Modelling interest rate pass-through in Rwanda: is the interest rate dynamics symmetric or asymmetric ?

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Abstract

The main objective of this paper is to investigate the relationship between the policy-controlled interest rates (Repo and Treasury bill rates) and the bank interest rates (interbank, deposit and lending rates) in Rwanda with the view to empirically examine the size and speed of the interest rate pass-through in the long run and short run and determine whether the pass-through process is symmetric or asymmetric. The empirical results of the paper indicate that the lending rates are cointegrated with none of the selected policy rates; hence the interest rate pass-through has been estimated by means of a transformed ADL model. By contrast, a cointegration relationship has been established between the interbank, deposit and policy rates, hence a non-linear error correction model has been used to detect adjustment process to long-run equilibrium. The estimated long-run as well as the short run interest rate pass-through of the selected policy rates to deposit and lending rates is weak and sluggish. Regarding the adjustment process of the bank rates, empirical results provided evidence that depending on the policy rate, the interbank, deposit and lending rates react differently following a negative and a positive shock in the policy rates. These results have been obtained using cointegration and asymmetric error-correction models.

Keywords: Interest rate pass-through, monetary transmission mechanism, asymmetric adjustment.

JEL: E430, E520

I. Introduction

The interest rate pass-through (IRPT) has received a great deal of attention in theoretical and empirical research on monetary policy making. However, while the bulk of the literature on the issue was devoted to industrial countries, it is only recently that a few studies focused on emerging and developing countries. The interest rate pass-through, defined as the extent to which changes on the policy rate are transmitted to bank retail interest rates, i.e. the deposit and lending rates, is a key element in the monetary transmission mechanism. Central banks use the policy rate to influence the short-term money market rates which in turn affect bank retail rates; in the end, banks' decisions on the yield of their assets and liabilities affect the behavior of deposit holders and borrowers on savings, investment and consumption. A fuller and faster interest rate pass-through enhances the effectiveness of monetary policy and improves the capacity of the central bank to achieve its macroeconomic goals of stabilizing aggregate output and prices. Therefore, the determination of the size and speed of the interest pass-through is crucial for the central bank to correctly calibrate its monetary policy stance.

Various studies have investigated the interest transmission dynamics in different countries. The overall findings of these studies indicate that : the pass-through process is incomplete and sluggish, implying that changes in the policy rate are not passed on one to one to bank retail rates and that the transmission takes time ; the size and speed of interest rate pass-through varies across countries and over time ; moreover , the interest pass-through varies depending on the bank rates considered and the bank products (Cottarelli ,Ferri and Generale ,1995; Mojon ,2000; De Bondt, 2002 ; Sander and Kleimeier , 2004). In addition, it was observed that the adjustment of the bank retail interest rates may be asymmetric, meaning that the reaction of the bank rates to policy rate shocks is different depending on whether the innovation in the policy rate is positive or negative (De Bondt , 2002 ; Sander and Kleimeier ,2006 ; Karagianis ,Panagopoulos and Vlamis , 2010).

A good understanding of the responsiveness of the bank retail and interbank rates to changes in the policy rates is particularly important in Rwanda, given that banks are the predominant financial institutions in collecting savings and providing loans to firms and households and are consequently the main conduit of monetary policy impulses to the real economy. This paper follows the above line of research and examines in the case of Rwanda how effectively the innovations in the policy rates are transmitted to bank retail and interbank rates and whether the interest rate pass-through is symmetric or asymmetric , using the most recently available data and appropriate methodology.

Research problem and motivation

Most empirical studies on the interest pass-through have been concentrated on developed countries and some emerging countries of Latin America, Europe and Asia, while the literature on the issue for Sub-Saharan African countries remains scanty. Regarding Rwanda, the issue did not attract much attention until recently as the monetary authorities envisaged to adopt the inflation targeting regime in a near future for the conduct of monetary policy.

In Rwanda, as in many other African countries, the monetary policy framework and the financial environment have undergone significant reforms in the last two decades resulting in the

abolishment of direct credit controls, the liberalization of bank interest rates and the removal of barriers to entry in the banking profession, while the Central Bank adopted the indirect and market based instruments for conducting monetary policy. However, despite the changing financial environment which was expected to have a significant impact on the interest pass-through and by implication on the effectiveness of monetary policy, no systematic investigation was carried out to assess the effects of the reforms on the interest rate pass-through. This study intends to fill the gap.

While some studies examined the monetary transmission mechanism in Rwanda (Davoodi, Dixit and Pinter, 2013; Kigabo, Munyankindi and Amahoro, 2008), only one recent study by Kigabo, Mwenese and Bagabe (2016) focused on the interest pass-through in Rwanda using the single equation and the autoregressive distributed lag model (ADL) with monthly interest rate series covering the period 2008-2015. The overall finding of this study is that the long-run and short run effect of changes in the Treasury bill rate on lending and deposit rates of different maturities is incomplete.

Compared to the paper by Kigabo, Mwenese and Bagabe (2016), the contribution of the present study is threefold. Firstly, this study not only examines the interest rate pass-through in Rwanda, but it is the first attempt to investigate the possibility of asymmetries in the dynamic adjustment of the bank retail rates in response to changes in the policy rates using cointegration and asymmetric error-correction model approach (Scholnick, 1996; Sander and Kleimeier; 2002) Secondly, in addition to the Treasury bill rate used as policy rate in the aforementioned paper, the present study examines the pass-through from the repo rate, which will provide empirical evidence of the relative effectiveness of each instrument in the transmission of policy rate changes to bank retail rates. Thirdly, the pass-through from policy rate to interbank rate has been investigated since it is the first step of the entire pass-through process.

Objective of the study

The primary objective of this research is to analyze the interest pass-through mechanism in Rwanda; more specifically, this study aims to:

-determine the size and speed of the pass-through between the policy and bank rates

in the long run and short run ;

-examine whether the short-run interest rate adjustment dynamics is symmetric or asymmetric;

The rest of the paper is organized as follows: section 2 provides a brief overview of the theoretical and empirical literature on the interest pass-through; section 3 highlights the main features of financial development and monetary policy framework in Rwanda; section 4 presents the data used and the modelling methodology; section 5 provides and discusses the empirical results of the research; section 6 concludes and summarizes the policy implications of the study.

II. Literature review

What are the factors explaining the bank retail rates stickiness when they adjust to changes in the policy rates? Answering this question posed major challenges to policy makers and economists with regard to the effectiveness of monetary policy. It also gave rise to many studies seeking to provide convincing explanation for stickiness in bank retail rates adjustment.

2.1. Theoretical review

Theoretically the factors that may affect the bank interest rates responsiveness to changes in the policy rate are various; they include but are not limited to the following: structure and ownership of the financial system, collusive behavior of banks, menu and switching costs, asymmetric information and macroeconomic conditions.

The structure of the financial system is a major determinant of the interest rate pass-through and refers to the number of market players, the degree of competition and bank concentration, the ownership structure, the level of development and openness of financial markets (Cottarelli and Kourelis, 1994). Cottarelli and Kourelis argued that the demand elasticity for loans is weaker in markets where there are a small number of competitors, high barriers to entry or no alternative sources of financing; consequently, in such markets, loan rates tend to react sluggishly to dynamics in the money market and policy rates in the short run. In contrast, a well-developed financial market with domestic bond and money markets, corporate debt securities and capital venture together with openness to international capital markets, result in a faster pass-through (Aziakpono and Wilson, 2010).

On the other hand, concentration introduces rigidity in the interest pass-through, as banks tend to adopt an oligopolistic behavior, causing the interest rates to adjust asymmetrically. Two competing theories have been proposed by Hannan and Berger (1991), Neumark and Sharpe (1992) to explain asymmetries in the adjustment of the bank retail rates: the collusive pricing behavior of banks and the adverse customer reaction hypothesis.

The collusive pricing behavior of banks argues that deposit rates will be rigid upwards following an increase in the policy rate because an increase in the deposit rate constitutes an additional cost for banks in the form of a higher payment to depositors, while the lending rates will exhibit greater rigidity downwards in reaction to a reduction in the policy rate because a reduction in the lending rate negatively affects the profit margin of banks. Conversely, the adverse customer reaction behavior suggests that deposit rates will be sticky downwards in the event of a decrease in the policy rate, whereas the lending rate will show greater rigidity upwards when the policy rate increases.

The ownership structure of the financial system also plays a central role when it comes to the transmission of monetary policy (Espinosa-Vega and Rebucci, 2003; Amarasekara, 2005). In economies where state-owned financial institutions (banks and non-banks) are predominant in the financial markets, those institutions are instrumental in achieving policy objectives of governments and maximizing profit is not their primary constraint. In such an environment, interest rates are

likely to adjust with delay due to inefficiencies and political considerations, hence causing stickiness in interest rate adjustment.

According to Rotemberg and Saloner (1987), price rigidity in response to changes in the underlying market conditions may be explained by “menu costs” which include the costs of changing and circulating the new price lists, printing, advertising, communicating changes to customers. The menu costs theory predicts that firms will adjust their prices only when the benefits from adjusting are greater than the cost of being out of equilibrium. Moreover, firms need to maintain a long term relationship with their customers and therefore do not want to continually alter their prices because this might have a negative impact on customer’s satisfaction. In line with this theoretical view, banks may delay before responding to changes in the policy rate (Cottarrelli and Kourelis, 1994).

When a customer decides to move from a bank or a financial product to another in order to obtain more favorable conditions, he is exposed to the so called “switching costs”, referring mainly to search and transaction costs, which include the information cost to discover a bank with more favorable rates, the cost of learning different rates and conditions on the new loans or deposits. Given these considerations, the higher the switching costs, the more difficult it will be for the customer to move from a bank to another; as a result of the customer’s behavior, the bank retail interest rate will become sticky (Lowe and Rohling, 1992).

In their insightful study, Stiglitz and Weiss (1981) relate bank retail rates stickiness to asymmetric information in loan market. If banks increase their lending rates, they may attract riskier borrowers (adverse selection) while the increase of lending rates will give poor quality borrowers incentives to choose riskier projects (moral hazard). Consequently, banks will prefer to set lending rates below the market clearing rates and ration the amount of credit supply even if the funding costs increase. Thus, the authors have shown that in markets with imperfect information, the equilibrium in the loan market is characterized by credit rationing and the prevailing lending rates will not necessarily be altered following changes in other interest rates, including the policy rate; in such an environment, the lending rates will exhibit rigidity to upward stimulus.

Macroeconomic conditions have also an important impact on the size of the pass-through and adjustment speed of the bank interest rates. Banks find it easier to quicker pass on changes in the policy rate to their lending and deposit rates during favorable economic conditions characterized by rapid economic growth and stability (Egert and MacDonald, 2009). On the contrary, a higher degree of volatility in the policy and money market rates (mirroring high macroeconomic instability and uncertainty), reduces the information content of the policy signals and hence, makes it harder for banks to disentangle noise from policy signals; this weakens the interest rate pass-through, given that banks will wait longer before changing their rates (Egert,Crespo-Cuaresma and Reininger, 2007).

2.2. Empirical review

Empirical works on the interest rate pass-through are relatively new in economic literature as early studies emerged only in the 1990s. In a logit modelling framework Hannan and Berger (1991) investigated the adjustment of prices in the US banking market over the period 1983-1986,

focusing on deposit rates and the issue of asymmetry. Their findings show that price rigidity is significantly greater in market characterized by high level of concentration and deposit rates are significantly more rigid when the stimulus for a change is upward rather than downward.

Cottarelli and Kourelis (1994) used an autoregressive distributed lag model and aggregate time series to analyze the degree of lending rate stickiness in response to changes in money market rates in 31 selected industrial and developing countries. Their empirical results revealed a sluggish and incomplete adjustment in the lending rates following a shock in the money market rates and showed that the pass-through is higher in the long-term than in the short-term. They further explained that structural features of the financial system, such as capital controls, poor bank competition, barriers to entry, degree of development and openness of financial markets are the factors that weaken the interest rate pass-through.

More recent works investigated the bank interest rates stickiness and explored the possibility of asymmetric adjustment in developed countries. De Bondt (2005) used a vector error-correction model to measure the pass-through from the overnight rate to deposit and lending rates in the Euro area in the period 1996-2001. He observed that the short run pass-through for both deposit and lending rates is incomplete, while in the long run, the pass-through to lending rates is complete, but is incomplete for deposit rates. Andries (2012) assessed the interest rate pass-through dynamics in the European countries over the period 1993-2002 using the bounds testing approach for co-integration. His econometric results revealed that the bank retail rates adjustment following monetary impulses is sluggish, implying that banks dampen monetary policy shocks; there is a limited short run pass-through for different bank products and important discrepancies across countries have been identified; the long run pass-through is higher for interest rates on loans of shorter maturity and greater for interest rates on loans compared to interest rates on deposits; there is a marked heterogeneity in the speed of adjustment across European countries .

Karagiannis, Panagopoulos and Vlamis (2010) used a disaggregated general to specific (GETS) model to analyze the short-run and long-run interest rate pass-through in the Euro area and the US. Their findings indicate mixed results for the size and adjustment speed of the interest pass-through. For the Euro area, evidence suggests that changes in the money market rate are more influential than changes in Central Bank rate. There is a complete pass-through from money market to deposit rates and incomplete pass-through from money market rate to lending rates. For the US, the empirical results suggest that there is a complete and significant pass-through from the Central bank rate to both lending and deposit rates. Moreover, the size of the adjustment parameter for upward adjustment is quite higher. It appears that there exists no pass-through from money market rate to either bank retail rates in the US, implying that the Central bank rate is more effective. For the Euro area, there is a negative asymmetry for deposit rates, meaning that banks transmit only negative changes to depositors; in contrast, a positive asymmetry was found for loan rates, suggesting that banks tend to pass more of the increases in money market to lenders than the decreases.

A growing number of studies on the interest rates stickiness in emerging and developing countries have yielded mixed results. The burst of interest for these studies resulted from the move to inflation targeting regimes in many emerging and developing in the mid-2000s and the adoption of

market-oriented instruments in the conduct of monetary policy which enhanced the role of the interest rate (Mohanty and Turner, 2008). These studies intended to understand and explain the persistence of interest rate rigidity and higher interest spread, even though financial reforms and liberalization were implemented in most emerging and developing countries.

An early study to be mentioned is that of Scholnick (1996) who found evidence of asymmetries in the interest rate adjustment for Malaysia and Singapore. Employing co-integration and non-linear error-correction model, his results showed that deposit rates in both countries are more rigid when adjusting upwards than downwards.

Egert, Crespo-Cuaresma and Reininger (2007) compared the interest rate pass-through in five Central and Eastern European countries (Czech Republic, Hungary, Poland, Slovakia and Slovenia-CEE-5), and three Euro area countries (Austria, Germany and Spain) selected as benchmarks. Using a multivariate vector auto-regression, this paper investigated the relationship between the policy rate and the bank retail rates on the one hand, the market and retail rates on the other hand. The study showed that the pass-through estimates vary from a country to another depending on the bank product; the pass-through is generally slow for overnight deposits, but becomes significantly higher from short to long term deposit rates; corporate lending rates are much more responsive to changes in the policy rate than deposit or household loan rates. In most cases, it was impossible to detect any co-integration relationship between the variables used.

Tai, Sek and Har (2012) assessed the pass-through from monetary policy rate to deposit and lending rates in Asian countries by running Seemingly Unrelated Regression (SUR) with data covering the period 1988-2010.The results of the paper revealed that: the pass-through from the policy rate to deposit and lending rates in short and long run is generally small and slow except for Malaysia, Hong Kong and Singapore where it is considerably higher and varies over time. In addition, it was also found that even though Korea, Philippines and Thailand adopted the inflation targeting regime and used the short term interest rate as the main monetary policy instrument, the interest rate adjustment remained sticky. Tai, Sek and Har argue that the faster transmission of the monetary policy stance in Malaysia, Hong Kong and Singapore may be explained by the improvement in efficiency of the banking system, the availability of alternative sources of financing and the increase of financial openness.

Cas , Menendez and Frantischek (2011) examined the strength of the pass-through in five Central American countries, the CADR-5 (Costa Rica, Dominican Republic, Guatemala, Honduras and Nicaragua) and six Latin American countries, the LA-6 (Brazil ,Chile ,Colombia, Mexico , Peru and Uruguay) taken as benchmarks , given their relatively more developed monetary policy frameworks. Panel estimation method with data covering the period 2004-2010 was employed to measure the pass-through from policy rate to lending rates. The main finding of the study was that the pass-through from policy rate to lending rates is generally weaker and slower in the CADR-5 countries than in the LA-6 countries. Factors influencing the interest rate adjustment include exchange rate flexibility, financial system development, independence and transparency of central banks, dollarization and bank concentration.

Studies that explored interest rate pass-through in Sub-Saharan African countries are scanty. Jankee's (2005) work on interest rate pass-through in Mauritius is the earliest attempt. He used the

Johansen co-integration approach, TAR and M-TAR models to examine how changes in the interbank rate were transmitted to lending and deposit rates during the period 1988-2003.This work concluded that the long run pass-through was incomplete in Mauritius for deposit as well as for lending rates. Asymmetry was found only for lending rates, which exhibited faster adjustment to negative than to positive shocks in the interbank rate. Acheampong (2005) found incomplete long-run pass-through of changes in money market rate to lending and deposit rates in Ghana using co-integration and error correction model with data covering the period 1994-2004. In addition, his findings supported evidence of symmetry in the adjustment of lending and deposit rates to changes in the money market rate. Acheampong argued that low competition, dependence on bank loans, interest inelasticity, contract maturity and menu costs could account for the high degree of interest stickiness.

Sanusi (2010) employed impulse reaction functions from a structural vector autoregressive (SVAR) to derive the dynamic elasticities of the pass-through of monetary policy and interbank interest rates to lending and deposit rates in Nigeria for the period 2002-2010. His empirical results may be summarized as follows: the pass-through is incomplete and slow for both deposit and lending rates; the pass-through of the policy rate to interbank rate is substantially higher and faster than to deposit and lending rates. The pass-through to money market rates increased significantly after the consolidation of the banking sector, while the pass-through to bank retail rates decreased relatively to the pre-consolidation period. Sanusi argued that these results are an indication that the consolidation of the banking sector and the reforms in the financial system succeeded in improving the efficiency in the money market but failed to remove the distortions in the retail loan and deposit rates market.

Samba and Yan (2010) examined the monetary policy transmission mechanism in the countries of the Central African Economic and Monetary Community (CAEMC) focusing on the pass-through from the policy rate to long term interest rates. They used data spanning the period 1990-2007 in an autoregressive distribution lag (ADL) framework. Several finding emerge from this study: the short run pass-through is higher in the lending rates than in the deposit rates. The long-run pass-through from the policy rate to deposit rates is incomplete, while the pass-through to lending rates exhibits an overshooting effect in response to change in the policy rate. The study supports the evidence of asymmetric adjustment for both deposit and lending rates. For lending rates, the adjustment coefficient is lower in the cycle of increasing policy rate, while there is an overshooting reaction in the decreasing cycle. Regarding the deposit rates, the adjustment speed is higher in the cycle of increasing policy rate than in the decreasing cycle. Samba and Yan argue that the absence of competition in the banking sector, combined with excess liquidity in CAEMC countries may help to explain the upward rigidity of deposit rates. At the same time, the overshooting reaction of lending rates may reflect the creditors' overreaction facing higher rates, in order to hedge their risks against uncertainty and under developed financial markets.

In their paper, Sande and Okello (2013) investigate the pass-through dynamics in Uganda, employing bivariate co-integration method and the associated error correction model with data covering the period 2005-2012.They relate the interbank rate to policy rate (repo rate) on the one hand , and the deposit and lending rates to policy rate , on the other hand. In summary, their findings are the following. The long run pass-through coefficient from the policy rate to interbank

rate is greater than one, implying an overshooting pass-through, while it is incomplete for time deposit and lending rates. Likewise, the size of the pass-through of policy rate to saving and demand deposit is incomplete. Regarding the short-run adjustment process towards equilibrium, the estimates of the error-correction models for the interbank and bank retail rates point to a sluggish adjustment. From these results, Sande and Okello conclude that the monetary policy transmission mechanism is effective only for the wholesale interest rates, while it is ineffective for retail rates, meaning that the change in the policy rate is not fully transmitted to the retail rates; the low speed of adjustment to equilibrium is also an indication of the ineffectiveness of monetary policy to influence the banks' pricing decisions.

III. Financial development and monetary policy in Rwanda

3.1. Structure and development of the financial system

The analysis of the interest rate pass-through in Rwanda requires a good understanding of how the banking sector structure and the financial market developments may influence the behavior of bank interest rates. The banking market structure refers to the number and size of banks, while financial development focuses on the existence of diversified debt instruments in the financial market providing alternative financing and saving opportunities. Existing literature documented that high concentration in the banking sector could reduce the degree of competition among commercial banks and have a negative impact on the interest rate pass-through (Di, 2014); in contrast, the development of the financial system strengthens the interest rate transmission mechanism as more alternative sources of capital increase the elasticity of demand for bank loans (Cottarelli, Ferri and Generale, 1995).

The financial sector in Rwanda has undergone important economic reforms during the two last decades. The reforms whose ultimate objective was to set up a sound and competitive financial system included: deregulation of interest rates, removal of credit controls, removing bank entry barriers, bank privatization and recapitalization, entrenchment of indirect monetary control instruments, development of money and capital markets, strengthening bank supervision and regulation and liberalization of foreign exchange markets. These reforms were part of a global liberalization process whereby the management of the economy shifted from a state-controlled to a market oriented economy relying on private sector .These changes which occurred during the 1990s and 2000s were implemented through successive economic adjustment and stabilization programs supported by international development partners of Rwanda

As a result of the above reforms, the structure and the volume of activities of the financial sector changed drastically. In the 1980s, the financial sector in Rwanda consisted of the National Bank of Rwanda(Central Bank),three commercial banks , one mortgage bank, one development bank ,one public insurance company , one public pension fund and a network of cooperatives working as a credit union. As at end December 2016, the banking sector is comprised of sixteen (16) banks, while the non-bank financial institutions include fifteen (15) insurance companies, 472 microfinance institutions and one (1) public pension fund (NBR, August 2017).

The other component of the financial sector is the capital market where long term debt instruments are traded. The capital market in Rwanda mainly consisting of Government T-Bonds is at an early

stage of development. Since the creation of the Capital market in 2011, outstanding Government and corporate bonds worth RWF 227 billion have been issued (Table 3), representing a mere 3.6% of GDP as at end 2016. It appears that so far, the capital market in Rwanda cannot compete with the banking system in providing funding and saving opportunities to the public.

Despite the presence of more participants in the financial sector, the banking system remains overwhelmingly the most predominant segment in the sector in Rwanda. As at December 2016, the banking system accounts for 66.9% of the total assets of the financial sector while the share of microfinance institutions and other non-bank financial institutions is 6.3% and 26.8 % respectively (NBR, August 2017).The share of the banks in financial intermediation is even stronger, as the banking system accounts for more than 90% of the loan and deposit markets. The banking sector is not only predominant, but also not competitive as illustrated by the persistence of large interest rate spreads (Figures 1 and 2). Another sign of low competition in the Rwandan banking sector is the high degree of liquidity preference. It has been shown in Kigabo, Mwenese and Bagabe (2016) that the liquidity preference curve for the banking sector in Rwanda becomes perfectly elastic at around 16%. Under a perfectly competitive loan market, excess liquidity and bank loans should become substitutes at a zero loan rate. The fact that they are substitutes at such a high rate is a clear indication that the banking sector is not competitive (Khemraj, 2007).

Another feature of the Rwandan banking sector is its relative concentration, suggesting that banks have been able to exert mark power over their clients and behaved in an oligopolistic manner. The National Bank of Rwanda noted however that the degree of concentration was significantly reduced in the last ten years as the share of the three largest banks in loans, deposits and total assets declined from 62.7%, 70.6% and 66% in 2006 to 44%, 47% and 45% respectively in June 2016 (NBR, July 2015-June 2016).

It has been widely documented that in a situation where firms and households depend on bank loans for their activities owing to underdeveloped money and capital markets, banks feel less pressurized to align their lending rates to the corresponding market conditions (Acheampong, 2005). In the case of Rwanda, alternative sources of debt such as credit from equity and bond markets are almost inexistent because Rwanda's security and money markets lack sufficient products and services suitable for majority of small and medium enterprises as well as for individuals. In such a context, bank retail rates may be unresponsive to monetary policy actions from the Central Bank due to the inelasticity of demand for loans. The policy implication of the structure of the financial system in Rwanda is that the banks predominance will lead to a low and sluggish interest rate pass-through.

3.2. Monetary policy framework

As in most African countries until the end of the 1980s, the financial sector in Rwanda functioned according to the McKinnon-Shaw financial repression paradigm characterized by government restrictions on the operations of financial system such as direct interest rate controls, credit ceilings and high reserve requirement.

While control of credit extension and high reserve requirement entailed inefficiency in the allocation of financial resources, interest rates ceiling hampered the channeling of savings in the banking system.

In order to set up a sound and competitive financial system with the view to ensuring an efficient mobilization and allocation of financial resources, credit controls were removed in 1992 and interest rates were fully liberalized in 1996.

With the introduction of the money market operations in 1998, the NBR adopted the monetary targeting regime framework for the conduct of monetary policy with the use of indirect market based instruments to control overall monetary and credit conditions through the demand and supply of liquidity in the banking system. These instruments included: reserve requirement, discount rate, open market operations and interventions in the foreign exchange market.

Regarding the exchange rate policy, it is worth mentioning that policy changes focused on setting up a flexible exchange rate regime. In December 1998, Rwanda has accepted the obligations of the IMF's article VII, sections 2, 3 and 4 and since then maintained an exchange rate system free of restrictions on payments and transfers for international transactions, making the Rwandan currency convertible (Government of Rwanda , 1998). Currently, as a result of successive revisions of the foreign exchange regulations, operations relating to imports and exports, services and capital account including direct and portfolio investments, lending in foreign currencies and personal transactions have been fully liberalized (Official Gazette N^0.44 of 04/11/2013).

Flexible exchange rate regime such as the one adopted by the National Bank of Rwanda allows the country to enjoy a greater autonomy in terms of setting domestic monetary policy (Frankel,1999) and as argued by Cas ,Menendez and Frantischek (2011), the interest rate pass-through is positively associated with exchange rate flexibility.

During the period covered by this study, the National Bank of Rwanda has been using the following monetary policy instruments: the Discount rate, the Cash reserve requirement and the Open market operations. However, the role of the discount rate and the reserve requirement has been progressively minimized and market determined instruments have been favored to regulate the amount of liquidity in the money market through the open market operations, namely the Treasury bill rate and the Repo rate. Since the introduction of the repo operations in 2008, the key repo rate (policy rate) which is announced on a quarterly basis has been used to signal the monetary policy stance of the National Bank of Rwanda, while the repo transactions have been employed in the open market operations as the main instruments to inject or absorb liquidity in the banking system. These operations involve the repo rate which is the rate at which commercial banks can obtain funds from the Central bank, while the reverse repo rate is the rate at which commercial banks can invest their surplus funds in Government securities. Therefore by altering the Key repo rate and the Repo rate, the National Bank of Rwanda signals its monetary policy stance which is transmitted to interbank rates and other money market rates and ultimately to bank retail rates.

To illustrate the developments in the money and financial markets in Rwanda in recent years, the main operations are summarized in Table 3 where the volume of transactions for each debt instrument is presented.

Table 3: Developments in domestic financial markets (in millions of RWF)

Assets	2009	2010	2011	2012	2013	2014	2015	2016
Interbank	549,044	518,095	395.0	-	145,800	224,800	242,500	444,953
Treasury bills	-	54,462	64,294	95,256	156,200	172,300	225,100	177,700
Repurchase agreements (repos)	58,100	106,800	114,900	52,450	29,500	47,500	26,500	30,500
Government T-bonds	-	15,000	15,000	10,000	18,500	42,500	55,000	55,000
Corporate bonds	1,000	-	-	-	-	15,000	-	-

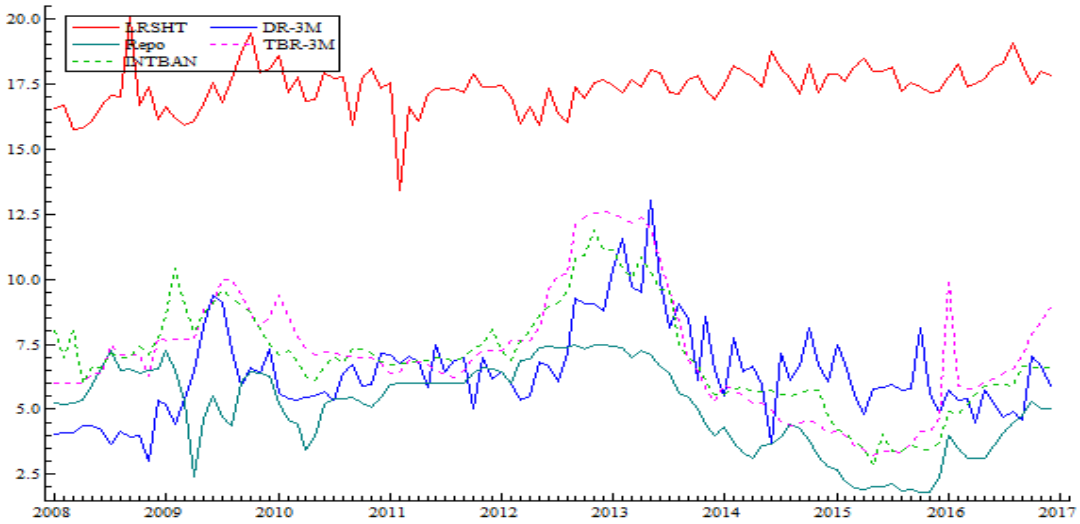
Source: NBR, Financial Markets Department

As shown in Table 3,the money and capital markets in Rwanda are dominated by the short term money market instruments including interbank transactions reflecting the volume of liquidity traded between banks, the Repo and T-Bill operations which are short term debt instruments used by the Central bank to regulate liquidity in the banking system. It is worth noting that transactions in repo agreements witnessed an upward trend between 2009 and 2011 reflecting a tighter monetary policy implemented by the National Bank of Rwanda, while a relaxed monetary policy stance was observed between 2012 and 2016. In contrast, the volume of T-Bill operations exhibits a different pattern as the transactions have been on the rise from 2010 to 2016, reflecting banks' investments in Government securities of longer maturities. As also can be seen in Table 3, the issuance of longer term debt instruments, namely, Government T-Bonds has been intensified since 2014 in a bid to promote and strengthen the capital market development and improve the monetary transmission mechanism in Rwanda.

3.3. Interest rate developments

Before engaging in a rigorous analysis based upon econometric technique, it is instructive to look at the behavior of the key variables during the sample period, namely the bank and the policy rates. To this effect, the developments of the short term lending rates (*LRSHT*), the three months maturity deposit rate (*DR-3m*), the interbank rate (*INTBAN*), the *Repo rate* and the three months maturity Treasury bill rate (*Tbr-3m*) are depicted in Figure 1,while the developments of the long term lending rate (*LRLOT*) , the interbank rate , the six months maturity deposit rate (*DR-6m*), the *Repo rate* and the six months maturity Treasury bill rate (*Tbr-6m*) are displayed in Figure 2 .A common feature to be pointed out in the two figures is that, there is a consistently large spread between the lending and deposit rates, suggesting that during the sample period, there have been no efficiency gains in the banking system in Rwanda pointing to persistence of a non-competitive market .

Figure 1: *LRSHT, DR-3m, Repo rate, Tbr-3m and INTBAN*



It is worth noting that during almost the whole period covered by this study, the banking system was characterized by excess liquidity, resulting notably from the expansion of public spending reflecting the scaling up of foreign aid to Rwanda, so that the different monetary policy instruments were used by the Central Bank to drain this excess liquidity by reducing banks' reserves.

It may be observed in Figures 1 and 2 that except for the year 2009 marked by the credit crunch and 2010 characterized by comfortable liquidity conditions in the banking system, the lending rates (short and long-term) were fairly stable and varied within a narrow range, while the deposit rates, the Treasury bill and the repo rates were more volatile and displayed stronger fluctuations. This contrasting behavior of the lending and other rates whereby lending rates seem to follow an independent development path, may be explained by the fact that the lending rates are unresponsive to changes in the policy rates because they are determined by factors other than the cost of funds, while the deposit rates are sensitive to changes in the policy rates and exhibit similar developments. As stated by the National Bank of Rwanda in a recent policy document, the weak responsiveness of the lending rates to changes in the key repo rate is due to, among other factors, high operating costs in the banking sector and high provisions for bad loans. In addition, behavior of borrowers such as lack of information on loan conditions and culture of not bargaining with banks contributed to the rigidities in lending rates charged by banks (NBR, February 2015).

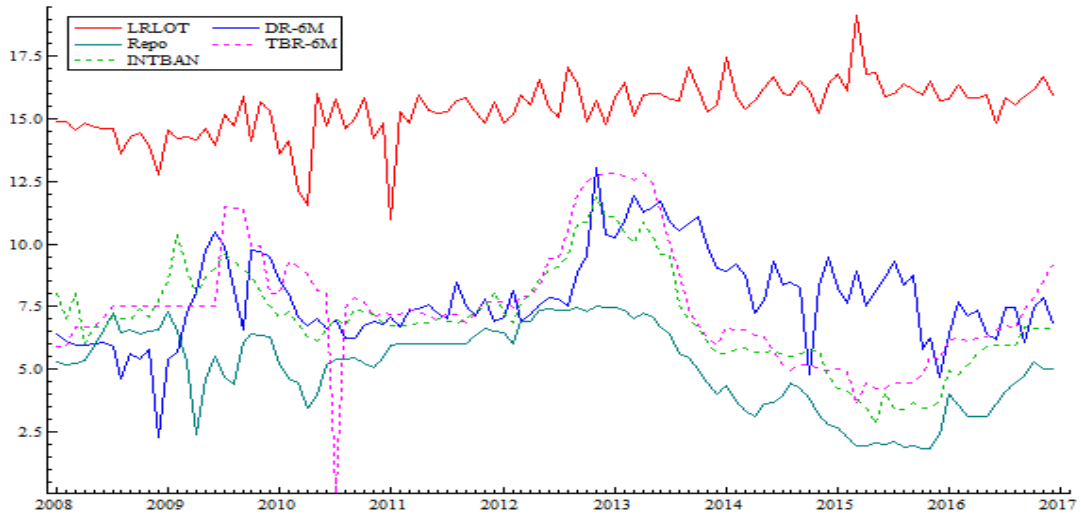
Despite their higher volatility, the deposit, interbank and policy rates exhibit a regular co-movement suggesting a long-run relationship between these rates; this co-movement is discernible in Figures 1 and 2. During the sample period, monetary policy has been actively used to cope with a variety of challenges stemming from domestic and external shocks. The shocks caused by global food and fuel crisis in 2008 resulted in higher inflation rising to more than 20% by end 2008. The National Bank of Rwanda responded to these developments with a tighter monetary policy by raising the policy rate in mid-2008. However, by end 2008 and early 2009, following the world economic slowdown and a domestic liquidity crisis in the banking system, the Rwandan economy experienced a sharp decrease in the growth of banks' credit to private sector from 32% in 2008 to

4% in 2009. As a result the Central Bank relaxed the monetary policy stance to curb the decline in broad money and credit to private sector. The ensuing accommodative monetary policy meant to improve banks' liquidity and stimulate credit to economy included the cut of the key repo rate from 9% in December 2009 to 7 % in early 2010. In subsequent years, the Central Bank implemented a prudent monetary policy to prevent risks of exacerbating inflation pressures resulting from rising inflation and uncertainties in the international and regional environment during the period 2011-2013.

Accommodative monetary policy was again implemented from the second half of 2013 through 2014 to support the recovery of the economy from the slowdown registered in 2013. The monetary policy stance was further relaxed in 2015 as the National Bank of Rwanda reduced the key repo rate to 6.5% in a context of low inflation. This downward trend of the policy rate was reversed in 2016 where money market rates have been increasing reflecting tighter liquidity conditions in the banking system in a context of economic slowdown. This change may also be explained by the interventions of the Central Bank in the foreign exchange market by selling US dollars to banks and the will of the monetary authorities to align the money market rates to the key repo rate so as to develop interbank market transactions (NBR, February 2017).

A close examination of the developments of the deposit and interbank rates in Figures 1 and 2 shows that the fluctuations of both rates follow closely the changes in the policy rates, i.e. the repo and Treasury bill rates, albeit with a lag.

Figure 2: LRLOT, Dr-6m, Repo rate, Tbr-6m and INTBAN



The responsiveness of the deposit and interbank rates to changes in the policy rate in the context of a global declining trend of the policy rates and relatively stable lending rates is consistent with the profit maximizing behavior of banks as the decline in the deposit rates increases the interest rate spread which contributes to the improvement of the banks' profit margin.

The foregoing analysis is an attempt to uncover the nature of the relationship between the bank rates and the policy rates in Rwanda. Overall, the visual inspection of the developments of the

different rates shows clearly that, lending rates are not sensitive to changes in the Repo and Treasury bill rates. Conversely, the deposit and interbank rates exhibit a closer relationship with the selected policy rates, suggesting that monetary policy actions have more influence on deposit and interbank rates than on lending rates. However, this preliminary assessment cannot provide convincing information on the real nature of the relationship between the bank rates and the policy rates; this task will be achieved through a rigorous econometric analysis.

IV. Data and methodology

4.1. Data

The data used in this research consist of monthly series of two policy rates , namely the Treasury bill rate of different maturities (from one to six months : *Tbr-1m,Tbr-3m and Tbr-6m)* and the Repo rate along with three bank rates (interbank , deposit and lending rates) collected from tables published by the National Bank of Rwanda. Interbank rate denominated as *INTBAN*, deposit rates of different maturities (from one to six months: *Dr-1m, Dr-3m and Dr-6m)* and lending rates of short, medium and long term (*LRSHT, LRMED and LRLOT*) have been considered for analysis. The data cover the sample period 2008-1 to 2016-12. This period has been chosen for two main reasons. First, the repo rate has been introduced in 2008 as a new monetary policy instrument. Second, during this period, the main reforms in the financial sector had been completed and the Central Bank had gained its full independence and relied more on the interest rate for conducting monetary policy. The choice of policy variables can be motivated as follows. In the current monetary policy framework, the key repo rate is the instrument used to signal the monetary policy stance of the National Bank of Rwanda. However, the key repo rate is announced on a quarterly basis and may remain unchanged for long time periods, which makes it less suitable for econometric purposes. By contrast, the Repo rate is dynamic since it is used by the National Bank of Rwanda in the open market operations as the main instrument to signal the financial conditions in the money markets on a daily basis; therefore, the Repo rate is considered as the main policy rate in this study. The Treasury bill rate of different maturities has also been used as policy rate since it has been argued in the literature that in the long-run, banks set their retail prices in line with their marginal cost, i.e. the funding cost on loans and opportunity cost of deposits, which can be best estimated by money market rates reflecting market conditions (De Bondt, 2005).

4.2. Methodology

i). **Conceptual framework**

The theoretical analysis of the interest rate pass-through starts with a good understanding of the banks' price setting behavior in the determination of their lending and deposit rates in the presence of monetary policy shocks. The price charged by banks is indeed crucial since it influences their profitability and the soundness of the banking system, which in turn enhances financial stability. The oligopolistic version of the Monti-Klein model of bank profit maximization theory implying imperfect competition in the banking market has been extensively used to explain the link between the policy rate and the bank retail rates (Makambi, Wawire and Omolo, 2013 and Mbowe, 2015). The present study relies on the same approach as the Rwandan banking system may be considered as an oligopolistic market. As presented in Makambi, Wawire and Omolo (2013), under

the Monti-Klein model**,** each bank is assumed to have direct clearing relationships with the Central Bank and seeks to maximize profit (π), subject to its balance sheet. The balance sheet of the bank is comprised of loans (L) and reserves (R) on the assets side and deposits (D) and settlement balance (S) with the Central Bank on the liabilities side, so that :

$$R+L=D+S \quad \ldots\ldots (1)$$

It also follows that from equation (1) that total deposits may be presented as:

$$D=R+L-S \quad \ldots\ldots (2)$$

Assuming that a commercial bank extends loans at a rate i_L and pays interest rate i_D on deposits, it follows that the net interest income (NII) of the bank is given by the difference between the total interest earned on loans and the total interest expense paid to deposit holders :

$$NII = i_L L - i_D (R+L-S) \quad \ldots\ldots (3)$$

Clearing operations with other banks are conducted via the Central bank and commercial banks whose balance is negative pay a liquidity penalty equivalent to a punitive interest rate, i_P, known as the policy rate multiplied by the difference between the settlement balance and the required reserves at the Central bank, which gives the following total penalty equal to:

$$i_P \delta (S-R) \quad \ldots\ldots (4)$$

The commercial bank also incurs costs of managing loans. Taking this cost function as given by μL and using the Monti-Klein model which assumes that banks are confronted with a downward sloping demand function for loans and an upward sloping function for deposits, the profit maximization function, π (L, R), derived from the combination of equations (3) and (4), may be expressed as the sum of the intermediation margins on loans and deposits minus the liquidity penalty and the management costs of loans as follows:

$$\pi (L,R) = i_L L - i_D (R+L-S) - \delta i_P (S-R) - \mu L \quad \ldots\ldots (5)$$

The bank's decision variables in the model are the volume of loans granted and the quantity of precautionary reserves it chooses to hold and profit maximizing bank equates its marginal revenue to marginal cost. Therefore, computing the first order conditions from the above profit maximization function by differentiating equation (5) with respect to L and R, and setting the results equal to zero yields:

$$i_L - i_D - \mu = 0 \quad \ldots\ldots (6)$$

and

$$- i_D + \delta i_P = 0 \quad \ldots\ldots (7)$$

From equation (6) and (7), it follows that $i_L - i_D = \mu$ and $i_D = \delta i_P$, implying that

$$i_L = \delta i_P + \mu \quad \ldots\ldots (8)$$

Thus, the Monti-Klein model demonstrates that there is a linear relationship between the policy rate and the bank retail rates and shows how changes in the policy rate may be transmitted to bank retail rates; equation (8) formed the basis of the interest rate pass-through analysis in the empirical literature. Nonetheless, the above model may be criticized on the ground that , first, banks are not bound to borrow from the Central bank and pay a penalty rate and, second, developments of bank retail rates do not necessarily reflect the behavior of the policy rate. The policy rate is indeed a very short-term rate, while lending and deposit rates are expected to reflect long-term rates; furthermore, banks may obtain funds from a variety of sources, including retail deposits, interbank, bonds and Treasury bill markets (Illes, Lombardi and Mizen, 2015). Hence, using the policy rate to measure the interest rate pass-through would lead to erroneous conclusion on the interest pass-through process. De Bondt, Mojon and Valla (2005), De Bondt (2002) argue that in the long-run, banks set their retail prices in line with their marginal costs, i.e. the funding cost on loans and the opportunity cost of deposits, which can be best estimated by money market rates reflecting market conditions.

ii). **Empirical model and estimation procedure**

In order to analyze the relationship between the policy rates and the bank rates and measure the size and speed of the interest rate pass-through in Rwanda, autoregressive distributed lag model (ADL), co-integration technique, non-linear error correction models have been be used. Using non-linear error correction model allows testing for differences in the bank rates adjustment when they are below or above their equilibrium level following a positive or negative shock in the policy rates.

To conduct the above analysis, the following basic model for interest rate pass-through proposed by De Bondt (2005) has been used:

$$br_t = b_0 + b_1 pr_t + \varepsilon_t \qquad (9)$$

where br_t is the endogenously determined bank rate; pr_t denotes the policy rate assumed to be exogenous; ε_t is the stochastic error term of the model; b_0 and b_1 are the long run model parameters; b_0 represents the constant markup and b_1 measures the degree of pass-through in the long run. Equation (9) provides a primary model of bank pricing decisions from which to assess the sensitivity of the bank rates to changes in the policy rates and in so doing the strength and magnitude of the IRPT. If markets are perfect (i.e. full information and perfect competition), the coefficient b_1 is expected to be equal to one, implying a complete long run pass-through or full transmission of monetary impulses to bank rates; in the context of imperfect markets, coefficient b_1 will be less than one, suggesting an incomplete interest rate pass-through or partial transmission of policy rate changes to bank rates. In fact , it is unlikely that the value of b_1 will be equal to one not only due to imperfect markets , but also to a number of factors including fixed menu costs, asymmetric information, high switching costs , collusive behavior and adverse customer reaction (Egert and Macdonald ,2009 ; Aziakpono and Wilson, 2010). It has also been pointed out that b_1 could be higher than one, hence recording an overshooting pass-through; this may occur when banks charge higher interest rates in an attempt to offset higher risks resulting from asymmetric information rather than reducing the supply of loans de Bondt (2005).

The econometric technique to be used for estimating Equation (9) depends on the time series properties of the data. Therefore, a natural starting point of the analysis is to test all the variables for unit roots and determine their order of integration.

If the time series of bank and policy rates are found to be stationary in level, Equation (9) may be estimated by ordinary least squares (OLS) technique. If the data are integrated in level, but stationary in first difference, the series will be tested for cointegration. If the first difference stationary series are not cointegrated, then equation (9) will be estimated by the conventional ADL model:

$$\Delta br_t = b_0 + b_1 \Delta pr_t + \sum_{i=1}^{n} b_i \Delta pr_{t-i} + \sum_{i=1}^{m} c_i \Delta br_{t-i} + \mu_t \qquad (10)$$

where Δ denotes the first difference operator, b_1 is the measure of the immediate pass-through while b_i represents the short run pass-through reflected in the different lags of the policy rate, c_i is the autoregressive coefficient of the lagged dependent variable , μ_t is the white noise error term, n and m are the optimal number of lags used in the model. From equation (10), the long-run pass-through coefficients b_1 in equation (9) can be computed as in Egert, Crespo-Cuaresma and Reininger (2007) and Kwapil and Scharler (2010):

$$b_1 = \sum_{i=1}^{n} b_i \; / \; (1 - \sum_{i=1}^{m} c_i) \qquad (11)$$

Keele and De Boef (2004) have also demonstrated that subject to some technical transformation, the conventional ADL may be used to generate an error-correction model with non-cointegrated stationary series. Thus, Keele and De Boef propose to estimate the following regression:

$$\Delta r_t = \alpha_0 + \rho r_{t-1} + \mu_1 \Delta pr_t + \mu_2 pr_{t-1} + \varepsilon_t \qquad (12)$$

which can further be reparametrized in an error-correction model :

$$\Delta r_t = \alpha_0 + \rho \, (r_{t-1} - \mu_2 pr_{t-1}) + \mu_1 \Delta_1 pr_t + \varepsilon_t \qquad (13)$$

in which ρ is interpreted as the speed of adjustment towards equilibrium and μ_1 captures the contemporaneous or immediate pass-through. The long-run parameters can be estimated from equation (12) as $\theta_0 = \alpha 0 / \rho$ and $\theta_2 = \mu_2 / \rho$.

If the time series of interest rates share a long-run relationship (i.e., cointegrated), this study will use a dynamic model referred to as the bounds test approach proposed by Pesaran, Shin and Smith (2001) for cointegration analysis:

$$\Delta br_t = \alpha_0 + \alpha_1 \Delta pr_t + \gamma br_{t-1} + \delta pr_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta pr_{t-i} + \sum_{i=1}^{m} c_i \Delta br_{t-i} + \mu_t \qquad (14)$$

where α_1 represents the immediate pass-through, γ and δ are the coefficients of the lagged level variables; c_i is the autoregressive parameter, α_i represents the short run pass-through ; μ_t is an i.i.d process with zero mean and constant variance.

The bounds testing approach presents important advantages over the other existing techniques in modelling cointegration dynamics as it provides greater flexibility in relaxing the assumptions that the time series should be integrated of the same order , they can indeed be I(0) or I(1). The small sample properties of the bounds testing approach are superior to that of other cointegration testing approaches. Furthermore , as argued by Fuertes and Heffernan (2008) and Ahmad , Aziz and Rummun (2013), equation (14) can be estimated by OLS and yields unbiased and consistent measures of long run mark-up b_0 and pass-through b_1 of equation (9).

Following the bounds testing approach, the presence of cointegration is detected by the implementation of the Wald coefficient restriction test (F-statistic) to the lagged level variables (br_{t-1} *and* pr_{t-1}) in equation (14) and the null hypothesis of no cointegration is H_0 : γ = δ = 0 against the alternative H_1: γ ≠ δ ≠ 0. The computed F-test value is compared with the critical values tabulated in Pesaran, Shin and Smith (2001). For a given level of significance, if the computed F-test statistic is smaller than the lower bound value, then the null hypothesis is not rejected; conversely if the computed F-test statistic is greater than the upper bound value, then the null hypothesis is rejected. On the other hand, if the computed F-statistic falls between the lower and upper values, then the result of the test is not conclusive. A significant F-test statistic for testing the joint significance of the lagged level variables indicates the existence of a long-run relationship and on the basis of equation (14) the long-run parameters of equation (9) can be calculated as $\beta_0 = - \alpha_0/\gamma$ and $\beta_1 = -\delta/\gamma$ and the new long-run relationship equation is :

$$br_t = \beta_0 + \beta_1 pr_t \qquad (15)$$

To investigate the interest rate pass-through, the error correction mechanism (ECM) has been generally used in the literature. This methodology has the ability to quantify both the degree and speed of adjustment of the bank retail rates following a change in the policy rate. It also allows a distinction between the long-run relationship of the two variables and the short run adjustment towards their long-run equilibrium. On the basis of equation (14) this study derives an error correction model similar to that used by Sander and Kleimeir (2004), Aziakpono and Wilson (2010) to examine the short run and long-run dynamics of the bank retail rates in response to changes in the policy rate:

$$\Delta br_t = \beta_0 + \beta_1 \Delta pr_t + \sum_{i=1}^{n} \beta_i \Delta pr_{t-i} + \sum_{i=1}^{m} \lambda_i \Delta br_{t-l} + \varphi ECT_{t-1} + \eta_t \qquad (16)$$

where Δ denotes the first difference operator, β_1 is the measure of the immediate pass-through while β_i represents the short run pass-through reflected in the different lags of the policy rate, λ_i is the autoregressive coefficient of the lagged dependent variable , η_t is the white noise error term, n and m are the optimal number of lags used in the model. ECT_{t-1} $(=br_{t-1} - \beta_0 - \beta_1 pr_{t-1})$ represents the error correction term lagged by one period obtained from the long-run relationship given by equation (15) and captures the extent of the disequilibrium at time (*t-1*); φ is the coefficient of the error correction term capturing the speed of adjustment of bank rates towards their long run equilibrium level and measures the portion of the disequilibrium that is corrected in the next period; if the coefficient φ is statistically significant and negative , it means that market forces are in operation to restore long run equilibrium after short run disturbances .

Equation (16) corresponds to the conventional linear error-correction model and implicitly assumes that the adjustment speed of the bank rates following a deviation from the long-run equilibrium represented by φ, is symmetric, meaning that it is the same following a positive or negative shock.

However, the short run dynamics may be asymmetric, meaning that the speed of adjustment may be different depending on the strength and the direction of the shock. Fuertes, Heffernan and Kalotchou (2006), argue that due to structural shocks, exogenous and endogenous factors, the speed of adjustment may be asymmetric with respect to the magnitude and direction of monetary policy action. Therefore, it is important to relax the symmetric assumption in order to assess the true nature of the adjustment dynamics. To account for the potential asymmetry in the adjustment process, this study follows Scholnick (1996), Sander and Kleimeier (2002).The procedure consists of splitting the residuals obtained from the long-run relationship into two series of positive and negative residuals defined as follows:

$ECT^{+} = ECT \text{ if } ECT > 0$ (17)

$ECT = 0 \text{ if } ECT < 0$

and

$ECT^{-} = ECT \text{ if } ECT < 0$ (18)

$ECT = 0 \text{ if } ECT > 0$

The asymmetric residuals specified in (17) and (18) are then introduced as separate variables in the error-correction model to obtain the asymmetric short run dynamic model:

$$\Delta br_t = \delta_0 + b_1 \Delta pr_t + \sum_{i=1}^{n} b_i \Delta pr_{t-i} + \sum_{i=1}^{m} c_i \Delta br_{t-i} + \varphi_1 ECT^{+}_{t-1} + \varphi_2 ECT^{-}_{t-1} + \mu_t \quad (19)$$

where φ_1 and φ_2 are respectively the coefficients of the positive and negative error-correction terms.

The positive error correction term (ECT^{+}_{t-1}) in equation (19) implies that if the bank rate is above its long-run equilibrium value following a decline in the policy rate, it will start falling in the next period; similarly, the negative error correction term (ECT^{-}_{t-1}) suggests that if the bank rate is below its equilibrium level following an increase in the policy rate, it will start rising in the subsequent period. The coefficients of the error-correction term, φ_1 and φ_2, provide the information on the speed of adjustment of the bank rates during expansionary and contractionary monetary policy.

The presence of asymmetry is tested using the Wald test on the restriction that $\varphi_1 = \varphi_2$ in equation (19). If equality of the two coefficients is not rejected, this implies no asymmetry in the adjustment process, while rejection of equality points to existence of asymmetry. On the other hand, if $\varphi_1 > \varphi_2$, this suggests that banks are quicker to adjust their rates downwards than they are to adjust them upwards, while if $\varphi_2 > \varphi_1$, means that banks would adjust their rates upwards faster than they are to adjust them downwards.

V. Empirical results and discussion

5.1. Time series properties of the data

The Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) unit root tests have been employed to determine whether the bank rates (lending , deposit and interbank rates) and the policy rates (Repo and Treasury bill rates) are stationary or not. The tests have been performed with level and first difference series with only deterministic assumption of constant as the time series on interest rates do not exhibit any trend.

Table 4: Unit root tests with constant: 2008:1 - 2016:12

Variables	ADF		PP	
	Level	First difference	Level	First difference
LRSHT	- 4.293981	- 17.22636	- 6.852495	- 37.87146
LRMED	- 3.487204	- 14.65414	- 3.167672	- 15.98055
LRLOT	- 3.681175	- 11.05033	- 6.580244	- 81.59973
Dr-1m	- 5.782765	- 10.66773	- 5.778322	- 42.22669
Dr-3m	- 2.348815	- 11.79147	- 3.938492	- 15.30330
Dr-6m	- 3.633511	- 13.18539	- 3.429478	- 14.58730
Tbr-1m	- 1.693834	- 15.07884	- 2.400946	- 14.89926
Tbr-3m	- 1.828337	- 11.42297	- 1.994364	- 11.36604
Tbr-6m	- 2.191023	- 13.59482	- 2.709599	- 13.61173
INTBAN	- 1.635134	-10.86784	- 1.850376	- 10.86802
Repo rate	- 1.850841	- 9.351902	- 1.900449	- 9.359472
Critical value at 1% significance level	- 3.493129	-3.493129	- 3.492523	- 3.493129

From the results of both tests in Table 4, it appears that the series of lending rates and one month deposit rate are stationary in level at 1% significance level , while the policy rates , the interbank , the three and six months deposit rates are found to be non-stationary , i.e I (1). However, all the variables are stationary in first difference.

5.2. Testing for co-integration relationship

Once the time series properties of the variables have been identified, the next step of the empirical analysis is to test for the co-integration relationship between the bank rates and the policy rates considered in this study. It is a common phenomenon that many economic time series data are non-stationary but move together over time; in particular, it has been documented in the literature that the bank rates cannot drift too far from the policy rate over a long period, suggesting that the series are bound by a long-run equilibrium relationship (Fuertes and Heffernan, 2008).

The following results emerged from the cointegration tests. A long-run relationship has been identified between the deposit and Treasury bill rates of same maturities on the one hand and

between the deposit and the Repo rates, on the other hand; the interbank rate is also cointegrated with the Treasury bill and the Repo rates. Given the presence of cointegration relationship between these variables, asymmetric error correction models have been examined. By contrast, the lending rates have been found to be cointegrated with none of the policy rates.

To test for the null hypothesis of no cointegration as well as for the significance of the long-run coefficients in equation (14), the Wald test (F-statistic) proposed by Pesaran, Shin and Smith (2001) has been used. Following the procedure explained earlier, equation (14) has been estimated by OLS and the computed F-statistic was compared with tabulated critical values.

Table 5 presents the empirical results of the Wald test for the pairwise relationships between the bank rates and the policy rates.

Table 5: Bounds cointegration test for deposit and policy rates

Relationship	Computed F-statistic	10% critical bounds	5% critical bounds
Dr-1m/Tbr-1m	7.39	4.04 - 4.78	4.94 - 5.73
Dr-3m/Tbr-3m	7.11	4.04 - 4.78	4.94 - 5.73
Dr-6m/Tbr-6m	6.25	4.04 - 4.78	4.94 - 5.73
Dr-1m/Repo rate	9.58	4.04 - 4.78	4.94 - 5.73
Dr-3m/Repo rate	7.15	4.04 - 4.78	4.94 - 5.73
INTBAN/Repo rate	9.178	4.04 - 4.78	4.94 - 5.73
INBAN/Tbr-3m	9.295	4.04 - 4.78	4.94 - 5.73

Note: The bounds testing critical values are obtained from Pesaran, Shin and Smith (2001), p.300; Table CI (iii), Case III: unrestricted intercept and no trend.

As can be seen in Table 5, the computed F-statistic test for every pairwise relationship between the selected variables is greater than the upper critical value at the 5% significance level, implying rejection of the null hypothesis of no cointegration and confirming the presence of a long-run relationship between the variables.

5.3. Regression results and discussion

Before proceeding to the discussion of empirical results, it is worth noting that in all regression results related to cointegration as well as to error correctional models, robustness of the estimated models has been assessed and was confirmed by the conventional diagnostic tests, i.e., the Breusch-Godfrey serial correlation LM test, heteroschedasticity test (ARCH test), Jarque-Bera normality and Ramsey Reset specification tests. However some of the models failed to fulfill the normality test, but given the large number of observations (108) involved, this does not invalidate the robustness of the models as argued in Dube and Zhou (2014). To determine the lag structure of different models this study relied on the Hendry (1987) general to specific approach by starting with twelve lags and then removing non-significant lags; this implies that for each set of dependent and independent variables, the most parsimonious model has been selected for interpretation.

i). Deposit and interbank rates

Long-run relationship

Results of equations (20) through to (26) present the estimates of the long-run coefficients of the pairwise relationship between interbank, deposit, and policy rates for which a co-integration relationship has been identified. Depending on the maturity, the estimated long-run pass-through between the deposit and the Treasury bill rates ranges between 0.19 and 0.53, respectively, while the pass-through between the deposit rates and Repo rate varies between 0.28 and 0.62. The long-run pass-through from the Repo rate and the three months maturity Treasury bill rate to the interbank rate is respectively 1.24 and 0.86.

Dr-1m = 3.36 + 0.19 Tbr-1m (20)

Dr-3m = 2.81 + 0.53 Tbr-3m (21)

Dr-6m = 4.11 + 0.51 Tbr-6m (22)

Dr-1m = 3.2 + 0.28 Repo rate (23)

Dr-3m = 3.62 + 0.62 Repo rate (24)

INTBAN = 0.72 + 1.24 Repo rate *(25)*

INTBAN = 0.65 + 0.86 Tbr-3m *(26)*

These results show that the interbank rate is highly sensitive to changes in policy rates, exhibiting even an overshooting pass-through of 1.24 with the Repo rate. This result is similar to that found by Sande and Okello (2013) for the case of Uganda. A stronger long-run interest rate pass-through is also observed when the three months deposit rate is associated with the Treasury bill rate of same maturity and the Repo rate, implying that a higher proportion of the change in the two policy rates is transmitted to the deposit rate. In a policy perspective, this suggests that in the current BNR monetary policy framework, the Repo rate may be considered as a more effective instrument than the Treasury bill rate in the conduct of monetary policy, since it exerts a stronger impact on deposit and interbank rates. This also indicates that the decision of the Central Bank of Rwanda made since 2008 to use the Repo operations as the main instrument in the open market operations was relevant as it reinforced the monetary transmission mechanism. It is worth noting that knowing the class of assets affected by the monetary policy stance in the banks' portfolio and the specific policy instrument that affects them is crucial for the Central bank.

The above result on the overshooting pass-through of the Repo rate to the interbank rate is a very interesting information, since the pass-through of the policy rate to interbank rate is the first step of the entire pass-through process from the policy rate to bank retail rates. Furthermore, depending on the policy rate considered, only a small portion of the changes in the policy rates is transmitted to deposit rates, implying that in Rwanda the interest rate pass-through is incomplete in the deposit market and confirms the findings of the earlier study by Kigabo, Mwenese and Bagabe (2016) in which the long-run pass-through from the Treasury bill rate to deposit rate ranged between 0.14 and 0.45.

The pass-through of the policy rate changes to deposit rates in Rwanda appears also to be significantly lower than in some other African countries. For Namibia, Sheefeni (2013) found a long-run interest rate pass-through of 0.88 between deposit rate and the 91 days Treasury bill rate; while the pass-through with the repo rate was 0.90. Using the repo rate as policy rate, Acheampong (2010) estimated a long-run pass-through of respectively 0.69 for the deposit rates in Ghana. For Nigeria, Ogundipe and Alege (2013) found a long-run pass-through of 0.60 between the Central bank policy rate and the deposit rate.

Short-run dynamics and asymmetric adjustment

The short run dynamics has been investigated using non-linear error-correction model as defined in equation (19) for asymmetric adjustment. A non-linear error-correction model corresponding to each of the long-run relationships presented in equations (20)-(26) has been estimated to unveil the possible asymmetric adjustment of short-run interest rate pass-through and the speed of adjustment of the interbank and deposit rates to long-run equilibrium.

The objective of the analysis is to empirically ascertain whether the speed of adjustment of bank rates is different following a positive or negative shock in the policy rates. To measure the potential asymmetric adjustment of interbank and deposit rates to changes in the policy rates, equation (19) has been used and the null hypothesis has been tested using the Wald test statistic. The null hypothesis posits that the speed of adjustment is the same following a rise or a cut in the policy rate, implying that the coefficients of the error-correction terms in equation (19) are equal , that is $H_0 : \varphi_1 = \varphi_2$. The results of the Wald test statistics are reported in Table 7.

Table 7: Results of asymmetric dynamic adjustment

Deposit rate / Policy rate	$\varphi_1 ECT(-1)^+$		$\varphi_2 ECT(-1)^-$		Wald test Null hypothesis $Ho : \varphi_1 = \varphi_2$
$\Delta Dr\text{-}1m/\Delta Tbr\text{-}1m$	-0.8014	-5.65 (0.000)	-0.2854	-1.41 (0.161)	3.2335 [0.0721]
$\Delta Dr\text{-}3m/\Delta Tbr\text{-}3m$	-0.5220	-2.96 (0.004)	-0.1509	-0.781 (0.437)	1.3844 [0.2304]
$\Delta Dr\text{-}6m/\Delta Tbr\text{-}6m$	-0.2534	-1.81 (0.074)	-0.5925	-3.37 (0.001)	1.5676 [0.2106]
$\Delta Dr\text{-}1m/\Delta Repo\ rate$	-0.8140	-5.19 (0.000)	-0.2641	-1.81 (0.067)	4.8427 [0.0278]
$\Delta Dr\text{-}3m/\Delta Repo\ rate$	-0.9666	-2.91 (0.005)	-0.2462	-2.45 (0.016)	3.6194 [0.0571]
$\Delta INTBAN/Repo\ rate$	-0.144	-1.95 (0.054)	-0.176	-1.73 (0.088)	0.0465 [0.829]

In Table 7, φ_1 represents the speed of adjustment coefficient associated with a positive deviations when the deposit rate is above its long-run equilibrium value, implying a decrease in the policy rate and φ_2 represents the speed of adjustment coefficient associated with a negative deviation when the deposit rate is below its long-run equilibrium value, reflecting an increase in the policy rate.

The results of the empirical estimates support the evidence of regime switching adjustment of the bank rates and confirm asymmetric adjustment of the deposit rates to changes in the policy rates in some cases. From these results, the null hypothesis, H_0:$\varphi_1 = \varphi_2$, has been rejected at the 5-10% significance level in three cases: when the deposit rate and the Treasury bill rate of one month of maturity are associated on the one hand, and when the deposit rate of three months of maturity is linked to Repo rate, on the other hand. Likewise, the null hypothesis has also been rejected at the 5% significance level when the deposit rate of one month of maturity is associated with the Repo rate. Hence in these three cases, presence of asymmetric adjustment has been demonstrated suggesting that in the other remaining three cases, including three months, six months maturity deposit rates and the interbank rate , the null hypothesis has not been rejected , implying that the adjustment process to long-run equilibrium is symmetric. Furthermore, it is worth noting that on average, in the cases where asymmetric adjustment has been detected, the coefficient φ_1 is higher than the coefficient φ_2. These findings are shown by the results of the Wald test statistic and the corresponding p-values reported in the last column of Table 7.

Given these results and considering cases where the null hypothesis has been rejected (three out of six), it appears that in Rwanda, the deposit rates exhibit upward rigidity, $\varphi_1 > \varphi_2$, implying that banks will tend to adjust their deposit rates downward at a faster rate than adjusting them upward. This finding which is consistent with the collusive pricing behavior of banks and valid in concentrated market, where banks are in a better position to avoid increase on deposit rates to minimize the cost of their funds has also been observed by Samba and Yan (2010) in member countries of the Central African Economic and Monetary Community and Aziakpono and Wilson (2010) in South Africa. Presence of asymmetry in the adjustment process of bank rates may also be attributable to inefficiencies in the banking sector (Fuertes, Heffernan and Kalotchou, 2006). Conversely, the adjustment speed of the interbank rate is stronger in case of negative shock, making it faster to adjust upward than downward.

It emerged also from the asymmetric adjustment models that only the relationships between the deposit and Treasury bill rates of three months maturity, the interbank rate and the repo rate exhibit a significant immediate pass-through of the policy rate with a coefficient of 0.255 and 0.483 respectively. The estimated mean adjustment lag that is the time it takes for the deposit rate to return to equilibrium after short term disturbance is one month and a half for the deposit rate and three months and a half for the interbank rate.

ii). Lending rates

Long-run and short run relationship

Empirical estimations showed that lending rates were cointegrated with neither of the policy rates; hence the short and long-run pass-through of the policy rate to lending rates has been estimated by means of the transformed ADL as proposed by Keele and De Boef (2004) on the basis of equations (11) and (12). Fifteen regressions have been run linking each category of lending rate (short, medium and long term) to policy rates. A significant long-run relationship has been identified only between the long term lending rate (*LROT*) and the Repo rate and an asymmetric error-correction model has also been estimated, while the other regressions yielded no significant

relationships between the variables. The estimated long-run pass-through of the Repo rate to long-term lending rate is as follows:

LRLOT = 5.16 + 0.228 Repo rate *(27)*

As mentioned above, only in one case, a significant long-run and short run pass-through has been detected between the long term lending rate and the Repo rate. The long-run pass-through estimated on the basis of equation (12) is 0.228 in equation (27), while the short run or immediate pass-through calculated following the error-correction model in equation (12) is 0.315. The speed of adjustment in the short run error-correction model is -0.18; on the other hand, the mean adjustment lag (MAL) in the model is close to four months. There is no evidence of asymmetric adjustment since the adjustment process adjusts only to positive deviations from long-run equilibrium value; this result is similar to the finding by Bangura (2011) in the case of Ghana.

Overall, it emerges from the above results that the interest rate pass-through from both policy rates to lending rate is incomplete in the short run as well as in the long-run. These results confirm those found in Kigabo, Mwenese and Bagabe (2016) where the long-run pass-through between the lending and Treasury bill rates was 0.097, while the short run pass-through was estimated at 0.19.

The lack of a cointegration relationship and the weak interest rate pass-through between the policy rates and lending rates confirm the absence of co-movement observed in the developments of the lending and policy rates depicted in Figures 1 and 2. It also suggests that lending rates may be determined by other factors than policy rates.

In a recent policy document published by the National Bank of Rwanda, it was recognized that the "weak responsiveness of the lending rates to the change in the key repo rate is due to, among other factors, high operating costs in the banking sector and high provisions for bad loans despite declining in NPL ratio. In addition, behavior of borrowers such as lack of information on loan conditions and culture of not bargaining with banks has contributed to the rigidities in lending rates charged by banks" (NBR, February 2015).

Kigabo and Barebereho (2008) also concluded that in Rwanda, the volume of non-performing loans and risk aversion, the operating costs and macroeconomic variables (inflation), are among the main determinants of high lending rates and interest rate spread. Similar conclusion was drawn by Kiptui (2014) in his analysis pointing to macroeconomic variables (inflation, GDP growth rate and exchange rate variability) as the main factors influencing the fluctuations of the lending rate and the interest rate spread in Kenya.

Empirical results for other African countries show also that on average the pass-through from the policy rate to lending rates is significantly lower in Rwanda. In the case of Nigeria the effect of the policy rate on lending rates is 0.72 and 0.70 in the short and long-run respectively (Ogundipe and Alege, 2013), while the pass-through of the market rate to lending rates in CAEM countries is 0.67 in the short run and 6.21 in the long run (Samba and Yan ,2010).

VI. Conclusion and policy implications

Drawing on a standard analytical framework and empirical strategies, this study investigated the interest rate pass-through and the adjustment dynamics between the bank rates and the policy rates in Rwanda. The study used monthly data covering the period from 2008-1 to 2016-12. ADL model, cointegration approach, linear and non-linear error correction models have been used for empirical analysis.

The results of the study may be summarized as follows. The estimated long-run and short run pass-through coefficients between the bank rates and the policy rates show clearly that the interest rate pass-through is incomplete in Rwanda, confirming the weakness of the interest rate channel found in previous studies. On average the pass-through is higher for deposit rates than for lending rates in the long-run. Concerning the adjustment process of the bank rates, this study provided evidence of asymmetric adjustment of deposit rates to changes in policy rates .The results of the study showed in particular that deposit rates exhibit upward stickiness, meaning that banks adjust their deposit rates downward faster following cuts in policy rates, while they are reluctant in revising them upward following an increase in the policy rates.

The incomplete interest rate pass-through between the bank rates in Rwanda may be the result of underdeveloped financial system, relative degree of concentration, low level of competition and structural excess liquidity in the banking system (Cottarelli and Kourelis, 1994). The presence of asymmetric adjustment on the other hand may be explained by asymmetric information in the loan and deposit markets (Stiglitz and Weiss, 1981) and inefficiencies in the banking system (Fuertes, Hefferman and Kaloutchou, 2006). Operating costs, high provisions for non-performing loans have also been pointed out to explain the stickiness of the lending rates to changes in the policy rate in Rwanda.

The empirical results of this study have policy implications. The weak pass-through identified in Rwanda implies that to be effective in the current monetary policy framework, cuts or increases of policy rates should be stronger. In this context, being aware of the asymmetric adjustment of the bank rates would allow monetary authority to determine the appropriate timing and instrument before taking policy action. With regard to monetary instruments, the findings of this study suggest that the Repo rate would be the most effective instrument to use given its higher impact on interbank, deposit and lending rates. Hence the role and the share of the repo transactions should be enhanced in the open market operations.

Overall, the results of this study suggest that reforms in the financial sector in Rwanda should be pursued and support creation of new financial products and non-bank financial institutions to reduce concentration and increase competition in the financial sector. In addition, the monetary authorities should promote and implement policies that will further spur the development of security market to provide alternative sources of saving and funding to firms and individuals mainly relying so far on the banking system; the efforts currently made to strengthen the capital market through issuance of Government T-Bonds are a step in the right direction. To enhance the interest rate pass-through and consequently the monetary transmission mechanism, regular communication between the National Bank of Rwanda with banks should focus on strategies to

reduce information asymmetry in the deposit and loan markets, promote efficiency of the banking sector in liquidity management, improve the quality of loans and reduce the operating costs.

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