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Abstract

This study examines the sovereign-bank nexus on financial system stability in Rwanda, using panel data from 9 commercial banks over the period 2014Q3 to 2024Q1. Applying a bias-corrected fixed effects model, the study investigated the impact of banks holding of government securities and bond yields measure as indicators of banks' exposure and preference in government securities, respectively, on financial stability. . The main findings reveal that the holding of government securities by banks does not have a statistically significant impact on loan loss provisions, suggesting that the government securities held by banks are still minimal to influence provisions for potential loan losses. In contrast, bond yields measure has a significantly negative effect on loan loss provisions, as banks perceive government securities as default-risk-free, resulting in lower provisions. Furthermore, lending rates significantly increase loan loss provisions due to higher borrowing costs and perceived risks, while return on assets shows a negative relationship with loan loss provisions, indicating that more profitable banks allocate fewer resources to provisions. Several robustness checks were conducted to validate the main findings, which collectively suggest an absence of sovereign–bank exposure in the Rwandan banking sector. Nevertheless, to mitigate against such exposures occurring in future, it would be beneficial for the National Bank of Rwanda to continue implementing prudential policies that optimize the level of sovereign securities held by banks and establish exposure limits to prevent excessive concentrations on their balance sheets, strengthen banking sector stability, and enhance financial market efficiency.

Keywords: *Sovereign securities, banks, panel data, fixed effects model*.
JEL Classification: *C23, G21, H63*.

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I. Introduction

Financial connections between banks and the public sector can pose risks to financial stability. These connections primarily arise because banks typically hold significant amounts of government debt securities. Moreover, fiscal intervention is seen as a final resort if the banking sector faces solvency issues. Potential problems within either the banking system or sovereign debt could lead to what's known as a "doom loop". This loop, linking the banking system and the sovereign, became evident immediately after the global financial crisis and during the subsequent sovereign debt crisis of 2012, impacting various European countries. During banking crises, economic activity declines, as does the government's fiscal position. Subsequently, during fiscal crises, governments implement austerity measures that, at least temporarily, dampen economic activity. This, in turn, impacts the banking system by increasing default rates and reducing demand for credit.

The prevailing discussion in the ancient and current stock of knowledge, often characterizes this connection as mutually beneficial yet occasionally harmful, particularly concerning the dimension of home bias i.e preferences for domestic sovereign holdings (Díaz-Alejandro, 1984; Kaminsky & Reinhart, 1999; Reinhart & Rogoff, 2015; Acharya, et al., 2014; Valencia & Laeven, 2008; Laeven & Valencia, 2012; Laeven & Valencia, 2018; Honohan, 2010; Farhi & Tirole, 2017; Dell'Ariccia et al., 2018). On a positive note, this connection has significantly contributed to bolstering bank liquidity, enabling fiscal support and enhancing capital markets, and facilitating policy transmission. Although these benefits exist, financial market imperfections have fostered binding constraints, which culminate in systemic distress in most cases, for example, the great depression (1930s), the global financial crisis (GFC) in 2008, and the European debt crisis in late 2009 and 2010. As a result, credit, liquidity, solvency, and reputational risks are also inherent in this relationship. In prosperous periods, the benefits of the relationship generally outweigh its drawbacks. However, recent crises such as COVID-19 have necessitated government intervention, revealing the potential vulnerabilities associated with these connections and emphasizing the importance of understanding these dynamics. Various tools have been developed to address sovereign-bank linkages. Risk-based supervision has emerged as the primary tool for regulators to achieve financial stability goals.

Understanding the financial relationships and the extent of interconnections within different parts of the macro-financial system is essential for effectively managing the financial system. The allocation of financial resources in a small, open economy like Rwanda, is greatly shaped by the government, which acts as the economy's manager, and banks serve as crucial intermediaries. Consequently, these economic entities are the primary providers of funding for each other, as well as for corporations and consumers. Therefore, evaluating the sovereign-bank relationship is of systemic significance.

Most prior research has focused on the drivers behind the increase in banks' holdings of sovereign debt securities from either a balance sheet (bank-specific), macroeconomic, or a combination of both perspectives. A number of these studies concentrated on advanced economies, particularly those affected by the sovereign debt crisis in Europe and Asia, (Rodrigues, 1993; Egesa, et al, 2015; Affinito, & Santioni, 2022; Chronopoulos, & Milonas, 2019; Dang & Huynh, 2020; Affinito et al., 2022; Chronopoulos et al., 2019; Ongena et al., 2019; Singh et al., 2022). In sub-

Saharan Africa, research on the determinants of banks' holdings of sovereign debt securities is limited, with one of the few studies focusing on balance sheet conditions only in the Ugandan banking sector, (Egesa et al., 2015).

Previous work focused on Rwanda is also scanty with limited evidence and quantification of sovereign exposure in banking sector, partly because no significant sovereign-bank stress episodes have historically been observed in the country. Nevertheless, with the ongoing development of the financial sector and lessons from best practices elsewhere, there is a growing need to analyze the current level of sovereign exposure and assess potential vulnerabilities, not only in Rwanda but also across the broader region and other developing economies.

From an empirical perspective, there is a broad understanding globally of the factors influencing banks' holdings of government securities and their implications for financial stability. Yet, in the case of Rwanda, empirical evidence remains scarce. To the best of our knowledge, no empirical studies have specifically addressed the impact of the sovereign-bank nexus on financial stability in Rwanda. Understanding the sovereign-bank nexus on financial system stability in Rwanda can not only support current and future prudential policy actions but also contribute to the literature and debate that is still open, since the sovereign-bank nexus remains insufficiently explored and requires more attention, particularly in developing economies like Rwanda, where the financial system is typically dominated by banks. This study employs the Bias-Corrected Fixed Effects (BC-FE) estimator to capture the dynamic structure, following Kiviet (1995) and Bruno (2005). Robustness of the results was assessed using pooled OLS and standard fixed effects (FE) models, allowing comparison of coefficient magnitudes, signs, and significance across specifications.

The findings of this study can provide crucial insights for policymakers aiming to enhance financial stability through informed prudential policies tailored to the country's specific economic context. Moreover, empirical findings from Rwanda could contribute valuable perspectives to the global discourse on managing sovereign risk and enhancing financial stability in developing economies. The paper is structured as follows. The next section provides stylized facts while section 3 and 4 discuss the empirical studies and the methodology, respectively. The findings are presented in section 5 and section 6 provides conclusions of the study.

II. Stylized Facts: Banking Sector Stability in Rwanda

2.1 Soundness of the Banking Sector

Table 1 shows that Rwanda's banking sector achieved significant strengthening across all key financial soundness indicators from 2018-2024, with capital adequacy ratios consistently exceeding international standards at 21.5-25.5%, exceptionally strong liquidity positions (Liquidity coverage ratios-LCR ranging 192-637%, net stable funding ratios-NSFR above 136%), and notably improved asset quality as NPL ratios declined from 5.0% to 3.1% while provisioning coverage increased significantly from 68.2% to 102.6% reflecting forward-looking risk assessments, especially in uncertain economic periods (e.g., COVID-19). The sector demonstrated enhanced profitability with return on assets rising from 1.9% to 4.9% and return

on equity increasing from 11.2% to 20.8%, alongside healthy credit growth averaging 16.8% and controlled foreign exchange exposure at moderate levels (8.3-11.4%).

Table 1: Key Financial Soundness Indicators for Banks (Percent)

	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22	Dec-23	Dec-24
Capital Adequacy Ratio (min 15% benchmark)	25.5	24.1	21.5	21.6	21.7	21.5	20.5
LCR (min 100% benchmark)	637.0	191.8	254.7	268.9	215.9	229.8	340.0
NSFR (min 100% benchmark)	222.0	129.3	161.4	147.1	136.8	137.4	148.4
FX loans/Gross loans	10.7	11.4	9.7	8.3	9.0	10.4	11.3
NPLs/Gross loans	5.0	4.5	4.5	4.6	3.1	4.1	3.1
Provisions / NPLs	68.2	83.6	106.3	119.8	141.9	99.1	102.6
Return on Assets (RoA)	1.9	2.2	2.0	2.5	3.0	4.8	4.9
Return on Equity (RoE)	11.2	12.5	11.8	15.0	17.8	20.7	20.8
Growth of loans	12.4	5.4	33.9	15.6	21.0	19.2	10.5

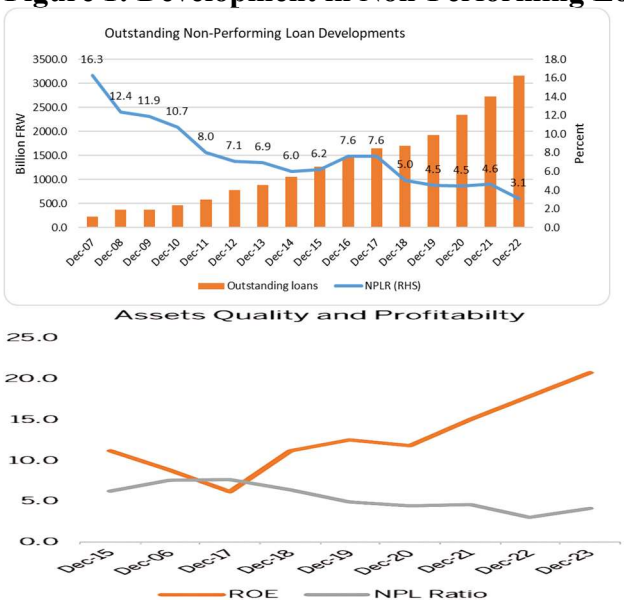
Source: The National Bank of Rwanda (2025)

Overall, these indicators collectively demonstrate Rwanda's banking sector evolution toward enhanced financial stability relative to the benchmarks in parentheses (Table 1), improved risk management capabilities, and strengthened resilience while maintaining adequate credit intermediation to support economic development objectives.

2.2 Dynamics of NPLs in the Rwandan Banking Sector

Figure 1 indicates that Rwanda's banking sector has seen steady improvement in the quality of its loan portfolio, with non-performing loans (NPLs) gradually declining to meet the 5% benchmark by 2018. From the end of 2018 to 2022, outstanding NPLs decreased slightly by an average of 0.5% and the NPL ratio stood at 4.3%. This marked a notable improvement, in view of the fact that prior to 2011, NPLs had averaged double-digit levels, around 12.8% between 2007 and 2010. The turnaround on NPLs reflects the combined impact of several initiatives introduced by the National Bank of Rwanda (NBR) to strengthen the prudential and regulatory framework. These measures included enhancing supervisory oversight, encouraging banks to clean up long-overdue loans, and establishing a credit reference bureau in 2010 to help address information gaps between lenders and borrowers. Additionally, the 2011 regulation on credit classification and provisioning played an important role in facilitating banks to proactively identify and address problem loans.

Figure 1: Development in Non-Performing Loans and Asset Quality

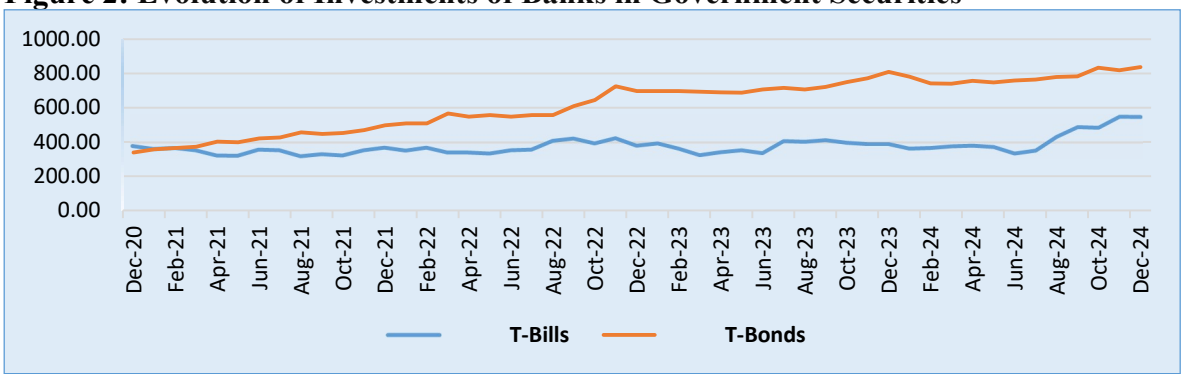


Source: The National Bank of Rwanda (2025)

The profitability of banks, measured by the Return on Equity (ROE) is negatively correlated with non-performing loans. The higher the NPL ratio, the lower the ROE and vice versa. This inverse relationship between expanding credit volumes and declining NPL ratios on Figure 1 on left-hand side demonstrates the success of Rwanda's banking sector reforms, including the NBR's enhanced regulatory framework, improved supervision, and the 2011 credit classification regulations, ultimately transforming the sector from a high-risk environment into a stable, growing financial system that supports economic development while maintaining asset quality standards. On the right-hand side, Figure 1 shows that the NPLs consistently declined while ROE substantially increased during the review period, reflecting the successful implementation of banking sector reforms and improved credit risk management that not only reduced problem loans but also enabled banks to achieve significantly higher returns, demonstrating the dual benefits of sound banking practices for both financial stability and sector profitability.

The bond market continued to grow as presented in Figure 2, reflecting a rising preference for long-term government securities, likely driven by stable yields, lower credit risk, and confidence in fiscal management, in addition to increased attention to short-term liquidity management in response to evolving market conditions.

Figure 2: Evolution of Investments of Banks in Government Securities



Source: The National Bank of Rwanda (2025)

This trends in Table 1, Figure 1 and Figure 2 highlight the simultaneous development of Rwanda's domestic bond market and the strength of the financial sector manifested in the continued growth in credit to the private sector and stable financial soundness indicators. These developments show that in Rwanda, there is no 'doom loop' in the sovereign-bank nexus, as banks' exposure to government debt remains at sustainable levels and the government's fiscal management is prudent. This balanced relationship helps maintain financial stability and prevents the emergence of any self-reinforcing negative cycles between the government and the banking sector.

III. Literature Review

Since the early 1990s, ensuring financial stability has emerged as the primary goal of economic policies, leading numerous central banks and international financial institutions to release routine financial stability reports. The 2008 financial crisis highlighted the critical connection between sovereign risk and financial system stability, prompting extensive academic investigation into the causal relationship between sovereign risk and financial stability.

From a theoretical perspective, banks' holdings of government securities are driven by portfolio rebalancing and financial repression. The portfolio rebalancing hypothesis suggests that during periods of economic stress, such as weak growth, high levels of NPLs, and undercapitalization, banks prefer safer and more liquid assets like government securities to meet capital and liquidity requirements. For example, Bonner (2016) indicates that regulatory incentives for financial stability make sovereign paper attractive for banks. Dell'Ariccia et al., (2018) argue that banks keep sovereign securities as the safest and most liquid assets, essential for meeting liquidity requirements, particularly in countries with underdeveloped capital markets. Sovereign bonds are crucial in the payment system, commonly used as collateral to secure credit, support hedging activities, and facilitate broader financial market operations due to their low volatility and relative safety. Gennaioli, et al., (2018) suggest that banks maintain an optimal share of sovereign securities to ensure liquidity for future investments, a strategy confirmed by Affinito et al., (2022) in the Italian banking sector.

Additionally, compliance with capital adequacy requirements motivates banks to hold sovereign papers. The Basel Accord mandates that banks hold capital proportional to their perceived credit

risks, with sovereign debt securities assigned a risk weight of zero. This incentivizes banks, particularly undercapitalized ones, to purchase sovereign debt securities to meet prudential regulations, encouraging the substitution of low-risk assets for higher-risk loans. Studies by Bonner (2016) and Buch, et al., (2016) found that undercapitalized banks invest more in government securities compared to well-capitalized counterparts, while Rodrigues and Keeton (1993) identified risk-based capital standards as a long-term factor in increasing banks' sovereign debt holdings. Furthermore, portfolio rebalancing is significant during weak loan demand and increased non-performing loans in recessionary periods. Keeton (1994) and Rodrigues (1993) observed that banks' investments in securities tend to rise relative to loans during such times due to reduced business activity, lower private sector loan demand, and declining interest rates. The rise in non-performing loans during recessions also discourages banks from extending more loans, even without interest rate changes.

The financial repression hypothesis posits that sovereigns may use moral suasion to pressure banks into purchasing new government securities, particularly when the risk and yield on these issuances rise (Dell'Ariccia et al., 2018; Becker & Ivashina, 2018). Rooted in the work of Shaw, (1973 and McKinnon, (1973), financial repression can crowd out private-sector financing by diverting funds away from loans. Evidence of this practice was observed in European countries during the sovereign debt crisis, impacting corporate lending (Becker and Ivashina, 2018). Despite the challenges of explicit financial repression in modern free markets, implicit financial repression through moral suasion can still occur (Ongena et al., 2019).

From an empirical perspective, the recent studies underscore the intensifying significance of the sovereign–bank nexus in emerging and developing economies. The IMF's Global Financial Stability Report (2022) highlights how the COVID-19 pandemic led to a surge in bank holdings of domestic sovereign bonds, sometimes exceeding 20 percent of bank assets, raising the risk of a destabilising feedback loop between sovereign distress and banking sector fragility, particularly in economies with weak fiscal buffers and undercapitalized banks. Complementing this, Deghi et al., (2022) delved deeper into the mechanisms of this nexus, namely the exposure, safety-net, and macroeconomic channels and found that higher sovereign debt exposure significantly increases banks' probability of default, especially in less-capitalized institutions, while sovereign distress curtails lending and hurts corporate investment. Similarly, the Dunz et al., (2024) documents a sharp rise in EMDEs with a 35 percent increase between 2012 and 2023-in banks' exposure to government debt, now averaging 16 percent of bank assets; it warns that even a modest 5 percent drop in the value of those holdings could render a substantial share of banks undercapitalized, heightening the risk of joint sovereign bank crises with severe GDP losses.

Rodrigues (1993) highlighted the role of economic cycles and interest rates in influencing banks' securities holdings. The study's analysis indicated that higher GDP growth and a wider loan-treasury spread decrease banks' holdings of government securities. This suggests that during periods of economic expansion and favorable loan conditions, banks are more inclined to shift their portfolios away from low-yield government securities towards more profitable lending opportunities. Both Rodrigues (1993) and Egesa et al. (2015) emphasized the importance of bank size and capitalization. Larger and well-capitalized banks tend to hold fewer government securities. This could be attributed to their ability to manage risk more effectively and their access to a broader range of investment opportunities. Conversely, undercapitalized banks or those with

deteriorating loan quality increase their holdings of government securities as a safer, more liquid asset to mitigate risk and maintain stability.

Affinito et al. (2022) and (Bouis, 2019) focused on the impact of bank-specific balance sheet conditions. Affinito et al. (2022) found that liquidity needs, capital charge convenience, and high yields make government securities particularly attractive during periods of liquidity demand and declining loan quality. Bouis's findings corroborate this, showing that economic downturns and rising non-performing loans lead banks to increase their holdings of government debt, aligning with the financial repression hypothesis. These insights underscore the strategic use of government securities to bolster liquidity and manage financial stress. Chronopoulos et al. (2019) introduced the dimension of bank ownership and governance quality. Their study showed a strong home bias in domestic sovereign debt holdings, particularly for domestic and government-controlled banks. This home bias is more pronounced in countries with high debt levels and weaker governance structures. This finding suggests that ownership and governance frameworks significantly influence banks' investment strategies, potentially driven by regulatory expectations or implicit guarantees from the government.

Lamas & Mencia (2018) and Dang and Huynh (2020) examined the influence of macroeconomic conditions. Lamas and Mencia found that Spanish banks increase their holdings of domestic sovereign debt during economic downturns and reduce them during upturns. Dang and Huynh's study on Vietnamese banks identified liquidity reserves and profitability needs as key drivers, with no evidence supporting the use of government bonds to improve capital positions. These findings highlight the responsiveness of banks to macroeconomic fluctuations and their strategic use of government securities to navigate economic cycles. Singh, et al., (2022) explored the portfolio rebalancing behavior of Indian banks. They found that weak economic activity and stressed asset quality encourage banks to increase their investment in government securities. While this strategy can improve profitability, it also leads to a crowding-out effect on private-sector credit, especially during periods of high government borrowing. This suggests a trade-off between financial stability and credit availability to the private sector, emphasizing the need for balanced regulatory policies.

The literature collectively underscores the multifaceted determinants of banks' holdings of government securities, shaped by a combination of economic cycles, bank-specific factors, ownership structures, and macroeconomic conditions. One notable gap in the literature pertains to the empirical exploration of the impact of banks' holdings of sovereign debt securities on financial stability in African countries, despite potential exposure given their heavily bank-dominated financial systems and the significant interactions between banks and the government.

IV. The Model, Estimation Approach and Data

This section presents the theoretical model, which introduces two key economic agents, the bank and the government, to clarify their respective roles and interactions, thereby guiding the derivation of the empirical specification. The section also outlines the estimation techniques used to achieve the research objectives, followed by a detailed description of the data sources and variables employed in the analysis.

4.1 Theoretical Model

Consider a simple two-agent model consisting of a bank and a government. In this setup, the government accrues sovereign securities from the bank, which operates within a context of monopolistic competition. The bank provides a loan L to the government, which subsequently repays $(1+r)\alpha L$, where r denotes the bank's interest rate. $\alpha \in [0,1]$ captures the level of bank preference for government securities with $\alpha = 0$ representing the bank is not willing to hold more securities due to their lower return, while at higher values $\alpha = 1$ indicate progressively high levels of bank preference. Let $C(L)$ denote the costs of the bank, which are assumed to be convex. Therefore, the bank's profit function can be written as follows:

$$\Pr ofit = (1+r)\alpha L - C(L) \tag{1}$$

Where, $L \geq 0$ and $C(L) \geq 0$. Furthermore, let ψ be a random variable that captures any random shock that can negatively affect the bank due to sudden government shocks, and it becomes unable to meet its payment obligations to the banks. These shocks could include crises (such as pandemics like COVID-19, natural disasters, wars, etc.). This type of shock does not have a direct impact on the government's debt securities amount L. Therefore, we proceed with the assumption that variable ψ is independent of L and we also assume that ψ $N(0,1)$. From the equation (1), the bank's profit becomes:

$$\Pr ofit = (1+r)\alpha L - C(L) + \psi \tag{2}$$

Where $\psi \in \Re$, the bank aims to maximize its expected profit. Let $E(\Pr ofit)$ profit, modifying equation (2) leads to

$$E(\Pr ofit) = \int_{t=1}^{T} [(1+r)\alpha L - C(L) + \psi]\, d\psi \tag{3}$$

At the optimum, we have $\partial E(\Pr ofit)/\partial L = 0 \rightarrow L^* = L'[(1+r)\alpha]$, L^* is the loan amount the bank must grant to the government if it wants to maximize its profit; this is the government's debt securities. By replacing L^*, we obtain the expression of the optimal expected profit of the bank, while d is an infinitesimally small change in the ψ.

$$E(\Pr ofit) = \int_{t=1}^{T} [(1+r)\alpha L^* - C(L^*) + \psi]\, d\psi \tag{4}$$

Literature indicates that the probability of default (PD) of a bank is the likelihood that losses exceed equity Tarazi (1992), In other words:

$$PD = \Pr ob(\mathrm{E}(\Pr ofit^*) \prec -Cap \tag{5}$$

Where $\mathrm{E}(\Pr ofit^*) \prec -Cap \rightarrow \psi \prec -Cap - [(1+r)\alpha L^* + C(L^*)$

Therefore Eq. (5) leads to

$$PD = f_{\psi}[-Cap - [(1+r)\alpha L^{*} + C(L^{*})] \quad (6)$$

Furthermore, from Eq. (6), we note that: $\partial PD / Cap \prec 0$

This implies that the higher the bank's capital, the lower its risk of default and the more stable it is. From the above theoretical derivation, two lemmas arise.

-Lemma (1): The risk of bank default can be written as a function of public debt securities (L^{*}), bank' preference of debt securities (α), and bank capital(Cap): $PD = f(L, \alpha, Cap)$. However, given the current levels of bond holdings observed in the Rwandan banking sector, the likelihood of default remains minimal.

-Lemma (2): Bank default risk is a decreasing function of bank capital, meaning that higher capital levels reduce the likelihood of default. Given the capital adequacy ratios observed in the Rwandan banking system, the probability of default is muted, reflecting the overall financial strength and resilience of banks in Rwanda.

4.2 Empirical Model

Using these propositions, we can deduce our empirical model. Indeed, the theoretical modelling shows that we can express the bank default risk (PD) as a function of public debts securities (BHGS), bank preference of securities (BYD), and bank capital(Cap). We augment the model with a vector of variables related to both the bank's characteristics (W) and its macroeconomic environment, which are known to influence its stability according to the literature.

$$PD = f(L, \alpha, Cap, W) \quad (7)$$

Taking an approach concerning asset returns, we substitute the probability of default(PD) with the default risk indicator (Loan Loss Provision-LLP) considered as a rough proxy for probability of default following the common practice in the literature (Beck et al., 2013; Bilgin et al., 2021; Bourkhis and Nabi, 2013). Therefore, eq (7) becomes:

$$LLP = f(L, \alpha, Cap, W) \quad (8)$$

Starting from Equation (9), the following specification enables the measurement of how the public debt securities and government distress affects-banking stability nexus:

$$LLP_{it} = \beta_0 + B_1 BHGS_{it} + \beta_2 BYD_{it} + \beta_4 BC_{it} + \beta_5 W_{it} + \eta_i + \varepsilon_{it} \quad (9)$$

Where: LLP is a measure of financial stability as the dependent variable, while bank holdings of government securities($BHGS$) is a measure of bank exposure to government securities and bank preferences to invest in securities (BYD), bank capital(BC), vector of other variables (W) affecting bank stability, such as macroeconomic variables and bank characteristics. η_i and ε_{it} represent bank-specific characteristics and error terms, respectively. We extend equation (9) to

capture the persistence of loan loss provisions to allow the dynamic set-up nature in the following equation:

$$LLP_{it} = \beta_0 + B_1 BHGS_{it} + \beta_2 BYD_{it} + \beta_4 BC_{it} + \beta_5 W_{it} + \beta_6 LLP_{it-1} + \eta_i + \varepsilon_{it} \quad (10)$$

LLP is computed as the ratio of bank loan loss provisions to bank loans and measures bank loan performance (bank loan quality), a proxy of financial stability. BHGS is a bank holding domestic government securities (treasury bills and bonds) as a share of the bank's total assets, measuring banks' exposure to government securities, i.e., a higher share reflects a stronger sovereign-bank nexus. The BYD captures the advantage of investing in government securities, where an increase denotes improvement in bond yields; banks are more likely to increase their investments in government securities when loan performance deteriorates, as suggested by the portfolio rebalancing hypothesis (Rodrigues,1993; Dang and Huynh, 2020).

Other variables included in the model are as follows: LR is the lending rate that measures the cost of borrowing money, which is a critical component of financial systems and has significant implications for both borrowers and lenders i.e. the higher the lending rate, the higher the loan loss provisioning due to increased risk of borrower default. Loans share to total assets (LSTA) is an important financial metric used by financial institutions to assess their asset composition and risk exposure, i.e banks have a larger portion of their assets tied up in loans, which are subject to credit risk. Return on assets (ROA) is a proxy measure for the overall profitability of banking activity. It captures the profit a bank can generate given total assets. A higher ROA indicates better profit prospects for growth and resilience to shocks. The literature argues that the least profitable banks have a greater incentive to increase earnings by purchasing high-yielding government securities (Buch et al., 2016; Affinito et al., 2022). Return on equity (ROE) is a financial performance metric that measures the profitability of a financial institution relative to its shareholders' equity. Thus, the expected signs on both ROA and ROE are negative. GDP is the real gross domestic product growth rate (a proxy for economic activity), allowing for the business cycle of the economy, and its expected sign is negative due to economic boom reducing credit defaults. Inflation (INFL) is a measure that can be either positive or negative. Higher inflation is associated with higher nominal asset values in banks, and borrowers' nominal repayment capacity may improve, potentially reducing the need for loan loss provisions. In contrast, higher inflation can pose a financial stability risk.

Estimation Method and Data

This study employs the Bias-Corrected Fixed Effects (BC-FE) estimator to capture the dynamic structure of Equation (10), following Kiviet (1995) and Bruno (2005), which mitigates small-sample bias in panels with short time dimensions. Robustness is assessed using pooled OLS and standard fixed effects (FE) models.[1].The analysis uses balance sheet data from nine commercial banks and macroeconomic indicators for 2014Q3-2024Q1. The variables of interest are Loan Loss Provisions (LLP), measured as the ratio of provisions to total loans, serve as a proxy for

[1] FE is preferred over other static models because bank-specific unobserved characteristics are likely correlated with explanatory variables, violating RE's orthogonality assumption, and our focus on within-bank variation over time aligns with FE methodology (Wooldridge, 2010; Cameron & Trivedi, 2005; Louzis et al., 2012). However, the FE cannot handle dynamic models, hence the usage of bias-corrected FE.

financial stability. Bank Holdings of Government Securities (BHGS) capture exposure to government debt, while Bond Yields measure (BYD), reflects the incentive to invest in government securities when loan performance deteriorates, consistent with the portfolio rebalancing hypothesis (Rodrigues, 1993; Dang and Huynh, 2020).

V. Discussion of the Empirical Results

Prior to running the regressions, the descriptive statistics in Table 2 show that LLP has a high skewness and kurtosis, indicating a distribution with extreme values. LBHGS is more evenly distributed but slightly negatively skewed. Bond yields measure (BYD) is nearly normally distributed with minor asymmetry. LR has a high mean, significant left skew, and heavy tails. LSTA is fairly symmetrical and peaked. ROA is highly skewed with extremely low values, while ROE has a distribution with some extreme values and a long left tail. GDP shows a left-skewed distribution with some extreme negative values, and INFL has a right-skewed distribution with a long tail of higher values. Given the data's significant variability, transforming variables and employing techniques specific to panel data, such as fixed effects, which account for within-entity correlations, ensure reliable regression results, which is paramount.

Table 2: Descriptive Statistics

Variables	N	mean	sd	min	max	skewness	Kurtosis
LLP	311	0.0233	0.0337	0	0.310	5.209	39.89
LBHGS	263	16.64	1.307	12.31	19.16	-0.389	2.958
BYD	350	-0	0.0522	-0.0934	0.0706	-0.758	1.754
LR	350	14.87	5.295	0	22.01	-2.240	6.713
LSTA	311	0.454	0.158	0.0255	0.858	-0.0991	2.563
ROA	311	0.0133	0.0436	-0.460	0.209	-4.385	50.54
CAR	311	0.321	0.453	0.0457	4.609	6.971	55.22
GDP	350	0.0692	0.0439	-0.125	0.206	-1.339	9.310
INFL	350	5.240	4.620	-0.633	21.13	1.617	5.747

Source: Authors' own computation

Furthermore, the results of correlation analysis presented in Annex 1 shows key relationships among bank performance metrics and macroeconomic indicators. Loan loss provisions (LLP), which measure loan performance, are negatively correlated with return on assets (ROA), suggesting that banks with deteriorating loan quality tend to have lower profitability. Conversely, higher LLP is associated with a higher loan share to total assets (LSTA), indicating banks with more loans relative to their assets face greater loan losses. Banks' holdings of government securities (LBHGS) are positively correlated with bond yields measure (BYD), aligning with the portfolio rebalancing hypothesis. LBHGS is also positively related to ROA, suggesting that more profitable banks hold more government securities. Inflation is positively correlated with LBHGS, indicating banks may increase their holdings in response to rising inflation.

For the main empirical analysis, the study utilized bias-corrected fixed effects (BC-FE) models, which mitigate potential small-sample bias and capture the dynamic nature of banks' provisioning behavior. The results of the BC-FE estimations are reported in Table 3.[2]

Table 3: Main Estimates- Bias-Corrected Fixed Effects Results

	BC-FE1	BC-FE2	BC-FE3	BC-FE4	BC-FE5	BC-FE6	BC-FE7
L.LLP	-0.116***	-0.118***	-0.115***	-0.105***	-0.090***	-0.088***	-0.082***
	(0.044)	(0.045)	(0.013)	(0.021)	(0.027)	(0.022)	(0.016)
LBHGS	-0.002	-0.002	-0.002	-0.001	-0.001	-0.000	-0.001
	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
BYD	-0.118***	-0.115***	-0.109	-0.122	-0.130*	-0.138*	-0.136
	(0.011)	(0.011)	(0.081)	(0.079)	(0.076)	(0.083)	(0.083)
LR		0.001	0.001	0.001	0.001	0.001	0.001
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
LSTA			-0.006	-0.004	-0.009	-0.023	-0.022
			(0.073)	(0.073)	(0.069)	(0.068)	(0.067)
ROA				-0.134**	-0.092***	-0.036***	-0.037***
				(0.061)	(0.028)	(0.010)	(0.008)
CAR						-0.084***	-0.081***
						(0.015)	(0.014)
GDP							0.025
							(0.019)
INFL	-0.000	-0.000	-0.000	-0.000	-0.000	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	168	168	168	168	168	168	168

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' own computation

The consistently negative coefficients of L.LLP across all BC-FE models (-0.082 to -0.116) indicate that banks exhibit a persistent approach to provisioning overtime. Higher past levels of loan loss provisions (L.LLP) correspond to lower current provisions, highlighting banks' reliance on historical data to manage credit risks effectively.

[2] BC-Fixed Effects provides more consistent estimates in panel macro analysis by correcting for the Nickell (1981) bias in dynamic panels, delivering superior consistency compared to standard fixed effects and GMM estimators, particularly with small samples and short time dimensions (Kiviet, 1995; Bruno, 2005; Bun & Kiviet, 2003).

In contrast, banks' holdings of government securities (LBHGS) show negligible coefficients (-0.001 to -0.002) across models. The results have the expected negative sign, but they are not statistically significant. The results show a negative relationship between bond yields measure and LLP (-0.109 to -0.136), and the results are statistically significant, indicating perceived safety in government securities as banks perceive these securities as safer assets, potentially lowering their anticipated loan losses.

The financial performance metrics such as return on assets (ROA), and capital adequacy ratio (CAR) consistently exhibit negative coefficients (-0.037 to -0.154 for ROA, and -0.017 to -0.081 for CAR). The results would imply that more profitable banks (ROA), and banks with stronger capital positions (CAR) allocate fewer resources to provisions, reflecting their ability to manage risks and absorb potential losses effectively.

We conducted several robustness checks to validate the main findings of bias-corrected fixed effects (BC-FE) estimates, using additional estimation techniques such as pooled OLS and fixed effects (FE) models. While there are variations in the magnitude and statistical significance of some coefficients across these alternative models, the overall direction of the relationships between the identified variables and loan loss provisions (LLP) remains broadly consistent. Nonetheless, a few variables displayed unexpected patterns, such as the positive relationship between bank holdings of government securities and loan loss provisions.

Regarding estimates from the pooled Ordinary Least Squares (OLS) models to explore the factors influencing banks' provisions for loan losses[3]. The estimated results in annex 2, show that banks' holdings of government securities (LBHGS) suggest a mixed relationship with loan loss provisions (LLP). While some models show a positive association between LBHGS and LLP, the OLS estimates overstate the effect of LBHGS on LLP, as other models show negative and insignificant coefficients, and the main results indicate a muted, non-significant negative effect. Other models demonstrate a negative impact. The negative relationship implies that less loan loss provisions are required with investment in safe assets and a possibility of limited exposure to risk loans.

Bond yields measure (BYD) indicates a negative and statistically significant coefficient across all models, suggesting that when government bond yields rise above their long-term trend, banks tend to reduce their loan loss provisions. This behavior may reflect a portfolio reallocation toward government securities, which are perceived as safer and default-risk-free assets. The Lending Rate (LR) consistently shows a positive coefficient in all models, indicating that higher lending rates are associated with increased provisions for loan losses. This relationship suggests that banks anticipate higher default risks when lending rates are elevated, leading to higher provisions to cover potential losses.

Return on assets (ROA) consistently displays a negative coefficient, indicating that more profitable banks allocate fewer resources to loan loss provisions, possibly due to their stronger financial position and ability to absorb losses. Loan size to total assets (LSTA), capital adequacy

[3] In our analysis, we employed the stepwise inclusion of variables in our panel data models to provide a structured framework for assessing the impact of each variable, ensuring a comprehensive understanding of the relationships within the data. Following the literature survey, we consider model 7 to be the most robust and correctly specified model.

ratio (CAR) and gross domestic product (GDP) do not show statistically significant coefficients across any of the models, suggesting that these variables do not significantly impact banks' provisions for loan losses. The negative inflation (INFL) coefficient indicates that inflation rates are associated with slightly lower loan loss provisions (LLP) by banks, i.e. during periods of modest inflation, banks may adjust their provisioning practices, potentially reflecting expectations of increased revenues or asset values that could mitigate loan defaults.

The results for the robustness checks conducted based on fixed effects (FE) approach are presented in Annex 3. This method addresses the limitations of OLS by incorporating bank-specific effects, which provides more robust estimates and deeper insights into the dynamics influencing banks' provisions for loan losses.

After accounting for heterogeneity between banks, the Pooled OLS, the bank's holdings of government securities (LBHGS) consistently show negative coefficients ranging from -0.001 to -0.004 across all models, i.e. the holding government securities by banks are associated with reduced provisions for loan losses indicating no exposure of banks into government securities. Bond yields measure and exhibits negative coefficients (-0.037 to -0.089), indicating perceived safety in government securities as banks perceive these securities as safer assets, potentially lowering their anticipated loan losses.

Conversely, the lending rate (LR) shows positive coefficients (0.003 to 0.004) across all models, suggesting that higher borrowing costs increase provisions, reflecting higher default risks. Loan Size to Total Assets (LSTA) demonstrates negative coefficients (ranging from -0.023 to -0.044), suggesting that banks with larger loans relative to their assets provision less for loan losses, suggesting that banks with a larger lending portfolio may rely on effective risk management and diversified, high-quality loans, allowing for a more moderate approach to provisioning. Other variables like return on assets (ROA), capital adequacy ratio (CAR), gross domestic product (GDP), and inflation (INFL) show mixed or insignificant coefficients, indicating varying impacts or no significant influence on LLP in this analysis. Overall, while the general direction of relationships between identified variables and loan loss provisions remains consistent across FE and pooled OLS models, the FE models provide more robust estimates by controlling for time-invariant bank-specific effects, thus offering deeper insights into the dynamics of provisioning decisions within banks over time.

VI. Conclusion

This study examined the sovereign-bank nexus on financial system stability in Rwanda, analyzing data from 9 commercial banks over the period from 2014Q3 to 2024Q1. The findings highlight several key determinants influencing banks' allocation for loan losses provision, a crucial indicator of financial instability. Across various models, including pooled OLS, fixed effects, and bias-corrected fixed effects, relatively consistent patterns emerged regarding the factors affecting loan loss provisions. Bank holdings of government securities showed mixed effects on loan loss provisions in pooled OLS models but consistently indicated a negative impact in FE and BC-FE models. Based on the BC-FE models, which constitute the main findings of the study, the holding of government securities by banks does not have a statistically significant impact on loan loss provisions, suggesting that the government securities held by banks are still

minimal to influence provisions for potential loan losses. The results of bond yields measure consistently exhibited a negative coefficient across all models, indicating banks tend to reduce provisions for loan losses, potentially due to perceived safety and return in government securities. On the other hand, lending rate consistently showed a positive coefficient across all models, implying that higher borrowing costs are associated with increased provisions for loan losses. This relationship underscores banks' anticipation of higher default risks during periods of elevated lending rates. Coefficients of return on assets, return on equity, and capital adequacy ratio consistently displayed negative coefficients in FE and BC-FE models, indicating that more profitable and better-capitalized banks allocate fewer resources to loan loss provisions, reflecting their stronger ability to manage risks.

Thus, even in the absence of both sovereign–bank exposure and crowding out of private sector credit in Rwanda, these findings have important policy implications for financial stability and contribute to the debate on the treatment of sovereign exposure in banking regulation and stability. Nevertheless, to forestall the occurrence of such exposures in future, the study recommends that the National Bank of Rwanda to continue implementing prudential policies that focus on optimizing the level of sovereign securities held by banks and establishing exposure limits to prevent excessive concentrations on their balance sheets to continue strengthening banking sector stability and enhancing market efficiency.

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Annexes

Annex 1: Correlation Matrix

	LLP	LBHGS	SD	LR	LSTA	ROA	CAR	GDP	INFL
LLP	1.00								
LBHGS	-0.19**	1.00							
	(0.00)								
BYD	-0.04	0.40***	1.00						
	(0.44)	(0.00)							
LR	0.08	-0.08	0.30***	1.00					
	(0.18)	(0.19)	(0.00)						
LSTA	-0.22***	0.15*	-0.14*	0.04	1.00				
	(0.00)	(0.01)	(0.01)	(0.47)					
ROA	-0.19***	0.38***	-0.14*	-0.19***	0.21***	1.00			
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)				
CAR	0.47***	-0.18**	0.12*	-0.10	-0.37***	-0.24***	1.00		
	(0.00)	(0.00)	(0.04)	(0.07)	(0.00)	(0.00)			
GDP	-0.04	0.01	-0.02	-0.05	-0.02	0.07	-0.03	1.00	
	(0.52)	(0.90)	(0.73)	(0.40)	(0.77)	(0.24)	(0.66)		
INFL	-0.14*	0.25***	0.11*	0.05	-0.05	0.10	-0.07	-0.19***	1.00
	(0.01)	(0.00)	(0.04)	(0.32)	(0.39)	(0.09)	(0.23)	(0.00)	

p-values in parentheses*: $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Annex 2: Regressions results from Pooled OLS

	P-OLS1	P-OLS2	P-OLS3	P-OLS4	P-OLS5	P-OLS6	P-OLS7
LBHGS	-0.001	-0.001	-0.001	0.001	0.002	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BYD	-0.089***	-0.081***	-0.080***	-0.127***	-0.138***	-0.143***	-0.142***
	(0.029)	(0.029)	(0.029)	(0.030)	(0.031)	(0.031)	(0.031)
LR		0.003**	0.003**	0.003**	0.002*	0.003**	0.003*
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LSTA			-0.012	-0.001	-0.001	-0.007	-0.008
			(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
ROA				-0.161***	-0.102*	-0.148**	-0.154**
				(0.035)	(0.054)	(0.062)	(0.062)
CAR						-0.023	-0.024
						(0.015)	(0.015)
GDP							-0.042
							(0.028)
INFL	-0.001**	-0.000*	-0.001*	-0.001*	-0.000*	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	263	263	263	263	263	263	263

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' own computation

Annex3: Fixed Effects Models Regression Results

	FE1	FE2	FE3	FE4	FE5	FE6	FE7
LBHGS	-0.003**	-0.002	-0.004***	-0.002	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
BYD	-0.073**	-0.071**	-0.037	-0.078**	-0.087**	-0.087**	-0.089**
	(0.033)	(0.032)	(0.034)	(0.034)	(0.035)	(0.035)	(0.035)
LR		0.003*	0.004***	0.003**	0.003**	0.003**	0.003**
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LSTA			-0.044***	-0.023	-0.025*	-0.030*	-0.031*
			(0.014)	(0.015)	(0.015)	(0.016)	(0.016)
ROA				-0.154***	-0.101*	-0.135**	-0.140**
				(0.037)	(0.056)	(0.064)	(0.065)
CAR						-0.017	-0.018
						(0.016)	(0.016)
GDP							-0.033
							(0.028)
INFL[4]	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	263	263	263	263	263	263	263

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' own computation

[4] The reported coefficient of inflation is not statistically significant, but it is not exactly zero, as the estimates have been rounded to three decimal places for consistency in reporting. Furthermore, ROE was excluded from the regression analysis because its coefficients were statistically insignificant in both the OLS and FE estimated tables.