UNDERSTANDING INTEREST RATE RISK IN THE RWANDAN FINANCIAL SYSTEM

Patrick Mugenzi[9]

[9] Economist, Monetary Policy Department, National Bank of Rwanda

ABSTRACT

This paper aims at examining the effect that the volatility in interest rates (hereafter called interest rate risk) has on the net worth of banks in Rwanda. The study used the static panel data model, specifically the fixed effect model, to estimate the effect of interest rate risk in the banking sector with data from 10 licensed commercial banks with available data from 2012Q1 until 2019Q2. The findings suggest that most commercial banks were most sensitive to the changes in the deposit rate. Specifically, an increase of 1 percent in the deposit rate induced a decline in net worth equivalent to 1.1 percent. Financial regulators can use this approach to monitor the build-up of interest risks and ensure timely actions to safeguard the financial system's stability.

Key words: Interest rate risk, banks' net worth, fixed-effects model

JEL classification: E43, G32, C33

1. INTRODUCTION

Interest rate risk management in the banking sector has received increasing importance, especially during the last decades of higher interest rate volatility. It has become increasingly important to measure, manage, and assess the impact of this volatility on banking economics. Over the past few years, both banking supervisors and researchers have nearly exclusively focused on banks' credit and operational risk. More recently, considerable attention is being turned to interest rate risk (Fisnik and Afrim, 2015). Since interest rate risks can result in systemic risks with detrimental effects on the financial system's stability, the renewed focus on this channel needs no further justification.

Interest rate risk is a catchall phrase intended to mean the effect of changes in market interest rates on the banks' financial conditions. These changes affect financial institutions in at least two main ways. One is through the balance sheet, and the other is through the income statement (Bednar and Elamin, 2014).

First, the interest rate risk allocation (i.e., who bears the risk) affects monetary policy transmission. If banks take interest rate risk, changes in interest rates affect bank net worth and, ultimately, the supply of loans via the bank balance sheet channel (Bernanke and Gertler, 1995; Jiménez et al., 2012).

The balance sheet is affected when rising interest rates alter the value of liabilities and assets and reduce the bank's net worth. Because of their differing maturities, an interest rate spike would affect bank assets and liabilities differently. For example, when assets lose value while the liabilities keep theirs, the net worth of the bank drops. In the end, this drop affects the bank's capital levels.

Therefore, some of the banks' assets are affected by market interest rates, declining in value when market interest rates go up. When this happens, it shrinks the capital banks have in hand to absorb losses on their market-priced assets. However, the interest rate risk affects not all bank assets (Bednar and Elamin, 2014).

In Rwanda, loans have been the primary income-earning activity with the highest share on the assets side of all bank balance sheets (Ntirushwamaboko et al., 2021). Deposits dominate the other side of the balance sheet (see appendix A and

B). In fact, changes in the lending rate potentially alter the value of the banks' assets and eventually the banks' net worth. Similarly, the spike in deposit rates will likely affect the value of banks' liabilities. Since banks use short-term deposits whose rates change after maturity to finance loans with longer maturity and a fixed rate, the earnings from loans are pretty limited. However, an interest rate spike may have differential effects on banks' assets and liabilities since they bear distinctive maturities

The primary motivation of this paper is based on the fact that the banking system in Rwanda is prone to interest rate risk emerging from different sources. The paper thus focuses on assessing the effect of interest rate risk on the financial sector, particularly on the banks' balance sheets in Rwanda. This paper sheds light on the interest rates that can potentially disrupt the value of assets and liabilities and, ultimately, the net worth of the banks. Understanding this risk aims to inform financial regulation and ensure appropriate monitoring of interest rate risks build-up to enable timely actions to protect the financial system.

The remainder of this paper is organized as follows, after the introduction; a review of relevant literature is presented in section 2. Section 3 discusses the interest rate risk in Rwandan financial system. Section 4 presents the research methodology, Section 5 presents the results before it ends with conclusion in section 6.

2. LITERATURE REVIEW

The Basel Committee on Banking Supervision (2004) points out several possible ways to define and measure interest rate risks. For supervisory purposes, the Committee suggests estimating the level of interest rate risk for exposures in G10 currencies by the decline of a bank's economic value with its regulatory capital following a standardized interest rate shock. An upward and downward 200 basis points parallel movement of the term structure gives this shock. A number of techniques are available for measuring the interest rate risk exposure of both earnings and economic value. Their complexity ranges from simple calculations to static simulations using current holdings to highly sophisticated dynamic modeling techniques that reflect potential business activities.

Many policymakers have raised concerns about the current levels of interest rate risk in the financial system. Governor Jeremy Stein of the Federal Reserve Board recently warned that a prolonged period of low-interest rates, of the sort we are experiencing today, can create incentives for agents to take on greater duration risk (Stein, 2013). Data unavailability was seen as a significant limitation in empirical work since measuring the effective maturities of assets and liabilities and exposures from derivatives is often impossible from public data. To overcome these limitations, several papers use market data to document negative stock price reactions to surprise increases in interest rates (Flannery & James, 1984; English et al., 2018; Ampudia & Van Den Heuvel, 2017). This result is consistent with the traditional view of banks as maturity transformers. Begenau et al. (2015) document significant exposures of U.S. banks to interest rates using a factor model estimated from public balance sheet data. Gomez et al. (2016) show that bank' exposures to interest rate risk affect monetary policy transmission using data on short-term assets and liabilities.

Hellwig (1994) questions the view that banks necessarily bear interest rate risk. In a Diamond-Dybvig model with aggregate risk, he shows that the optimal contract is such that banks are fully insulated from changes in interest rates. They take variable-rate deposits and make variable-rate loans. More recently, Drechsler et al. (2018) show that frictions in the deposit market enable banks to engage in maturity transformation without being exposed to interest rate risk. Banks' market power results in limited pass-through of market rates to deposit rates so that deposits effectively behave like long-term fixed-rate liabilities. Consequently, holding long-term fixed-rate assets is a way for banks to hedge rather than taking the risk.

Consistent with this view, the net interest margins of U.S. banks have been stable over time, despite significant swings in interest rates (Hoffmann et al., 2018). This matching view is supported by Kirti (2017), who shows that banks with more floating-rate liabilities tend to extend more floating-rate loans.

The major source of interest rate risk in the banking book, namely maturity mismatch or, more precisely, the repricing mismatch, was highlighted in the literature. According to banks, interest rate risk is the most significant source of market risk for commercial banks (IFRI-CRO, 2007). Hence, after credit risks it is the second most important source of risk for the capital adequacy of these institutions. Banks and regulators are aware of the importance of both risks. But because of the limited availability of appropriate models, they tend to manage these risks separately even though, as Jarrow and Turnbull (2000) point out, economic theory tells us that market and credit risk are intrinsically related to each other and not separable.

Because there is still no standardized access to banks' internally quantified interest rate risk, most models proposed in the literature and applied by banking supervisors rely on accounting-based data. These include Bennett et al. (1986), Planta (1989), Patnaik and Shah (2004), and the Federal Reserve's Economic Value Model (EVM) presented by Houpt and Embersit (1991) and analyzed by Wright and Houpt (1996), and Sierra and Yeager (2004), as well as the standardized framework suggested by the Basel Committee on Banking Supervision (BCBS, 2004).

Several perspectives for assessing interest rate risk exposure are grouped in three perspectives (Ngalawa and Ngare, 2014): (1) the earnings perspective, also known as the traditional approach, which focuses on the analysis of the impact of a change in the interest rate on accrual or reported earnings of banks; (2) the economic value perspective, which reflects the sensitivity of the net worth of the banking institution to fluctuations in interest rates; and, (3) the embedded losses perspective that evaluates the level of interest rate risk a banking institution is willing and able to assume, it considers the impact that past interest rates may have on future performance.

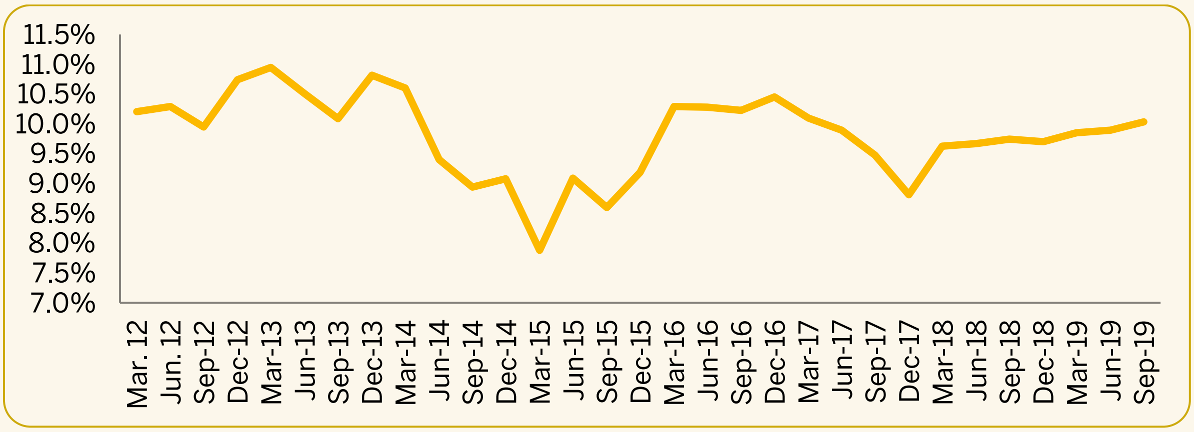
Our paper is inclined towards the economic perspective, which asserts the assessment of the impact of both lending and deposit rate fluctuations on the net worth of the financial system in Rwanda. Since the economic value perspective considers the potential impact of interest rate changes on the present value of all future cash flows, it provides a more comprehensive view of the possible long-term effects of changes in interest rates than offered by the earnings perspective (Ngalawa and Ngare, 2014).

3. INTEREST RATE RISK IN RWANDA'S FINANCIAL SYSTEM

Several indicators support the conventional wisdom that interest rate risk does not pose a significant threat to the commercial banking system. Most notably, the stability of commercial bank net interest margins (NIM) as the proxy of bank's profitability and growth: NIM (the ratio of net interest income to average assets) lends credence to this conclusion. However, the banking system in Rwanda has shown that their net interest margins fluctuate along the period under consideration. Particularly, NIM outstandingly shows three incredible lows in the period of March 2015, September 2015 and December 2017 as broadly highlighted in Chart 3.1.

Net Interest margins, however, offer only a partial view of interest rate risk. They may not reveal longer-term exposures that could cause losses to a bank if the volatility of rates increased or if market rates spiked sharply and remained at high levels. They also say little about the potential for changing interest rates to reduce the ''economic'' or ''fair'' value of a bank's holdings. Economic or fair values represent the present value of all future cash flows of a bank's current holdings of assets, liabilities, and off-balance- sheet instruments. Therefore, approaches focusing on the sensitivity of an institution's economic value involve assessing the effect a rate change has on the present value of its on and off-balance-sheet instruments and whether such changes would increase or decrease the institution's net worth. Given this gap of net interest margin, we extend the analysis of interest rate risk in the financial system by using an econometric model, which considers the effect of changes in market rates on a bank's net worth.

Chart 3.1: Net interest margin (NIM)

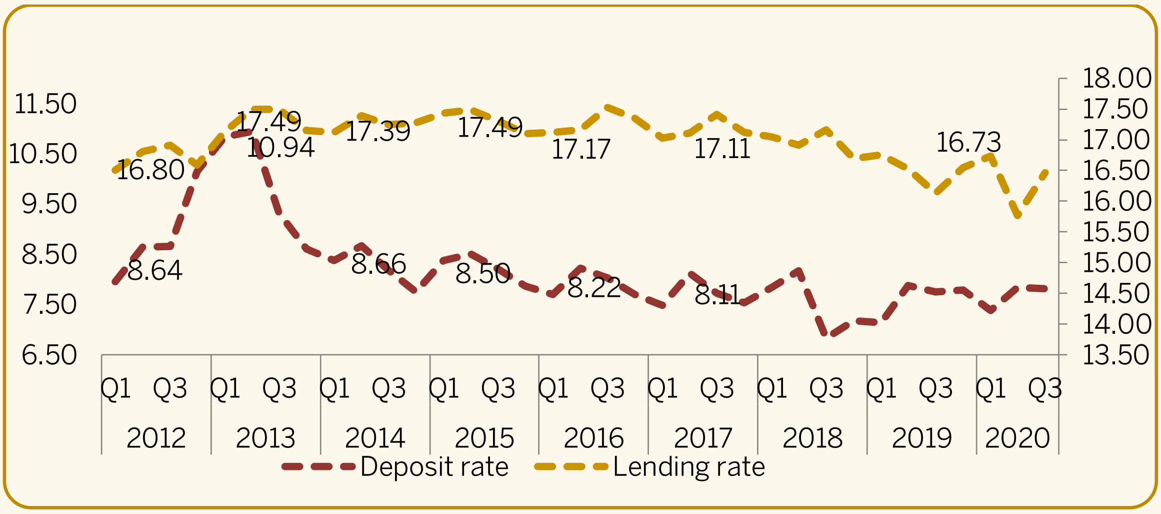


Source: Author's calculation

Chart 3.2 describes a more or less stable lending rate with slight upward and downward trend along the sample period. An upward trend of weighted average lending rate from 2012 until the end of 2013 and after reveals relatively stable fluctuations stretching up to 2018Q3 and then gradually declined. Similarly, the weighted average deposit rate in the banking system presents remarkable volatility in the first two years up to 2014; afterward, it shows a slight wavering, with an exceptional drop in 2018Q3. Deposit rates, among other costs of funds for banks, have not significantly eased, which is linked to the higher negotiation power of big depositors, predominantly corporate institutions, thus making the lending rate stuck at a higher rate.

The volatility of market rates in the banking system caught our attention and thus needs to be explored since their variability triggers changes in the net present value of a bank's net worth.

Chart 3.2: Market interest rates



Source: Author's calculation

4. RESEARCH METHODOLOGY

Panel data of the banking system were analyzed to gauge the effect of interest rates volatility in the banks' financial condition represented by the net worth of the financial system in our model. Banks are heterogeneous and distinct in terms of pricing lending rates on the loans. The cost of deposits depends on the characteristics of depositors, which behave differently in the banking sector. We apply a static panel data model that relates a bank's net worth to interest rate risk exposure, specifically market rates. Given that bank-specific effects[10] may be correlated with explanatory variables and probable omitted bias effect, the random effect model is not consistent, as confirmed by the Hausman test. Therefore, this paper uses the fixed effect model as the appropriate approach to control for unobserved heterogeneity, such as the bank's pricing model in the banking sector.

[10] The example is the bank-specific price lending rate.

4.1. The model and variables of interest

The fixed effects panel data model is presented as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \alpha_i + \mu_{it}$$

Y_{it} stands for Total Assets (TA), Total Liabilities (TL), and Net worth (TA-TL), respectively, as presented in Table 3. These explained variables are scaled in logarithmic form. While X_{it} is a 1×k vector of explanatory variables. Our model considers the bank's specific lending rate and deposit rate as the only independent variables, consistent with most of the literature on the subject matter. We also include the individual-specific intercepts in the model as α_i , i =1,…,n, The α_i are bank-specific intercepts that capture heterogeneities across the banking system. In addition, μ_{it} represents the error term.

The fixed effects estimator is equivalent to demeaning all of the dependent and independent variables with respect to the group and then estimating the model using OLS. Demeaned OLS algorithm in R programming, which is computationally more efficient than estimating regression models with k+n regressors (i.e., the Least-squares dummy variable model), is preferably used. After demeaning the data, there is no need to estimate n-1 dummies and an intercept. The demeaned OLS model can be stated as follows:

$$\tilde{Y}_{it} = \beta_0 + \beta_1 \tilde{X}_{it} + \tilde{\mu}_{it}$$

Using these variables, we estimate the changes in the net worth of the financial system given the volatility in interest rates. In addition, it is essential to highlight the sensitivity of both Total Assets and Total Liabilities in the banking system, given changes in market interest rates in separate models.

The choice of variables follows an economic perspective in assessing interest rate risk in the financial system (Ngalawa and Ngare, 2014). The stated perspective assesses the impact of both lending and deposit rate fluctuations on the net worth of the financial system. Thus, this paper covers data of chosen variables from 10 licensed commercial banks with available data from 2012Q1 until 2019Q2.

5. RESULTS

5.1. Descriptive statistics

Table 1 below depicts the characteristics of the variables observed in the dataset. The common feature in all the variables is the heterogeneity in cross-sectional observations, which is confirmed by standard deviation statistics. The average deposit rate (ADR) reflects the average rate at different maturity in a given bank. This ADR noticeably reveals high variability compared to the other variables under study, which is reasonable since depositors are different across the banks. Again variability in Average Lending Rate (ALR) expresses that banks have not only different loan pricing mechanisms/models but also distinctive rates respective to the size of the loan or the maturity (short-term, medium-term, or long-term). In addition, total assets, total liabilities, and Net worth (Total assets less total liabilities) expressed in logarithmic form as Log TA, LogTL, and Log(TA-TL), respectively, reveal more or less a lower variability compared to other variables.

Table 1: Summary statistics[11]

Variables	Obs	Mean	Std.Dev	Min	Max
Log TA	300	18.54	**0.97**	15.88	20.59
LogTL	300	18.36	1.00	15.66	20.42
Log(TA-TL)	300	16.65	0.90	14.26	18.99
ALR	300	17.16	1.28	14.40	22.00
ADL	295	7.6	2.15	3.0	14.4

Source: Authors' computations

[11] For Deposit rate, five observations were missing in the data set

5.2 Regression analysis

Since the random effects approach has a significant drawback, which arises from the fact that it is valid only when the composite error term $\omega_{i,t}$ is uncorrelated with all of the explanatory variables. This assumption is more rigid than the corresponding one in the case of the fixed effects. This can also be viewed as a consideration of whether any unobserved omitted variables that were allowed for by having different intercepts for each entity are uncorrelated with the included explanatory variables. A random-effects approach can be used; otherwise, the fixed effects model is preferable. A test for whether this assumption is valid for the random effects estimator is based on a slightly more complex version of the Hausman test.

The Hausman test affirms that the fixed-effects model is appropriate and consistent, as evidenced by (table 2).

Table 2: Hausman test results

	Statistic	Degree of Freedom	P-value
Chi square	6.3805	3	0.0945*

* $p < 0.1$,

Source: Authors' estimations from R Programming

Table 3 presents the results of the three fixed-effects models. Column 1 gives the model results, focusing on explicitly examining the effect of the lending rate and deposit rate on total assets in the banking system. The results from the model highlight that an increase in the lending rate has a negative statistically significant effect on the value of assets. These findings are consistent with the literature such as (Bednar and Elamin, 2014). It is noteworthy to mention that the spike in lending rate would pose a high risk to the value of assets. On the other hand, changes in deposit rates do not significantly affect the value of assets. Subsequently, the lagged values of assets show a persistent effect in the model.

Similarly, in columns 2 and 3, the findings arrive at the same conclusion mentioned in the previous paragraph on the effect of lagged values. However, one can note that the increase in the lending rate reduces the value of total liabilities more than it does to the value of total assets (see columns 1 and 2). On the other hand, increments in the deposit rate positively affect the value of total liabilities in the banking system (column 2).

Finally, the last model (column 3) reveals that the net worth of the financial system is riskier and more exposed to the upswing in deposit rates but not the lending rate. An increase in the deposit rates significantly shrinks the bank's financial conditions and, ultimately, the capital level of the banking system in Rwanda.

In fact, when interest rates change, these differences can give rise to unexpected changes in the cash flows and earnings spread between assets, liabilities, and off-balance sheet instruments of similar maturities or repricing frequencies.

For instance, a bank that funded a long-term fixed-rate loan with a short-term deposit could face a decline in both the future income arising from the position and its underlying value if interest rates increase. These declines arise because the cash flows on loan are fixed over its lifetime, while the interest paid on the funding is variable and increases after the short-term deposit mature.

Table 3: Regression results

	Dependent variables		
	(1)	(2)	(3)
Independent variables	**Log (TA)**	**Log(TL)**	**Log(TA-TL)**
Log (Y_{t-1})	0.964***	0.951***	0.950***
	(74.1)	(67.92)	(45.2)
ADR	0.005	0.007***	-0.011**
	(1.66)	(2.33)	(-2.75)
ALR	-0.016**	-0.029***	0.012
	(2.66)	(4.14)	(1.23)
N	287	295	287
R2	0.958		0.903
R2 Adjusted	0.957		0.899
F-statistic	2,100.459***		852.557***

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. CONCLUSION

The results show a significant risk of the market rates on the balance sheet of the Rwandan financial system.

This study sought to establish the exposure to interest rate risk among commercial banks in Rwanda. From the available data of 10 commercial banks, we have found that a 1 percent positive change in the deposit rate would result in a decline of net worth equivalent to 1.1 percent.[12]

Generally, most of the papers document a significant negative relationship between interest rate movements and bank's capital. This result has been mainly attributed to the typical maturity mismatch between banks' assets and liabilities. Banks usually are exposed to a positive duration gap because the average duration of their assets exceeds the average duration of their liabilities. Thus, the net interest income and the bank value are negatively affected by rising interest rates.

The present paper highlights the interest rates that highly affect a bank's net worth and has the policy implication that understanding this risk informs the financial regulators to ensure appropriate monitoring of interest risks build-up and take timely actions to protect the financial system. The approach used in this paper serves a significant role in evaluating interest rate risk in the banking system as much as traditional accounting approaches, which are primarily used in measuring this risk.

In this paper, we have mainly focused on exploring the effect of market-rate volatility on banks' net worth using an econometric model, particularly the panel fixed-effects model. However, further research is needed using other methods capable of utilizing granular data such as market rates at different maturity, the value of deposits, and the value of loans, to mention a few.

[12] Model 3, which is log-level model (log net worth and market rates at level), the slope -0.011 is interpreted as 100 *(-0.011): -1.1 which is the **semi-elasticity** of net worth with respect to deposit rate. In other words, one percent increase in deposit rate will result in a decline of net worth by 1.1 percent.

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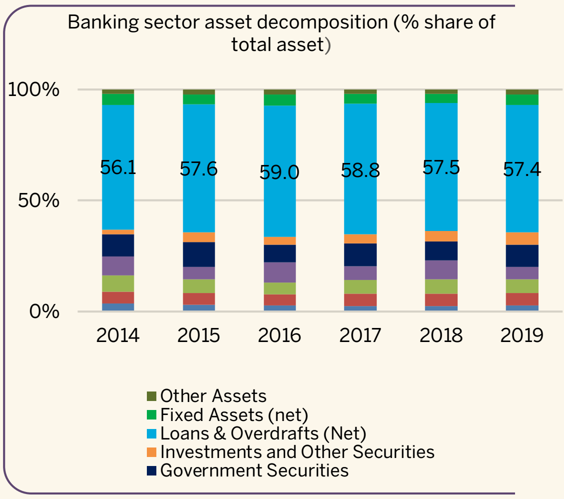
Appendices

Appendix A: Banking sector assets decomposition



Appendix B: Banking sector source of funds