nonperforming loans across most countries. Considering the bank-level variables, the estimation results show that a higher equity-to-assets ratio leads to lower NPLs, thus confirming the "moral hazard" effect, and higher profitability measured by return on equity (ROE) contributes to lower NPLs and suggests that better-managed banks have on average better quality of assets. Increased risk-taking, as measured by the loans-to-assets ratio, raises NPLs in both fixed effects and difference GMM. The effect of past excess lending captured by the lagged lending growth implies higher NPLs as well. Net interest margins, interbank loans, the real interest rate and real exchange rate appreciation also Granger cause NPLs. However, bank size and expense-to-income ratio were found to be insignificant.

Turk & Love (2013) examined macro-financial linkages in Egypt for the 1993-2010 period. They analyzed the link between several macroeconomic aggregates and loan portfolio quality in a multivariate framework and used a Panel VAR method which controls for bank-level characteristics. The results demonstrate that a positive shock to real GDP growth and capital inflows improves banks' loan portfolio quality. On the contrary, higher lending rates lead to adverse selection problems and, therefore, to a drop in portfolio quality. The paper also suggests that a big market share of foreign

banks in the industry leads to improvement in loan quality.

Sunday et al. (2020) examined the determinants of NPLs in the Ugandan banking sector using the ARDL model for the 2002Q1-2017Q2 period and found that NPLs grow with the rise in lending rates, real effective exchange rate depreciation and high unemployment rate while an increase in returns on assets and real GDP growth rate decrease NPLs. The authors advise commercial banks to diversify their asset portfolio by holding other income-earning assets such as government bonds and equity in order to lower credit risk exposure. Furthermore, policies that boost economic growth and reduce unemployment and lending rate would improve the asset quality of Ugandan banks.

Some papers also focused on bank characteristics such as income diversification, profitability measured by return on assets (ROA), capitalization, and operating efficiency as possible determinants of NPLs. Their findings in terms of signs of coefficients diverge a lot Asif Khan et al. (2020). For instance, Glogowski (2008), Boudriga et al. (2010), Makri et al. (2014), Berger & De young (1997), Rachman et al. (2018), Asif Khan et al. (2020) found that R0A and income exert a negative impact on NPLs. They suggest that banks begin to invest in high-risk projects when they observe declines in ROA, resulting in high NPLs. Regarding bank operating efficiency (BOE), Fiordelisi et al. (2011), Berger & De young (1997), and Asif Khan et al. (2020) confirm that an improved efficiency of banks improves their future risk levels, implying that BOE and NPLs are negatively related. However, Ekanayake & Azeer (2015), Benthen (2017) find a positive link between BOE and NPLs, indicating that the management conduct of the bank affects its asset quality. Conversely, Louzis & Vouldis (2012), and Rachman et al. (2018) find that BOE does not influence NPLs. It is important to highlight that different measures of operating efficiency used by several above mentioned authors largely impacted on the direction effect of BOE on NPLs.

In the case of bank capital, Makri et al. (2014), Kumar & Kishore (2019), and Keeton (1999) reveal that low capitalized banks (measured by low capital adequacy ratio) are inclined to get involved in high-risk investments and give loans which may not follow proper credit rating and monitoring procedures. This reflects a negative relationship between bank capital and NPLs. On the other hand, Rajan (1994), Constant & Ngomsi (2012), and Amakwa & Boakye (2015) found a positive relationship between bank capital and NPLs. They argue that banks with high capital levels tend to lower their credit stance and give out loans quite easily since they do not fear bankruptcy. Consequently, those banks engage in highly risky credit activities. Rachman et al. (2018) find income diversification (ID) to be negatively related to NPLs, suggesting that banks with a more diversified income base are more likely to lower their risks as some of the investments are likely to be in less risky ventures. However, Louzis & Vouldis (2012) reveal that non-interest income has a positive association with NPLs, while ROA has a negative impact on them.

The second strand of the literature explores the feedback from the financial sector to the real economy. Indeed, the impact of the real economy on NPLs is mainly reflected in a weakening of

borrowers' capacity to pay back their loans, whereas the feedback from NPLs to the real economy is often shown through the credit supply channel. The objective of this study falls in this category of the literature.

Beaton et al. (2016) examined the determinants of NPLs in the Eastern Caribbean Currency Union (ECCU), specifically in Dominica, Grenada, St. Kitts and Nervis, St. Lucia, St. Vincent and the Grenadines for the period spanned 1996Q1-2015Q4. This study also explored the feedback effects of the banking system on economic activity. The results show that low asset quality can be caused by both macroeconomic and bank-specific variables. Banks with lower exposure to the construction sector and household loans and banks with higher profitability tend to have lower NPLs. In addition, foreign-owned banks have lower NPLs than domestic banks, indicating important differences across bank practices that impact asset quality. In fact, domestic banks function on a very small scale in their country of origin, whereas foreign banks constitute mainly branches and subsidiaries of large international banks with global operations. This larger scale of foreign banks' operations may offer economies of scale for banks to implement great risk management activities that lead to lower NPLs. Regarding the feedback from the banking sector to the real economy, and by using a Panel VAR, the findings suggest that worsening asset quality decreases credit with sharp sectoral differences. Specifically, a deterioration in asset quality causes significant and persistent reduction in credit growth in tourism, agriculture, manufacturing, and construction industries. The results also demonstrate that a decrease in NPLs boosts the real GDP growth in the ECCU, principally through the agricultural and construction industries. In turn, real GDP growth, through the associated reduction in unemployment and a rise in disposable income, largely decreases NPLs mainly in personal and tourism sectors.

In the same context, Klein (2013) conducted a study on determinants of NPLs for sixteen Central Eastern Southern Eastern European (CESEE) countries in the period of 1998-2011 and its feedback effect on the real economy. Using the difference GMM method of Arllelano & Bond (1991), he finds that the level of NPLs can be explained by both macroeconomic conditions and banks' specific factors; however, the impact of the latter set of factors is relatively low. The results suggest that the level of NPLs rises when unemployment increases, the exchange rate depreciates, and inflation is high but declines when economic activity, measured by real GDP growth, picks up. Considering the impact of bank-level data, the results suggest that higher quality of banks' management, as measured by the previous period's profitability, reduces NPLs. However, moral hazard incentives, such as low equity, deteriorate NPLs. Amplified risk-taking (as measured by the loans-to-assets ratio and the growth rate of the Bank's loans) raises NPLs in the subsequent periods. These bank-level factors were significant during both the pre-crisis and post-crisis periods. Regarding the feedback effect from the banking sector to the real economy, the paper uses a Panel VAR model. The findings reveal that a rise in NPLs has a negative effect on credit as a share of GDP and real GDP growth, but a positive impact on unemployment while reducing inflation in the periods ahead.

Espinoza & Prasad (2010) also examined macroeconomic and bank-level determinants of NPLs in the GCC (Gulf Cooperation Council) comprising Baharain, Kuwait, Oman,Qatar, Saudi Arabia, UAE banking sector utilizing a bank-wise panel dataset and fixed effect, difference GMM, and System GMM models. They also explored the feedback effect from the banking sector on the real economy by using a Panel VAR model for the period 1995–2008 on around 80 banks in the GCC. The results confirm a strong negative relationship between real non-oil GDP and NPLs. Global financial market conditions also affect the NPLs of banks. Considering bank-level data, efficiency and past expansion of the balance sheet were significant. The paper also estimated the feedback from increasing NPLs to the real economy using a Panel VAR. Generally, the increase in NPLs has a negative effect on non-oil growth GDP in the GCC. As a policy implication, the study suggests that policymakers in the GCC should monitor carefully the evolution of default in the loan book of banks. In addition, in the context of exchange rate pegs in these countries, a stronger focus on macro-prudential regulation, mostly through capital and liquidity buffers, and countercyclical provisioning, could help alleviate the impact of macroeconomic risks on the banking system and the feedback effects of credit risks on the economy.

From the discussed literature concerning the expected signs of different variables, real economic growth measured by RGDP growth is negatively linked with NPLs. Indeed, good economic conditions improve the capacity of borrowers to service their debts, thus resulting in improved asset quality (Glogowski (2008); Fofack (2005); Turk & Love (2013)). Regarding the impact of inflation (INFL) on the NPL ratio, it can either be negative or positive. On the one hand, a reasonable level of inflation can prompt the growth of the economy, thus recovering the debtors' capacity to pay back their loans, thereby reducing NPLs within the banking sector. On the other hand, high inflation on the side of the borrowers (especially whose loans are inflation-indexed) lessens the real value of income and deteriorates their ability to service the loan; thus, NPLs increase (Klein (2013);(Fofack (2005)). The impact of exchange rate depreciation [measured by real effective exchange rate (REER)] on NPLs can either be positive or negative. In fact, exchange rate depreciation in a flexible exchange rate regime with large amounts of lending in foreign currency may increase NPL accumulation for borrowers who do not earn foreign currency. With regard to countries with a high level of exports, exchange rate depreciation may improve the debts servicing possibilities of export-oriented firms if the loans are denominated in local currency and therefore reduce NPLs (Sunday et al. (2020); Fofack (2005)).

Considering bank characteristics, real interest rate (RIR), is positively associated with NPLs different authors posited that a high real interest rate implies an extra debt burden conveyed to borrowers, and therefore, NPLs are expected to rise, (Glogowski (2008); Quagliariello (2006)). However, the existing evidence on the effect of the size of banks on NPLs is mixed. For instance Tarron & Sukrishnalall (2009) found that there is no relationship between the size of bank and NPLs ratio,

Ekanayake & Azeer (2015) found a negative relationship between the two variables while Louzis & Vouldis (2012) and Haq & Heaney (2012) found a positive association between the same variables supported by "Too Big To Fail" theory stated in Stern & Feldman (2004).

In this paper, the size of a bank is measured by the assets of that bank to the total assets of the banking sector. The coefficient on Capital Adequacy Ratio (CAR) (measured by total qualifying capital to total risk-weighted assets) is expected to either be negative or positive. For instance, Makri et al. (2014), Kumar & Kishore (2019), and Keeton (1999) argue that low-capitalized banks tend to be involved in high-risk investments and give loans that do not follow proper credit rating and monitoring systems; thus, NPLs go up. Other researchers, such as Rajan (1994), Constant & Ngomsi (2012), and Amakwa & Boakye (2015), on the other hand, contend that banks that have a high level of capital tend to lower their credit stance more easily since they do not fear bankruptcy. As a result, they engage in highly risky credit activities. Income diversification (ID), measured as non-interest income/ total income, can be negatively or positively related to NPL ratio. Rachman et al. (2018) postulate that banks with diversified income other than interest income are more cautious in taking risks which reduces NPLs.

Conversely, Louzis & Vouldis (2012) found that ID has a positive association with NPLR. The coefficient on the growth of loans (GrL) is expected to either be positive or negative (Klein (2013); Karuhanga K. et al. (2018)) while operating efficiency (BOE), measured by non-interest expenses/non-interest income, can either has a negative or a positive relationship with asset quality; (Fiordelisi et al. (2011); Asif Khan et al. (2020)) suggest a negative relationship, while Ekanayake & Azeer (2015), and Benthen (2017) find a positive link between BOE and NPLs, concluding that the management conduct of a bank affects its asset quality. On the other hand, Louzis & Vouldis (2012), Rachman et al. (2018) find that BOE does not affect NPLR. In addition, NPLs, measured by the total NPLs of a bank over its total gross loans, tend to persist over time, so the lagged NPL ratio (L. NPLR) is added as an explanatory variable. The results given by the literature reveal that previous NPLs contribute to the amount of the current NPLs, so we expect to have a positive sign in our estimation results.

With regard to the feedback effect from NPLs ratio to the selected macroeconomic variables, we expect that an increase in NPLs reduces credit growth, contracts real GDP and definitely decreases inflation due to a reduction in aggregate demand (Klein (2013); Espinoza & Prasad (2010)).

With regard to different methodologies, many authors examined the determinants of NPLs in specific countries or in a panel of countries in the same region. Such studies mostly used panel data models with fixed effects, random effects, difference GMM or system GMM. Endogeneity encountered in these types of studies is normally addressed using IV-GMM estimators. However, these estimators are biased for small panels, specifically when the number of cross sections (banks)

is low, which is the case in this study. Consequently, this paper makes a new contribution to the literature by using a bias-corrected fixed estimator for the dynamic panel data model that works for the autoregressive coefficient estimator and has proven to outperform GMM estimators in dynamic panel models with small cross-sections. However, the feedback of NPLs on macroeconomic performance has been analyzed by many authors via the use of Panel VAR models, as done in this study.

4 Analytical Procedure, Model Specification, and Data

4.1 Methodology

The linear panel model takes the following dynamic specification:

$$NPLR_{it} = \alpha NPLR_{it-1} + \beta X'_{it} + \eta_i + \varepsilon_{it} \tag{1}$$

where $NPLR_{it}$ is the nonperforming loan ratio and $NPLR_{it-1}$ is the lag non-performing loan ratio. X_{it} represents a vector of regressors namely: Real GDP, Inflation rate, Real effective exchange rate, Real interest rate, loan growth, Bank size, Capital adequacy ratio, Bank operating efficiency, and Income diversification. Where i and t denote Bank and time respectively, η_i is the unobserved time-invariant specific effects. Finally, ε_{it} is the two-way error component term of the model assumed to be normal, independent, and identically distributed (IID) with $E(\varepsilon_{it}) = 0$; $Var(\varepsilon_{it}) = \sigma^2 > 0$. Due to the fixed effects and the lagged dependent variable among the regressors, equation (1) cannot be estimated using the conventional ordinary least squares (OLS) technique. As a standard practice in panel data analysis, unobserved heterogeneities can be dealt with using fixed effect (FE) or random effect (RE) estimators. However, these estimators are inconsistent or biased for dynamic panel models, and their standard errors are not robust in terms of cross-sectional dependence. Besides heterogeneity and cross-sectional dependence, the estimation of equation (1) is also subject to endogeneity[2]. One source of endogeneity and simultaneity bias may come from omitted variable bias since some relevant determinants of NPLs might not be included in the model measurement error, which arises from poor variable proxies.

However, the addition of the lag-dependent variable causes a correlation between the lag-dependent variable and the error term, resulting in biased estimates of parameters (Hsiao (2003); 181999Judson & OwenJudson & Owen ()). Endogeneity is commonly addressed using IV-GMM estimators. However, these estimators are biased for small panels specifically when the number of cross sections (banks) is low and requires a bias-corrected alternative. This study, therefore, uses the bias-corrected FE (BCFE) estimator for the dynamic panel data model that works for the autoregressive coefficient estimator and has proven to outperform GMM estimators in dynamic

[2]Endogeneity refers to the correlation between explanatory variables and the disturbances in a model

panel models with small cross-sections (Kao et al. (2021)).

The study also explores the feedback effects of the banking sector's behaviour, through NPLs, on macroeconomic performance. In particular, we are interested in the linkages between NPLs of banks, growth of loans, GDP growth, and inflation. The assessment of these relations, causality, magnitude, and duration using the most recent Panel VAR (Abrigo & Love (2016)) is expected to reveal potential macro-financial vulnerabilities. The model is specified as follows:

$$Y_{it} = Y_{it-1} + f_i + \epsilon_{it} \tag{2}$$

where Y_{it} is a set of variables, namely NPLs ratio, loan growth, real GDP growth and inflation rate, while f_i is individual characteristics. This technique is advantageous since it combines the traditional VAR approach, which treats all the variables in the system as endogenous, with a panel data approach which allows for unobserved individual heterogeneity. The dynamic behavior of the model is analyzed within the context of impulse response functions. The shocks in the VAR are ordered in a way that the variables appearing earlier in the ordering are considered more exogenous, while those appearing later in the ordering are considered more endogenous. The following table shows the expected signs of key variables from the literature.

Authors	Variable	Expected signs
Glogowski (2008) Fofack (2005) Turk & Love (2013)	RGDP growth	-
Klein (2013) Fofack (2005)	Inflation	+/-
Sunday et al, (2020) Fofack (2005)	REER	+/-
Glogowski (2008) Quagliariello (2006)	RIR	+
Louzis & Vouldis (2012) Ekanayake & Azeer (2015) Tarron & Sukrishnalall (2009)	Size	+/- or no effect,
Makri et al. (2014) Amakwa & Boakey (2015)	CAR	+/-
Rachman et al. (2018) Louzis & Vouldis (2012)	ID	+/-
Klein (2013) Karuhanga et al. (2018)	GrL	+/-
Benthen (2017) Asif Khan et al. (2020) Rachman et al. (2018)	BOE	+/- or no effect
Fofack (2015) Karuhanga et al. (2018)	L. NPLR	+

Table 4: **Summary on expected signs from literature**

4.2 Data description

In our empirical investigation, we use quarterly data for the 2012Q1–2022Q1 period for a sample of fourteen banks. One bank licensed in 2017 was excluded due to a short period of data. The choice of the number of banks, the variables, and the time are determined by the need to consider the possible big number of banks referring to the starting period of their activities in Rwanda for a long sample period. The choice of variables is guided by the theory, the past literature and the realities of the Rwandan banking sector. The main source of bank-level data is the balance sheet of each bank in the dataset of the National Bank of Rwanda (NBR) while data on the macroeconomic

variables are obtained from the NBR and the National Institute of Statistics of Rwanda (NISR).

5 Empirical Findings

5.1 Descriptive statistics

Some preliminary empirical analyses, namely descriptive statistics and correlation, were undertaken before embarking on the panel estimations. Table 4 reports the descriptive statistics of the Rwandan banking sector variables and some macroeconomic indicators. During the period between 2012Q1 and 2022Q1, NPLs were, on average 6.2 percent, higher than the minimum requirement of 5 percent. There has also been significant volatility in a change of different variables. In fact, this volatility in data is a good indicator that our panel model is appropriate for our estimation because it captures heterogeneity arising from different cross-section unities. The correlation between NPLR and their determinants has also been studied. The results reveal that capital adequacy ratio, income diversification and bank operating efficiency are negatively linked to NPLR. However, REER and bank size are positively associated with NPLR, though not statistically significant, while RGDP is negatively linked to NPLR but not statistically significant (see appendix table 1)

VARIABLES	N	mean	SD	min	max	skewness	kurtosis
NPLR	574	0.0622	0.0416	0	0.295	1.675	7.186
RGDP	574	0.0641	0.0518	-0.187	0.206	-1.110	7.378
INFL	574	0.0381	0.0262	-0.0415	0.0898	0.246	2.114
REER	574	0.0247	0.0422	-0.0637	0.115	0.120	2.662
GrL	574	0.253	1.687	-0.432	39.96	22.81	536.9
RIR	574	0.136	0.0387	0.0103	0.273	0.486	4.066
SIZE	574	0.0704	0.0659	0.00299	0.316	2.070	7.423
CAR	574	0.257	0.135	0.112	2.116	6.454	73.52
ID	574	0.293	0.109	-0.00199	0.701	0.509	3.657
BOE	574	1.413	13.24	-314.6	6.292	-23.73	566.8

Table 5: Descriptive Statistics, Author's own computation (2023)

5.2 Empirical results

The results of the estimation are presented in Table 5 for both FE taken as benchmark model while BCFE is an alternative model that largely confirms that all bank-specific and macroeconomic factors play a role in influencing the banks' asset quality. However, the contribution of bank-level factors is relatively low compared to macroeconomic factors, specifically RGDP growth, inflation and real effective exchange rate. These results are similar to the ones found byKlein (2013). The significance level can be either in FE, BCFE or both, as shown in table 5. From model one to model

4 for each estimator, we assess the contribution of each bank characteristics to NPLs.

An increase of 1 percentage point in real GDP growth leads to a decline in NPLR for all considered models in both FE and BCFE. The coefficient ranges between – 0.068 and – 0. 079. These results are consistent with the findings of Marcucci & Quagliariello (2009); Quagliariello (2006), and Fofack (2005). An increase of 1 percentage point in inflation raises the NPLR in all fixed effects models. The coefficient stands between 0.355 and 0.389. These results are consistent with those of Klein (2013) and Fofack (2005). A depreciation of 1 percentage point in REER reflects an increase in NPLR in all FE and BCFE models, with a coefficient standing between 0.098 and 0.114. These results coincide with those of Fofack (2005) and Sunday et al. (2020).

Considering the impact of bank-specific factors on NPLR, a rise in RIR deteriorates the NPLs ratio. We found a positive sign for all models in both FE and BCFE, with a coefficient ranging between 0.298 and 0.324. The results are in line with Turk and Love (2013) and Fofack (2005). A rise of 1 percentage point in banks' size increases the NPL ratio by 0.252 percentage points in the FE2 and 0.262 percentage points in BCFE 1. These results are in line with Louzis and Vouldis (2012).

The low-capitalized banks tend to be involved in high-risk investments and give loans that do not follow a proper credit rating and monitoring; thus, NPLR goes up. We found a negative relationship between CAR and NPLR with a coefficient of -0.025 in the FE3. These results are similar to Makri et al. (2014), Kumar & Kishore (2019), and Keeton (1999).

The ID coefficient is found to be negative and significant, with a coefficient standing at -0.045 for FE1 and -0.048 for FE4 but not significant in BCFE. These results are in line with the ones of Rachman et al. (2018), and Asif Khan et al. (2020). The BOE coefficient has been found to be negative and significant but very low in both FE 1 and BCFE 4. This result is similar to those of Asif Khan et al. (2020).

The Lagged NPL ratio has been added as an explanatory variable to capture the persistence of NPLs. Its coefficient is positive and significant in all BCFE1, BCFE2, BCFE3 and BCFE4 models, with a coefficient standing at 0.076, 0.073, 0.073 and 0.076, respectively. Hence signifying that a shock to NPLs is likely to have a prolonged effect on the banking system.

	FE1	FE2	FE3	FE4	BCFE1	BCFE2	BCFE3	BCFE4
RGDP	-0.068**	-0.079**	-0.071**	-0.068**	-0.072**	-0.064**	-0.062**	-0.062**
	(0.034)	(0.034)	(0.035)	(0.034)	(0.030)	(0.030)	(0.030)	(0.030)
INFL	0.387***	0.355***	0.379***	0.389***	0.366	0.390	0.398	0.396
	(0.103)	(0.103)	(0.104)	(0.104)	(0.254)	(0.240)	(0.246)	(0.246)
REER	0.100**	0.109***	0.106***	0.098**	0.114***	0.112***	0.104**	0.106***
	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.042)	(0.041)	(0.041)
GrL	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
RIR	0.318***	0.304***	0.308***	0.324***	0.298*	0.301*	0.315*	0.308*
	(0.085)	(0.086)	(0.085)	(0.085)	(0.173)	(0.169)	(0.174)	(0.178)
SIZE	0.113	0.252**	0.187	0.110	0.262**	0.201	0.132	0.135
	(0.129)	(0.121)	(0.126)	(0.129)	(0.127)	(0.140)	(0.171)	(0.169)
CAR	-0.018		-0.025*	-0.019		-0.023	-0.017	-0.017
	(0.013)		(0.013)	(0.013)		(0.028)	(0.025)	(0.025)
ID	-0.045**			-0.048**			-0.043	-0.041
	(0.019)			(0.019)			(0.041)	(0.040)
BOE	-0.000*						-0.000***	
	(0.000)						(0.000)	
L.NPLR			0.076**	0.073*	0.073*	0.076**		
			(0.038)	(0.038)	(0.038)	(0.037)		
N	574	574	574	574	560	560	560	560
R2	0.075	0.053	0.059	0.070				
AIC	-2.2e+03	-2.2e+03	-2.2e+03	-2.2e+03	.	.	.	.
N_g	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000
Log-likelihood	1131.132	1124.490	1126.367	1129.590				

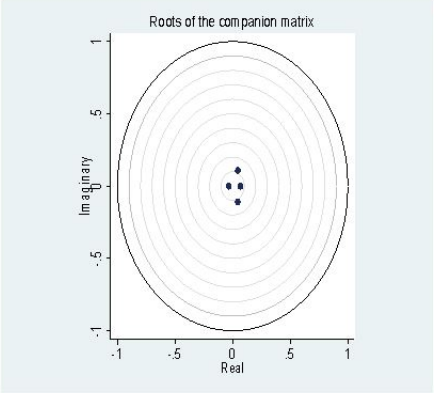
Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: **Estimation of determinants of Non-Performing Loans**

5.3 Feedback effect

In furtherance of the comprehensive analysis of the factors influencing the NPL ratio, this segment undertakes an evaluation of the reciprocal interactions between the banking sector, as mediated

by NPLs, and the broader economic landscape. This is accomplished through the utilization of a panel Vector Autoregressive (VAR) framework aimed at scrutinizing the repercussions of NPLs on credit expansion, real GDP growth, and inflation rates. The outcomes derived from our estimations generally align with theoretical premises and practical applications. The impulse response functions presented in figure 4 can be summarized as an exogenous shock to NPL ratio instigates a contraction in the availability of credit, which subsequently triggers a downturn in real GDP growth and a reduction in inflation levels owing to diminished pressures on aggregate demand. Before conducting an empirical exercise, we first check for stability. As shown in Figure 3, all eigenvalues are within the inner cycle. This implies that PVAR satisfies the stability conditions.



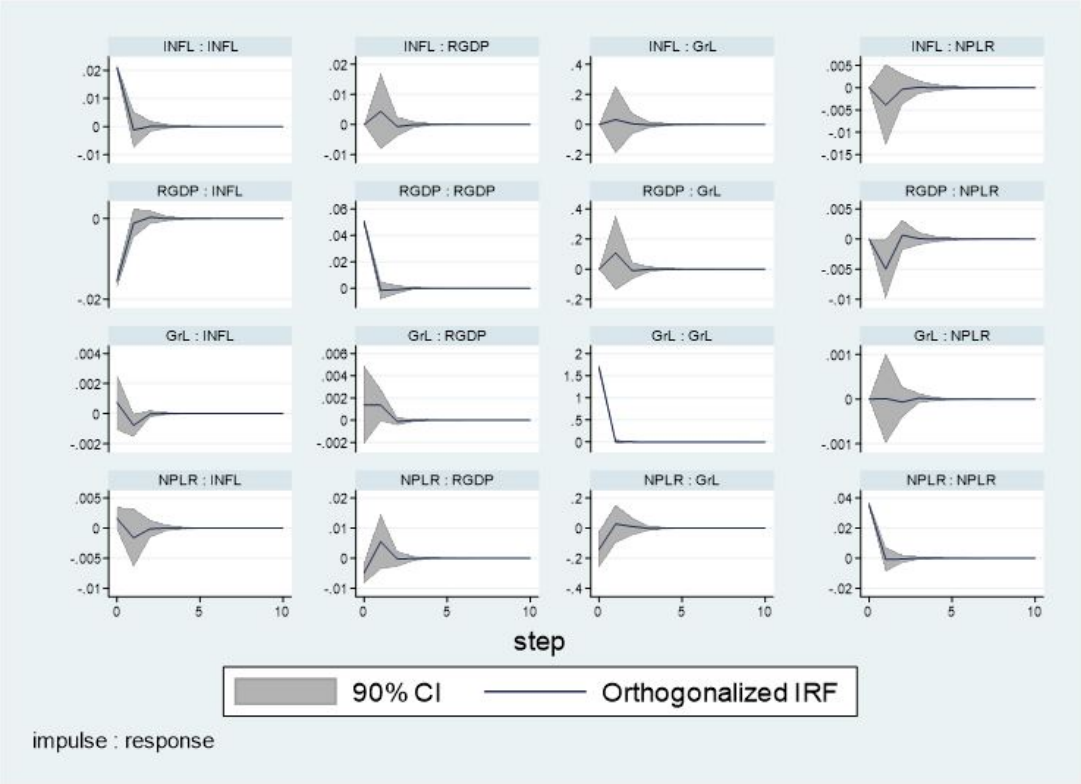
Eigenvalue stability condition

Eigenvalue		
Real	Imaginary	Modulus
.2242414	0	.2242414
-.0118705	-.0429812	.0445903
-.0118705	.0429812	.0445903
.0265343	0	.0265343

Source: Author's own computation (2023)

Figure 3: **Stability conditions**

Figure 4, which illustrates the impulse responses stemming from a Panel Vector Autoregression (PVAR) model, indicates that a 1 percentage point shock to the NPLR yields several noteworthy effects. Firstly, this shock led to a minor decrease in credit availability by approximately 0.0001 percentage points in the initial quarter. Banks, in response to this shock, tend to curtail their loan supply to borrowers as a preventative measure to mitigate further deterioration in asset quality. Secondly, the impact of one -percentage point NPLR shock reduces RGDP growth by 0.05 percentage points within a one-quarter timeframe. It is worth noting that RGDP eventually reverts to its normal trend after three quarters. Lastly, evidence suggests that the effect of one-percentage-point NPLR on inflation has the expected direction but is not statistically different from zero. It is worth mentioning that these empirical findings are consistent with the research conducted by Klein (2013) and the work of Espinoza & Prasad (2010).



Source: Staff estimates and calculations (2023)

Figure 4: **Panel VAR impulse response functions**

As mentioned above, the effect on RGDP growth and bank lending is in the expected direction, though short-lived. This may be associated with the realities of the Rwandan economy, where financial deepening is not that strong, and banks have the room to increase lending in other sectors which are not strongly affected by NPLs in case the latter is not generalized. Besides, the relatively lower effect on RGDP growth can also be associated with the fact that the influence of the financial sector on the real economy in Rwanda is not as strong as in the case of developed countries. Lastly, the absence of effect on inflation can also be associated with these realities explained above, but also with the fact that there are many episodes of inflation in Rwanda, which were supply-driven mostly from agricultural production shock, unrelated to the performance in the financial sector. The gray space represents the 90 percent confidence interval derived by using the technique of Kilian (1998). In the impulse–response graph, each row shows an impulse, and each column represents a response variable. Each graph's horizontal axis identifies the time units in which the VAR is

evaluated, in this paper, quarters. So, the impulse–response graph depicts the effect of a shock over 10 quarters. The vertical axis represents the variables in the VAR in their respective units; in this case, everything is measured in percentage points. Thus, the vertical units in all panels are percentage point changes.

6 Conclusions and Policy Implications

The objective of this study was to assess the determinants of NPLs in Rwanda's banking sector and the feedback of NPLs to the broader macroeconomy. Building on the work of previous authors, we used bias-corrected fixed effects estimators to identify macroeconomic factors and bank-level variables that are capable of affecting the behaviour of NPLs. The results regarding the impact of macroeconomic variables suggest that the increase in the real GDP growth and inflation reduces and raises the non-performing loans ratio, respectively, while the depreciation of REER leads to an increase in NPLs. In fact, the descriptive analysis part showed that the loans in foreign currency have been rising over time in Rwanda, given that Rwanda is a net importer, so the depreciation of REER increases the burden of the borrower in terms of paying back their loans in foreign currencies. The insignificance of inflation in our main estimator (BCFE) can be associated with many episodes of inflation in Rwanda, which were supply-driven mostly from agricultural production shock, unrelated to the performance in the financial sector.

With regards to the effect of bank-specific variables on NPLs, the rise in real interest rate, bank size, and lagged NPLs raises NPLs while the increase of capital adequacy ratio, income diversification, and bank operating efficiency reduces NPLs. Examining the feedback effects highlights the strength of macro-financial feedback. By using the panel VAR model, the impulse response functions indicate the feedback effect where shocks to NPLs reduce credit growth, and GDP, while inflation has a consistent direction but is not statistically significant.

Several policy implications arise out of these findings and discussions. Given the adverse effect of NPLs on the economy and because of the contribution of bank-level variables to NPLs, it is imperative for regulators and the National Bank of Rwanda to be concerned about rising NPLs during periods of low growth and tight financing conditions. Thus, it is vital that policymakers put in place policies that ensure sustainable macroeconomic stability. In addition, there is a need to reinforce the supervision of banks to ensure that banks avoid excessive lending, maintain high credit standards and be prudent in lending in foreign currency in order to avoid a sharp buildup of NPLs in the future. In simple terms, healthy and sustainable growth cannot be reached without a sound and resilient banking system. Since this paper was limited only to determinants of NPLs and their feedback on some macroeconomic variables, we recommend for future analysis to also check the effect of domestic banks, subsidiaries of foreign banks and foreign inflows on NPLs.

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Appendices

Appendix A Correlation Matrix

	NPLR	RGDP	INFL	REER	GrL	RIR	SIZE	CAR	ID	BOE
NPLR	1.00									
RGDP	-0.06	1.00								
	(0.12)									
INFL	0.04	-0.54***	1.00							
	(0.39)	(0.00)								
REER	0.06	0.38***	-0.52***	1.00						
	(0.18)	(0.00)	(0.00)							
GrL	-0.12**	0.02	0.03	0.01	1.00					
	(0.00)	(0.64)	(0.48)	(0.85)						
RIR	-0.04	0.41***	-0.65***	0.34***	-0.03	1.00				
	(0.29)	(0.00)	(0.00)	(0.00)	(0.41)					
SIZE	0.00	0.01	0.01	0.01	-0.03	-0.19***	1.00			
	(0.98)	(0.85)	(0.84)	(0.87)	(0.52)	(0.00)				
CAR	-0.15***	0.03	0.11**	-0.08	0.06	-0.04	-0.20***	1.00		
	(0.00)	(0.51)	(0.01)	(0.05)	(0.14)	(0.32)	(0.00)			
ID	-0.18***	0.05	0.01	-0.05	0.12**	0.04	-0.15***	0.14***	1.00	
	(0.00)	(0.26)	(0.72)	(0.21)	(0.00)	(0.34)	(0.00)	(0.00)		
BOE	-0.08	-0.01	0.04	0.00	0.01	-0.05	0.01	0.02	0.09*	1.00
	(0.05)	(0.81)	(0.38)	(0.98)	(0.81)	(0.28)	(0.78)	(0.56)	(0.03)	

p-values in parentheses.
*p< 0.05, **p< 0.01, ***p< 0.001

Table 1: **Correlation Matrix**