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# Assessing the Lending Channel of Monetary Transmission Mechanism in Rwanda using Panel Data

**by**

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**Abstract**

This paper investigates the existence of the bank lending channel of monetary policy transmission in Rwanda using quarterly panel data during the period 2010:Q4-2017:Q2. Specifically, we investigate the impact of monetary policy changes on banks' lending behavior. In addition, the impact of individual bank characteristics; size, liquidity, and capitalization on the banks' loan supply function are also investigated. We aim to test whether there are differential effects of monetary policy across banks. Using a large set of micro data, we test the assumptions that the effect of a change in the monetary policy stance on a bank's lending activity depends on its capital, its size and on its liquidity. A set of macroeconomic variables are also included in the model to control for economic activity. The results of the panel estimation using fixed effect model and GMM showed that the lending channel exists in Rwanda and that there are differential effects of monetary policy across banks depending on their level of capital, liquidity and size.

**Keywords:** Monetary Transmission Mechanism, Bank Lending Channel, GMM

JEL classification: C23, E55, G21

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## I: Introduction

Understanding the effect of monetary policy on bank lending is important for the transmission mechanism of monetary policy. The transmission mechanisms of monetary policy actions to the real economy pass through the demand side and the supply side of the credit. The existing literature shows that the availability of bank credit plays a crucial role to boost up the economic growth especially in emerging markets.

Bernanke and Blinder (1988) and Bernanke and Gertler (1995) showed that the monetary policy can also influence the economy from the supply side by affecting the volume of money available for credit through open market operations. For example, the contraction of money supply through repo operations reduces the bank deposits and thus loanable funds. However, in less-developed financial sectors, changes in banks' loanable funds may not be transmitted into changes in market interest rates which are in most cases sticky downwards due to other market frictions (Sichei and Njenga, 2012).

The minor and infrequent fluctuations in deposit and lending rates originate from other factors external to the monetary policy decisions. This may not be surprising though; in low income countries with less developed financial markets the basic interest rate channel does not generally work or is weak (Mishra and Montiel, 2012). On the contrary, one would argue that the financial landscape, characterized by imperfections, of low income countries mostly favors the bank lending channel which requires the presence of credit market imperfections of some extent to properly function well (Oliner and Rudebusch, 1995). This paper seeks to examine the presence of the bank-lending channel of monetary transmission in Rwanda.

The remainder of the paper is structured as follows: Section 2 presents the theoretical and empirical literature review on bank lending channel of monetary policy, while Section 3 describes the financial system and monetary policy framework in Rwanda. The econometric modeling, data description and empirical findings of the study are given in Section 4. Section 5 draws the conclusion and policy implications.

## II. Literature review

### 2.1 Theoretical literature review

Monetary transmission mechanism refers to the way monetary changes affects the economy while monetary policy is policy that government implements to control money supply. In essence, the bank lending channel posits that if monetary policy squeezes the banks' reserves drop and banks are left with fewer funds to lend (Bernanke and Blinder, 1988). However, if in any economy, banks are able to raise costless additional liabilities such as uninsured deposits, the loanable funds will remain unaffected. Yet, since there are market frictions and there is generally a cost attached to raising liabilities, monetary policy tightening is assumed to result in a net reduction in loanable funds (Stein, 1998).

The premise for the traditional bank lending channel to work (Bernanke and Gertler, 1995) is that on one hand, banks cannot easily replace deposits and monetary policy actions, through open markets operations, are able to affect the deposits available for lending and the cost of lending (Mishra and

Montiel, 2012). On the other hand, borrowers cannot easily find alternative sources of financing; imperfect substitutability. In other words, deposits and loans have to be important elements in the balance sheet of both banks and borrowers; a situation that arise from financial market imperfections (Oliner and Rudebusch, 1995). Once this condition is met, the effectiveness of the bank-lending channel will depend on the level of intermediation and the development of the banking system; that is how imperfect is the credit market in the economy. Indeed, the market structure and characteristics such as banking concentration and competition and system liquidity impact on how banks can shield their lending and pricing from policy shocks. When banks are concentrated and the financial sector is small; that is few banks control a considerable percentage of total bank assets and have substantial interest margins, they are less likely to react to a contraction in monetary policy. On contrary, more competition leaves banks with less power to control rates movements especially downwards as they have to attract customers and thus become more sensitive to monetary policy actions which affect rates. Banks that operate in an underdeveloped interbank market and payment system, tend to keep liquidity in form of excess reserves leaving less scope for the monetary authority to create shortage in loanable funds.

The strength of the banking-lending channel is also influenced by Bank specific characteristics. Gambacorta (2011) found evidence that in the United States, banks with low capital levels and liquidity constraints reduce lending after a monetary policy tightening. Theoretically, banks differently react to shocks depending on how they are positioned in the business. Well-capitalized banks possess other options to attract funds to keep giving out loans even when deposits shrink (Apergis and Alevizopoulou, 2011). In the same vain, the more liquid a bank is the more latitude it has to defer its reaction to contractionary monetary policy.

The existing literature shows that the availability of bank credit plays a crucial role to boost up the economic growth especially in emerging markets. The credit channel of monetary policy transmission is an indirect amplification mechanism that works together with the interest rate channel. Factors that reduce the availability of credit reduce agents' spending and investment, which leads to a reduction in output. Chodechai (2004) further stressed that "banks' lending decisions are also influenced by the past relationship with the borrowers". Past relationship according to him can help banks to obtain more private information, leading to a more accurate understanding of the borrower's business and financial situation. Carletti et al (2003) however, discussing on multiple lending had the opinion that banks choose to share lending whenever the benefit of greater diversification, in terms of higher cost per project monitoring dominates the cost of free-riding and duplication of efforts.

According to Cottalerri and Kourelis (1994) financial markets in low-income countries tend to be less flexible to lending rates, thereby, limiting the effectiveness of monetary policy transmission mechanism. The bank lending channel predicts that banks reduce their aggregate supply of loans when monetary policy is tight. The process begins with a monetary contraction, which drains reserves from the banking system, and this leaves banks with fewer funds to lend (Bernanke and Blinder (1988)). It is possible that banks can react to this by increasing non-reservable liabilities such as uninsured deposits, thus leaving lending unaffected. However, since raising non-reservable liabilities is costly, tightening monetary policy is expected to still result in a net reduction in loanable funds (Stein (2000).

Any empirical study of the credit channel of monetary policy faces a key challenge and the literature has not succeeded so far in defining a clean identification strategy to address it. Changes in the demand for credit and in credit supply conditions are in general unobserved variables. A restrictive monetary policy shock may reduce at the same time credit demand and supply. When the policy interest rate increases, the cost of the loan (lending rate) raises, possibly dampening loan demand. At the same time, also the external finance premium faced by non-financial borrowers and banks increase, therefore affecting credit. Observable credit macro-aggregates (quantities and prices) do not convey enough information to isolate changes in credit supply. In fact, following a monetary tightening, both the classical interest rate channel (through loan demand) and the credit channel would predict a decline in the volume of new loans granted.

Concerning the price of loans, average loan spreads may not even significantly increase in the outcome of a monetary tightening because of flight to quality of banks to the best borrowers (Bernanke, Gertler and Gilchrist, 1996). Hence, the composition of bank loans' portfolio changes as well, thus implying that average loan spreads and volumes are insufficient measures to identify the credit channel.

The literature has tried to solve this identification problem with the help of micro data, such as firm and bank level data (see Bernanke and Gertler, 1995). However, as pointed out by Kashyap and Stein (2000), the micro identification cannot analyze the total effect of a monetary policy shock on aggregate credit and output, but only a difference-in-difference effect by comparing banks (see e.g. Kashyap and Stein, 2000).

### 2.2 Empirics on Bank Lending Channel and Identification Problem

A number of papers have used cross-sectional variation in bank characteristics to identify changes in loan supply and have found evidence for the bank lending channel. Kashyap and Stein (1995, 2000) for instance, use bank size and liquidity to differentiate banks. The argument is that the lending of small banks with illiquid balance sheets should be most sensitive to changes in monetary policy, because raising wholesale liabilities is more costly for them. The authors find that small banks with liquid balance sheets reduce their lending less in response to monetary contractions than other small banks. Other studies find similarly that the effects of monetary tightening are decreasing in the expected costs of raising non-reservable liabilities.

Kashyap and Stein (1995, 2000) in the United States made a research on the bank-level characteristics, such as capitalization, size and liquidity. They found that banks with fewer total assets tend to reduce loans relatively more under a tight monetary policy. It is relatively easier for large-scale banks to borrow in interbank markets or issue certificates of deposit. For this reason, even if a tight monetary policy is implemented, large-scale banks do not have to reduce loans.

Kishan and Opiela (2000) complement previous work and emphasize the role of bank capital in the bank lending channel. They argue that banks with fewer liabilities have much more capital and can cover the reduction in deposits. They conclude that banks with less capital tend to reduce loans following tight monetary policy.

Adel Boughrara and Samir Ghazouani (2009), investigated whether there are differential effects of monetary policy across bank size, liquidity and capitalization in some selected MENA countries namely Egypt, Jordan, Morocco and Tunisia, to test for the presence of the bank-lending channel. They used a panel of bank balance sheet data to estimate the response of bank lending to changes in monetary policy. Findings turn out to be heterogeneous among MENA countries. For Jordan the results seem to be consistent with the fact that lending by banks with a relatively weak capital base reacts more to a change in the monetary policy stance than lending by better capitalized banks. Likewise, size plays a significant role in shaping the response of Jordanian banks to monetary policy changes. Size turned out to be an important bank characteristic that affects the way Tunisian banks react to monetary policy changes. For Morocco, only liquidity appears to play a role in this context. Well-capitalized banks seem to respond strongly to monetary policy when compared to less capitalized ones.

Gunji and Yuan (2010) used Chinese data to identify a bank lending channel, and find that profitable banks tend to be less sensitive to monetary policy, because when tight monetary policy leads to a fall in deposits, less profitable banks face a higher cost of capital. Sichei and Njenga (2012) empirically investigated bank lending channel (BLC) of monetary policy transmission in Kenya using annual bank-level panel data during the period 2001-2008. They found out that BLC exists in Kenya based on bank liquidity and capitalization when a modified IS/LM model with bank lending was used. They further argue that banks with less liquid balance sheets and low total capital to risk-weighted asset ratios are hit most by monetary policy.

Walker (2012) used annual bank-level data on bank lending and balance sheets for the period 1993-2008 to investigate the transmission of monetary policy, through the bank lending channel, in the five East African Community countries. He finds evidence that the lending behavior of less well-capitalized banks and smaller banks is more sensitive to monetary policy shocks than that of better-capitalized banks and larger banks. His results lend support to the hypothesis that there exists a bank lending channel of monetary policy transmission in the EAC countries taken as one whole. He also finds evidence that, in contrast to advanced economies, the liquid asset ratio plays little or no role in explaining the volume loans lent out by banks, or the extent to which they react to monetary policy shocks. In this study, Walker found that for Rwanda, there are for some specifications too few observations to perform the regression; and where there are enough observations, coefficients are found to be insignificant, or significant with counter-intuitive signs.

Opolot (2013) examined the relevance of the bank-lending channel of the monetary policy transmission mechanism in Uganda using micro-level data. In addition, the impact of individual bank characteristics of size, liquidity, and capitalization on the banks' loan supply function are also investigated. This is estimated in a dynamic panel data framework using a generalized method of moment (GMM) .The empirical results indicated the presence of the bank-lending channel of the monetary policy transmission mechanism in Uganda. In addition, individual bank-characteristics of liquidity and capitalization also play a significant role in influencing the supply of bank loans.

## III. Financial system and Monetary Policy framework in Rwanda

### 3.1 Rwanda financial sector structure

During 1964-1990, the National Bank of Rwanda applied direct monetary instruments as it actively regulated the demand and supply of money. The central bank used a number of measures to limit the flow of credit to private sector. These included the use of credit ceilings, maintaining the authority of loan approval, imposition of conservative collateral arrangements onto borrowers and emphasizing lending according to purpose. The Central Bank regulated both deposit and lending rates.

The National Bank of Rwanda embarked on financial liberalization in 1990 but managed to attain a fully-fledged liberalized financial system in 1995. This financial liberalization involved removal of: interest rate controls, requirements for banks to lend to specific sectors as well as credit ceilings. Other important reforms included the strengthening of bank supervision by putting in place appropriate rules and regulations and building the capacity of the concerned employees.

Following the financial liberalization, the financial sector has considerably expanded as the number of banking and non-banking financial institutions has increased. The economy started attracting foreign banks' participation (especially due to the 2007/08 restructuring and merger acquisition). Ipso facto, the degree of competition has increased thereby improving banks' efficiency

The Rwandan financial sector consists of banks, microfinance institutions, insurance companies, pensions, the payment system which are all regulated and supervised by National Bank of Rwanda (BNR). It also includes the capital market which is regulated by the Capital Market Authority (CMA). The banking sub sector remains the largest component of Rwanda's financial sector with a share of 66.9 % of the total assets in the financial sector. and comprised of twelve commercial banks, four microfinance banks, one development bank and one cooperative bank. This composition is given in Table 1.

**Table 1. Structure of Rwandan Financial sector**

| | **Dec-10** | | **Dec-15** | | **Dec-16** | | **Jun-17** | |
|---|---|---|---|---|---|---|---|---|
| | Number | Share in TA[1] | Number | Share in TA | Number | Share in TA | Number | Share in TA |
| Banking sector | 14 | 71.3 | 17 | 66.7 | 16 | 66.9 | 17 | 66.9 |
| Insurance | 8 | 10.2 | 14 | 9.7 | 15 | 9.7 | 16 | 9.7 |
| Pension | 1 | 14.9 | 1 | 17.2 | 1 | 17.1 | 1 | 17.1 |
| MFIs | 11 | 3.7 | 494 | 6.4 | 472 | 6.3 | 473 | 6.3 |
| Total | 34 | 100 | 526 | 100 | 504 | 100 | 507 | 100 |

Source: *MPFSS, 2017*

The Rwandan banking sector remains concentrated with only three big banks representing 52% of total assets. The structure of the Rwandan financial sector plays a key role in the monetary transmission mechanism. The interest channel is not active in Rwanda due to the banking

[1] TA stands for total assets

concentration in loans, deposits and assets. The market power of few banks and less developed capital and money markets are also a hindrance to the private sector to mobilize resources as an alternative to banks loans. BNR monetary policy has been working through its impact on the volume of loans to the private sector (or amount of M3) than through the cost of loans (Kigabo, 2016).

### 3.2 Monetary Policy Framework in Rwanda

The National Bank of Rwanda (BNR) implements a monetary targeting framework, with base money as an operating target and broad money as the intermediate target while the ultimate objective is price stability. Under this framework, the overall objective is to keep money supply close to its estimated demand level because significant excess or shortfall may lead to important deviations in outcomes of inflation and economic growth compared to their targets. The framework is based on the assumption that the money multiplier and money demand are stable.


Different studies show that the money multiplier and money demand in Rwanda have increasingly become unstable in recent years especially due to financial sector developments, such as the modernization of payment systems (Kigabo, R., & Irankunda, J., 2012). This has weakened the link between monetary aggregates and the real economy and thus forcing the BNR to think about switching from the reserve money program to a more based price monetary policy, using interest rate as operating target, by 2018.

## IV. Econometric modeling, data description and empirical findings

### 4.1. The Econometric Model

At first, in order to have a better understanding about the basis of the empirical analysis, we focus on the simplified version of the model for the bank lending channel which is developed by the Ehrmann et. al. (2001) in the spirit of the Bernanke-Blinder (1988) framework. We restrict the model of the deposits market to an equilibrium relationship, assuming that deposits (D) equal money (M) and that both depend on the policy interest rate (i) as follows:

$$D = M = -\delta(i) + \tau \quad (1)$$

Where other factors that affect the deposit demand, except the policy interest rate are denoted by $\tau$. The demand for loans ($L_i^d$) that a Bank i faces is assumed to depend on economic activity measured by RGDP (y), on the price level (p), and the interest rate on loans ($i_L$ ):

$$L_i^d = \emptyset_1 y + \emptyset_2 p - \emptyset_3 i_L \quad (2)$$

Loan demand is supposed to be positively related to economic activity, and negatively related to the loan nominal interest rate. The coefficient associated to inflation, namely $\emptyset_2$ , could be either positive or negative in close relation with the nature of the steady-state equilibrium in the economy.

The loan supply by bank i $(L_i^S)$ is a function of the available amount of money (or deposits) (D), the interest rate on loan ($i_L$), and the monetary policy rate directly. The direct impact of the policy interest rate arises in the presence of opportunity costs for the bank, when banks use the interbank market as a liquidity source, which pass on increases in deposit rates to lending rates. Thus, loan supply is modelled as:

$$L_i^S = \mu_i D_i + \emptyset_4 i_L - \emptyset_5 i \quad (3)$$

In addition, it is assumed that not all banks are equally dependent on deposits. In particular, the model considers that the impact of a change in deposits is smaller the lower the bank characteristics related to size, liquidity and capitalization ($X_i$ ); $X_i$ stands for either a single bank characteristic or a set of characteristics. This is defined as follows:

$$\mu_i = \mu_0 - \mu_1 X_i \quad (4)$$

The equilibrium condition in the lending market, together with equations (1) and (4) result in the following reduced form of the model:

$$L_i = \frac{1}{\emptyset_3+\emptyset_4}(\emptyset_1\emptyset_4 y + \emptyset_2\emptyset_4 p - (\emptyset_5 + \mu_0\,\delta)\emptyset_3 i + \mu_1\,\delta\emptyset_3 i X_i + \mu_0\emptyset_3\,\tau - \mu_1\emptyset_3\tau X_i) \quad (5)$$

Expression (5) can be expressed in a more compact form as follows:

$$L_i = ay + bp - c_0 i + c_1 i X_i - dX_i + const \quad (6)$$

The coefficient $c_1 = \frac{\mu_1\,\delta\emptyset_3}{\emptyset_3+\emptyset_4}$ relates the reaction of bank lending to monetary policy interacting with its characteristics (size, capitalization and liquidity). Under the assumptions of the above model, a significant coefficient for $c_1$ implies that the monetary policy affects the supply of loans. This requires, in particular, that the interest elasticity of loan demand which is faced by a bank is independent of its characteristic $X_i$ . In other words, the coefficient $\emptyset_3$ is the same for all banks.

The assumption of homogeneous reaction of the loan demand across banks is therefore crucial for the identification of the monetary policy effects on loan supply. It rules out the cases where, for example, small or large bank customers are more sensitive to interest rate changes. Such an assumption seems quite reasonable in view of the fact that bank loans are the main source of finance with few substitutes available, even for large firms. In addition, the empirical model allows for asymmetric responses of bank lending to changes in the economic activity (GDP) and in the inflation rate by the inclusion of these variables interacted with the bank characteristics (this is equivalent to allowing for different values of $\emptyset_1$ and $\emptyset_2$ among banks with different size, liquidity and capitalization).

Instead of modeling level of loans, we model growth rate of bank lending and hence, estimate the model in first differences. This is due to the fact that banks react to a change in the monetary policy by adjusting the new loans. While it is true that the level of loans approximates the stock of loans, the flow can be better approximated by the first difference (Ehrmann et al., 2001). The empirical model is therefore expressed by the following equation:

$$\begin{aligned}\Delta\log(L_{it}) = \quad & a_i + \sum_{j=1}^{l} b_j \,\Delta\log\left(L_{it-j}\right) + \sum_{j=0}^{l} c_j \,\Delta r_{t-j} + \sum_{j=0}^{l} \delta_j \,\Delta\log\left(GDP_{t-j}\right) + \\ & \sum_{j=0}^{l} e_j \,infl_{t-j} + fX_{it-1} + \sum_{j=0}^{l} g_{1j} X_{it-1} \,\Delta r_{t-j} + \sum_{j=0}^{l} g_{2j} X_{it-1} \,\Delta\log(GDP_{t-j}) + \\ & \sum_{j=0}^{l} g_{3j} X_{it-1} \,infl_{t-j} + \varepsilon_{it} \end{aligned} \tag{7}$$

with i = 1,..., N and t = 1,...,T and where N is the number of banks, l the number of lags. $L_{it}$ are the loans of bank i in quarter t to private non- banks. $\Delta r_t$ represents the first difference of a nominal short-term interest rate; $\Delta\log(GDP_t)$ denotes the growth rate of real GDP and $infl_t$ is the inflation rate. The Bank specific characteristics are given as $X_i$. The model further allows for fixed effects across banks, as indicated by the bank specific intercept $a_i$, which is included to control for other bank specific characteristics that differs across banks but remains constant over time.

In the above equation (7), the growth rate of bank lending, $\Delta\log(L_{it})$, is regressed on changes in the interest rates, $\Delta r_{t-j}$, controlled by monetary authority, and on its interactions with the bank specific characteristics. As an indicator variable of monetary policy shocks, interest rate changes are used to capture the effect of monetary policy on bank lending. The bank specific characteristics are included and also interacted with the monetary policy indicator in order to identify the differential lending responses of banks with different balance sheet strength. Real GDP growth, $\Delta\log(GDP_t)$, is added as a control variable to the model to account loan demand movements and effects of macroeconomic developments on bank lending. With better economic conditions, the number of projects becoming profitable in terms of expected net present value increases, which in turn causes a rise in demand for credit (Kashyap et al.,1993). The inclusion of this variable is important since it isolates the monetary policy component of interest rate changes and allows us to truly capture the cyclical macroeconomic movements (Gambacorta, 2005).

The distributional effects of monetary policy should be reflected in a significant interaction term of the bank specific characteristic with the monetary policy indicator. The usual assumptions in the literature are that a small, less liquid or less capitalized bank reacts more strongly to the monetary policy change than a bank with a high value of the respective bank characteristic. This would imply *positive coefficients on the interaction terms.*

### 4.2 Data description

Quarterly data from fourth quarter 2010 to the second quarter of 2017 were used. The database comes from the banks 'financial statements, National Bank of Rwanda (BNR) and National Institute of Statistics (NISR) website.

**Table 2. Description of data used**

| Series | Description & Transformations | Source |
|---|---|---|
| DlGloans | Change in Quarterly Gross loans in billions RWF | BNR |
| lRGDP | Quarterly Real Growth Domestic Product in billion RWF at constant 2014 prices transformed in logs | NISR |
| Interbank | Quarterly Interbank interest rate (average of three months) | BNR |
| tbills | 3 Months treasury bills rate | BNR, |
| CAR | The capital ratio, taken as the ratio of Core Capital over the Total risk weighted assets | BNR |
| LIQR | Liquidity ratio, taken as the ratio of liquid assets over Total Assets | BNR |
| SIZE | The size is taken as a share of one bank Total assets over all banks total assets. | BNR |
| DCPI | CPI inflation | BNR |
| DEP | Total deposits per bank in billion RWF | BNR |

**Table 3. Expected sign**

| Variable | Sign | Explanation |
|---|---|---|
| $\sum_{j=1}^{l} b_j \Delta \log(L_{it-j})$ | + | Persistence effect in authorized loans |
| $\sum_{j=0}^{l} c_j \Delta r_{t-j}$ | − | The rise in policy interest rate leads to a rise in opportunity costs of the banks when banks use interbank market as a liquidity source, which passes on increases in deposit rates to lending rates. |
| $\sum_{j=0}^{l} \delta_j \Delta \log(GDP_{t-j})$ | + | Better economic conditions, the number of projects becoming profitable in terms of expected net present value increases, which in turn causes a rise in demand for credit (Kashyap et al.,1993) |
| $\sum_{j=0}^{l} e_j \, infl_{t-j}$ | − | Inflation will increase interest rate, cost of borrowing and reduces the demand for loans |
| $fX_{it-1}$ | + | Small, less liquid or less capitalized bank reacts more strongly to the monetary policy change |
| $\sum_{j=0}^{l} g_{1j} X_{it-1} \Delta r_{t-j}$ | + | Small, less liquid or less capitalized bank reacts more strongly to the monetary policy change than a bank with a high value of the respective bank characteristic. Thus imply ***positive coefficients on the interaction terms***. |
| $\sum_{j=0}^{l} g_{2j} X_{it-1} \Delta \log(GDP_{t-j})$ | + | The economic growth lead to an increase in loan demand thus increase in loan supply |

### 4.3 Empirical findings

To test the bank lending channel of monetary policy transmission in Rwanda for the period 2010:Q4-2017:Q2, we estimated our equation by using the generalized methods of moments for dynamic panel data put forward by Arellano and Bond (1991). The key results of the study are reported in Table below, which presents the estimated long-run coefficients, their standard errors and the probability. The analysis is conducted for the whole period 2010:Q4-2017:Q2.

**Table 4. Results of the GMM estimation**

Dependent variable: DLGLOANS
Method: Panel Generalized Method of Moments
Sample: 2010q4 2017Q2
Total panel observations: 324

| Variable | Coefficient | S.E | Prob.Value |
|---|---|---|---|
| **Bank characteristics** | | | |
| CAR | -0.04 | 0.06 | 0.43 |
| LIQR | -0.09 | 0.04 | 0.02 |
| SIZE | 0.16 | 0.05 | 0.001 |
| **Macroeconomic Variables** | | | |
| DCPI(-1) | -0.001 | 0.002 | 0.30 |
| DRGDP(-1) | -3.52E-06 | 1.11E-06 | 0.002 |
| Dtbills | -0.009 | 0.02 | 0.63 |
| C | 0.08 | 0.13 | 0.51 |
| DW Stat | 2.35 | | |
| J-Stat | 6.90 | | |

The response of growth rate of bank loans to a monetary policy shock has the expected negative sign but not significant. The significant coefficient of real GDP indicates that the change in economic activity have an effect on bank lending. However its negative sign means that the increase in GDP allows people to have profits and make savings and therefore reduce their borrowing amount but again the coefficient is very small. The coefficient of inflation is not significant. Another finding is the relationship between bank characteristics and their lending behavior. The coefficient of the Capital ratio is not significant while the size and liquidity ratio are significant. The negative sign of liquidity ratio is explained by the increase in cost of deposits.

Another model estimated is fixed effect model and the results are summarized in the table below.

**Table 5. Results of the FEM estimation**

Dependent variable: DLGLOANS
Method: Fixed Effect
Sample: 2010q4 2017Q2
Total panel observations: 374

| Variable | Coefficient | S.E | Prob.Value |
|---|---|---|---|
| Dlgloans(-1) | 0.22** | 0.08 | 0.08 |
| Dtbill(-1) | 0.90 | 0.58 | 0.12 |
| Dlrgdp(-1) | -0.27 | 0.34 | 0.43 |
| Dlcpi(-1) | 0.25 | 0.85 | 0.86 |
| Capr(-1) | 0.17** | 0.01 | 0.02 |
| liqr | -0.04 | 0.00 | 0.80 |
| dsize | 0.38** | 0.15 | 0.01 |
| Capr(-1)* Dtbill | 0.004 | 0.00 | 0.31 |
| Liqr* Dtbill | 0.0001 | 0.00 | 0.93 |
| Size* Dtbill | -0.012 | 0.01 | 0.30 |
| Capr*dlrgdp | 0.22** | 0.12 | 0.07 |
| Liqr*dlrgdp | 0.025 | 0.24 | 0.30 |
| Size*dlrgdp | 0.56 | 1.04 | 0.59 |
| Capr*dlcpi | 0.03 | 0.24 | 0.88 |
| Liqr*dlcpi | 0.80 | 0.06 | 0.25 |
| Size*dlcpi | -0.56 | 1.03 | 0.58 |

Legend: * p<.1; **p<.05; ***p<.01

The first column presents the estimated coefficients. The response of the growth rate of loans to its lagged value is significant and positive. The significant and positive coefficient of capital ratio means that the capitalization is a factor that explains the difference of banks behavior in loans granting following their level of capital. The change in size is also positive and significant explaining the importance of size in loan granting. This positive sign means that big sized banks lend more following a tightening monetary policy. As regards with the distributive effects of monetary policy on bank lending, we find no significant interaction coefficient of the bank characteristics variables with the treasury bills rate change. The coefficient of interaction between capital ratio and real economic growth is significant and positive. This means that most capitalized banks react differently to the economic growth compare to less capitalized banks. The most capitalized banks lend more following increase in economic growth. We find the interaction coefficients of liquidity and size with treasury bills rate change non-significant.

To test whether the results may change using other monetary policy rate, the table below gives the results of the estimation using the interbank rate.

**Table 6. Results of the FEM estimation**

| Dependent variable: DLGLOANS<br>Method: Fixed Effect Model<br>Sample: 2010q4 2017Q2<br>Total panel observations: 374 | | | |
|---|---|---|---|
| Variable | Coefficient | S.E | Prob.Value |
| Dlgloans(-1) | 0.10 | 0.08 | 0.20 |
| interbank(-1) | -0.16* | 0.008 | 0.06 |
| Dlrgdp(-1) | -0.34 | 0.35 | 0.33 |
| Dlcpi(-1) | 1.60 | 1.36 | 0.24 |
| Capr(-1) | 0.01** | 0.007 | 0.02 |
| liqr | -0.001 | 0.002 | 0.57 |
| dsize | 0.42*** | 0.15 | 0.05 |
| Capr(-1)* Dinterbank | 0.004* | 0.003 | 0.00 |
| Liqr* Dinterbank | -0.001* | 0.0006 | 0.05 |
| Size* Dinterbank | -0.003 | 0.012 | 0.79 |
| Capr*dlrgdp | 0.22* | 0.12 | 0.07 |
| Liqr*dlrgdp | 0.28 | 0.02 | 0.24 |
| Size*dlrgdp | 0.57 | 1.00 | 0.57 |
| Capr*dlcpi | -0.23 | 0.24 | 0.33 |
| Liqr*dlcpi | 0.24 | 0.06 | 0.72 |
| Size*dlcpi | 0.81 | 0.97 | 0.40 |

Legend: * p<.1; **p<.05; ***p<.01

The results of the table 6 show non-significant persistence effect of loans granting. The coefficient of the interbank rate has a significant expected negative sign meaning that a contractionary monetary policy increasing the level of interest rate lead to a decline in loan granting. The significant and positive coefficient of capital ratio means that the capitalization is a factor that explains the difference of banks behavior in loans granting following their level of capital. The positive sign means that well capitalized banks lend more following an increase in interbank rate contrary to less capitalized banks with no other possibility to acquire money to lend and decrease their loan following an increase in interest rate. The change in size is also positive and significant explaining the importance of size in loan granting. This positive sign means that big sized banks lend more following a tightening monetary policy. As regards with the distributive effects of monetary policy on bank lending, we find significant interaction coefficient of capital ratio and liquidity ratio with the interbank rate change. The positive sign of capital ratio means that well capitalized banks lend more following an increase in interbank rate while negative sign of liquidity ratio means that more liquid banks do not necessary lend more following an increase in interbank rate. The coefficient of interaction between capital ratio and real economic growth is significant and positive. This means that most capitalized banks react differently to the economic

growth compare to less capitalized banks. The most capitalized banks lend more following increase in economic growth.

We want again to test whether the results may change using other monetary policy rate, the table below gives the results of the estimation using the repo rate.

**Table 7. Results of the FEM estimation**

Dependent variable:DLGLOANS
Method: Fixed Effect Model
Sample: 2010q4 2017Q2
Total panel observations: 374

| Variable | Coefficient | S.E | Prob.Value |
|---|---|---|---|
| Dlgloans(-1) | 0.15* | 0.08 | 0.06 |
| repo(-1) | -0.02* | 0.008 | 0.08 |
| Dlrgdp(-1) | -0.37 | 0.34 | 0.29 |
| Dlcpi(-1) | 1.03 | 1.38 | 0.46 |
| Capr(-1) | 0.02** | 0.007 | 0.01 |
| liqr | -0.001 | 0.002 | 0.74 |
| dsize | 0.36** | 0.14 | 0.01 |
| Capr(-1)* Drepo | 0.007* | 0.004 | 0.06 |
| Liqr* Drepo | -0.002* | 0.001 | 0.09 |
| Size* Drepo | -0.03 | 0.02 | 0.17 |
| Capr*dlrgdp | 0.23* | 0.12 | 0.07 |
| Liqr*dlrgdp | 0.03 | 0.02 | 0.27 |
| Size*dlrgdp | -0.11 | 1.06 | 0.92 |
| Capr*dlcpi | 0.07 | 0.29 | 0.80 |
| Liqr*dlcpi | 0.03 | 0.07 | 0.67 |
| Size*dlcpi | -0.23 | 1.03 | 0.82 |

Legend: * p<.1; **p<.05; ***p<.01

The results of the table 7 show persistence effect of loans granting. The coefficient of the repo rate has a significant expected negative sign meaning that a contractionary monetary policy increasing the level of interest late lead to a decline in loan granting. The significant and positive coefficient of capital ratio means that the capitalization is a factor that explains the difference of banks behavior in loans granting following their level of capital. The positive sign means that well capitalized banks lend more following an increase in interbank rate contrary to less capitalized banks with no other possibility to acquire money to lend and decrease their loan following an increase in interest rate. The change in size is also positive and significant explaining the importance of size in loan granting. This positive sign means that big sized banks lend more following a tightening monetary policy. As regards with the distributive effects of monetary policy on bank lending, we find significant interaction coefficient of capital ratio and liquidity ratio with the repo rate change. The positive sign of capital ratio means that well capitalized banks lend more following an increase in repo rate while negative sign of liquidity ratio

means that most liquid banks do not lend more following an increase in repo rate. The coefficient of interaction between capital ratio and real economic growth is significant and positive. This means that most capitalized banks react differently to the economic growth compare to less capitalized banks. The most capitalized banks lend more following increase in economic growth.

## V. Conclusion and policy implications

The objective of this study was to trace out the effects of monetary policy on the lending behavior of individual banks. We estimated a model for the bank lending channel including banks characteristics variables using quarterly data from 2010Q4 to 2017Q2.

The results of the panel estimation using fixed effect model and GMM showed that the lending channel exists in Rwanda and that there are differences across banks depending on their level of capital, liquidity and size. The negative impact of banks concentration on monetary transmission mechanism in general and on lending channel in particular emphasizes the need for further development of our financial sector through increasing the competition in the banking sector by reducing concentration and diversifying financial products.

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