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Foreword

The National Bank of Rwanda has increasingly focused on promoting evidence-based policy making and information sharing with the different economic actors and the general public on the key economic developments in Rwanda. Understanding the structure of the Rwandan economy is paramount to unpack the factors hampering the effectiveness of monetary policy and to come up with strategies to revise the monetary policy framework to better respond to the latest developments of the real economy. In this eighth volume of the BNR economic review, four research papers are published to fit into the aforementioned context.

In line with the BNR objective of switching from reserve money targets to the interest rate target by 2018, the first paper assesses the degree of the interest rate pass-through in Rwanda and the factors hindering the response of money market rates to changes in the central bank policy rate. The study concludes that the response of lending rates to adjustments in the 16-weeks T-bills rates (a proxy for the policy rate) is still low both in the short-run and long-run on the back of factors such as the still low degree of saving, low financial sector development and presence of excess liquidity in the banking system.

Mindful of the impact of structural excess liquidity on the effectiveness of monetary policy, the second paper dwells on the development of a methodology to estimate the optimal excess liquidity that would ensure the smooth operation of the money market so that changes in the central bank policy rate affects the yield curve. After estimating the banks' demand function for reserves, the paper reveals that the demand for reserves is significantly explained by the level of total deposits in the banking system, the repo rate (a proxy for interest rate on short term maturity assets) and the penalty rate applied to banks whose reserves fall below the required level. The paper then uses the estimated optimal demand function for reserves to derive the optimal level of excess reserves. The paper recommends mopping up of excessive liquidity until excess reserves fall within a band spanning from 20% to 30% above the required reserves, which corresponds to a repo rate band of 5.28% to 4.04%.

In view of the fact that the monetary policy actions are largely aimed at influencing the lending behaviour of banks so as to have an impact on the real economy, the third paper examines the relationship between commercial banks' credit and economic growth. The paper takes note of the Rwandan context characterized by unequal access to credit by different sectors of the economy, one of the reasons for their unequal contribution to economic growth, to investigate how sectoral access to credit has affected sectoral GDP growth. Having identified the sector-specific impediments of access to credit, the paper urges policy makers to devise strategies aimed at easing sectoral access to credit by especially reducing credit risk in agriculture and mining.

In acknowledgement that economic growth is not only supported by monetary policy but also by fiscal policy, the fourth paper assesses the impact of some of the tax policy measures implemented in Rwanda since 2006. It is widely accepted that the government cannot provide the necessary fiscal stimulus or undertake the required public investment projects to support the development of the private sector without being able to raise enough tax revenues. The paper investigates the effect of the various tax policy reforms on tax revenue collections by estimating tax buoyancy and elasticity for total tax revenue, import duties, value added taxes, excise duties and direct taxes. The study concludes that buoyancy is higher than elasticity except for import duties, indicating that overall discretionary policy measures implemented over the past years have yielded a positive impact on the tax collections in Rwanda.

In conclusion, I would like to express my gratitude not only to the authors but also to the reviewers of the papers and to the participants in BNR research forum for their comments and discussions that have contributed to improve the quality of the papers. I am also grateful to GIZ for its support in the review process.

Comments and questions can be sent to the Office of The Chief Economist (tkigabo@bnr.rw or Monetary_Policy_Res_Group@bnr.rw), KN 6 Avenue 4, P.O Box 531 Kigali-Rwanda.

John Rwangombwa

Governor

Table of contents

Interest rate Pass-through in Rwanda

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Abstract

In an environment of unstable demand function, the implementation of the monetary policy in the monetary targeting framework has become quite a challenge for the National Bank of Rwanda. The adoption of the alternative inflation targeting regime relies on a working interest rate channel. This study analyzed the degree of the interest rate pass-through in Rwanda using the single equation and the Autoregressive Distributed Lag model. The study found that the 16-weeks T-bills rates have an effect on lending rates in the long and the short run but the long run effect is very minimal between 0.14 and 0.45. The short run effect hovers around 0.15. The interest rate pass-through is thus incomplete and lower to that found in some East African Community member countries. Factors such as a still low degree of saving, financial development and excess liquidity in the banking system are identified to be limiting a higher degree of interest rate pass-though.

Key words: Interest rate, pass-through

JEL Classification: E43

1. Introduction

Soon after the 2007-8's global financial crisis, one of the important challenges addressed to monetary authorities especially in the advanced economies is why interest rates are exceptionally low and the economic recovery still sluggish. This question revived the debate on the effectiveness of monetary policy for decision makers, academia and business people as well. Indeed, the effective monetary policy refers to the ability of the monetary authority to affect the real economy (employment, investment or production) with an aim of achieving its prime objective of price stability. However, this is objective is always coupled with an objective of ensuring stable financial system, reducing unemployment and contributing to economic growth.

The traditional channel through which monetary policy actions are transmitted to the real economy is the interest rate channel. The channel can be divided in two stages. The first is the interest rate pass- through which describes how markets rates (deposit and lending rates) react to changes in the monetary policy rate. The second stage is related to the impact of nominal interest rate changes on real economy.

Before the 2007-8's global financial crisis, several empirical researches found a complete interest rate pass-through in different developed economies. However, different scholars found an incomplete pass-through in low income countries and related it to the development level especially of their financial systems. For instance, Tieman (2004) identified a positive influence of the degree of competition and the absence market power in addition to the conclusions of Cottarelli and Kourelis (1994) on the role of developments in money markets instruments which play a role in removing rigidities in interest rates. This was

corroborated by Carare et. al,(2002) who also emphasized the role of other variables such as absence of fiscal dominance and external stability.

But why is it important to analyze the interest rate pass-through in Rwanda?

The National bank of Rwanda (BNR) implements a monetary targeting framework with the broad monetary aggregate (M3) as intermediate target and reserve money as operating target. Targets on reserve money are achieved through open market operations conducted through sale and purchase of government securities as well as repurchase agreement (REPO) with commercial banks. Others monetary instruments used by the BNR are reserve requirement, standing facilities and rediscount facilities. Since August 2008, the BNR introduced the use of Key Repo Rate (KRR) initially to provide banks with new reference for an efficient management of liquidity by setting the central bank rate at 8% per annum. This rate has regularly been reviewed by the Monetary Policy Committee (MPC) and progressively becoming a tool for the BNR to signal its monetary policy stance.

The implementation of the monetary targeting necessitates the stability of money demand function for which the velocity and the money multiplier are assumed to be stable and constant. However, there is evidence that these two elements are not constant and have limited the effect of monetary policy actions (see Kigabo and Irankunda, 2012). The effectiveness of monetary policy under monetary targeting regime was also a challenge in other East African Community member countries (EAC) and was discussed by Central Banks' Governors in the Monetary Affairs Committee (MAC). The Governors decided to move into inflation targeting framework by 2018 in which interest rate is used as an operating target. Thus it is imperative for the BNR to evaluate the empirical functioning of the interest rate channel in Rwanda.

The objective of this paper is to analyze how fast and to what extent changes in BNR bank rate are transmitted to market rates (deposit and lending rates) as the first building block for the interest rate channel of monetary transmission. This is the first research on the topic in Rwanda and is a contribution to the BNR's effort of putting in place necessary requirements for the use of interest rate as operational target by 2018 in line with the EAC monetary affairs committee's recommendation. In addition, the paper provides recommendations to policymakers in order to enhance monetary policy effectiveness in Rwanda.

The rest of the paper is organized as follow:
The section 2 summarizes the literature review on interest rate pass through. Section 3 analyzes some factors viewed as limiting the interest rate pass-through in Rwanda. Section 4 covers the methodology used in this paper. Empirical results are presented in the section 5, and section 6 provides the conclusions and policy recommendations.

2. Literature review

2.1 Theoretical foundations

The interest rate channel of the monetary policy transmission mechanisms refers to how monetary policy actions affect the real economy. There are several channels through which a monetary authority can influence output or prices namely the interest rate channel, the exchange rate channel, the portfolio/assets channel, the credit channel and the expectations channel. The Interest rate channel is the traditional approach rooted in the Keynesian liquidity preference theory.

It states that an increase in money supply in an economy in excess to demand will push interest rate down. The falling interest rate will imply cheap loans and

induce more borrowing which will raise investment and consumption. With the latter the aggregate demand in the economy will go up which will put upward pressures on inflation. The opposite will happen in case of a reduction in money supply.

$$(MS \uparrow) \gg int. \downarrow \gg C \uparrow (inv \uparrow) \gg agg.\ dd. \uparrow \gg \pi \uparrow$$

$$(MS \downarrow) \gg int. \uparrow \gg C \downarrow (inv \downarrow) \gg agg.\ dd. \downarrow \gg \pi \downarrow$$

2.2 Some empirical considerations

Empirically, the interest rate pass-through has been the subject of several studies, particularly in developed countries, especially following the adoption of inflation targeting framework for monetary policy. The evidence on features of interest rate pass-through shows that the transmission mechanism of interest rate is generally not complete and the speed of adjustment and the size of pass-through in long run vary due to differences in macroeconomic conditions and financial market developments (Gigineishvili, 2011).

Higher interest rate pass-through to lending and deposit rates has been observed during the period of rapid economic growth as well as in the period of high inflation. By contrast, higher interest rate volatility, which is an indicator of macroeconomic instability and uncertainty, weakens the interest rate pass – through.

The development of financial market plays an important role in monetary transmission. If the demand elasticity for deposits and for loans respectively is inelastic, the pass-through may not be complete. Inelasticity of the demand for deposits and loans may result from imperfect substitution between bank deposits and other money market instruments of the same maturity, between bank lending and other types of external finance due to low level of economic development (equity or bond markets), high switching costs as well as problems

related to asymmetric information such as adverse selection and moral hazard (Sander and Kleimeier, 2004), and the competition within the banking sector and in financial sector.

Indeed, when banks have high market power, changes in policy rate as well as changes in banks 'costs of funds may impact spreads (difference between lending and deposit rates) rather than market rates by maintaining fixed lending rates when deposit rates declined as result of a reduction in the policy rate, (Sander and Kleimeir, 2004, Catarelli and Korellis, 1994, De Bondt, 2002, Dabla Norris et al., 2007, Stephanie Medina, et al., 2011).

Financial shallowness tends to lead to higher excess liquidity in banks which limit the development of the interbank market and reduce the effectiveness of interest rate pass-through. In addition, more developed domestic capital markets, including a secondary market for government securities and long term domestic currency securities, strengthens the transmission (Leiderman et al., 2006, Stephanie Medina Cas, et al., 2011).

The health of the financial system may also impact the effectiveness of the interest rate transmission mechanism. Financially weak banks may respond to an injection of central bank liquidity or lower policy interest rates by building up liquidity or increasing margins in order to raise capital positions and increase provisioning rather than extending credit (IMF, 2010). Furthermore, high level of non-performing loans on the balance sheet may crowd out new loans and limit the impact of lower interest rates (Archer and Turner, 2006).

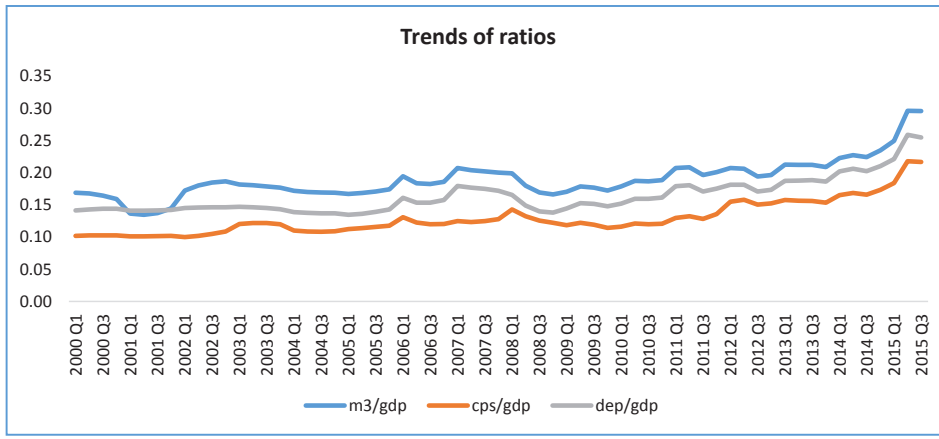
3. Analysis of key drivers of interest rate pass-through in Rwanda

The financial system in Rwanda has undergone significant reforms since 1995, with adoption of market based mechanisms, coupled with financial sector

liberalization and economic reforms. However, the sector remains not very well developed.

The level of monetization of the economy in Rwanda as measured by the ratio M3/GDP still low even if it shows increasing trends. Similarly, the level of financial intermediation still low as indicated by Deposits/GDP ratio and credit/GDP ratio. Between 2006 and 2014 the money supply (M3), credit and deposits as percentage of GDP increased from 19% to 23%, from 12% to 22% and from 16% to 25% respectively.

Chart 1: selected financial sector development indicators

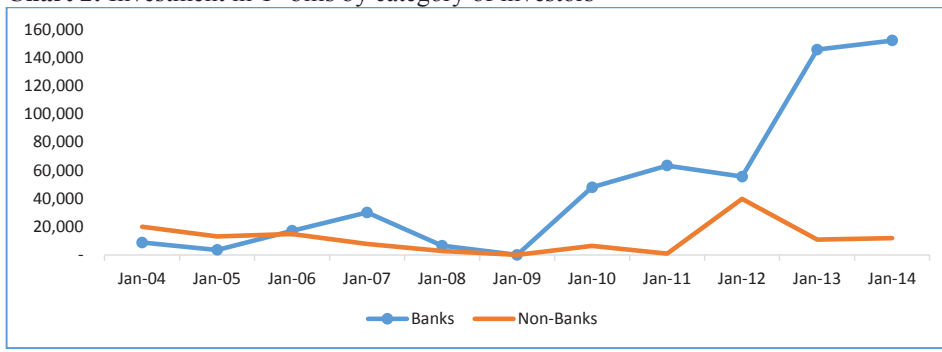


Source: Authors' computations

The financial sector in Rwanda is dominated by the banking system which limits the substitution between bank deposits and other money market instruments of the same maturity (e.g. money market funds or T-bills) and between bank lending and other types of external finance (equity or bond markets).

Indeed, the share of commercial banks in Treasury bill investment was 65.7% in average between 2002 and 2013 against 34.3% for non-bank financial institutions.

Chart 2: Investment in T- bills by category of investors



Source: Authors' computations

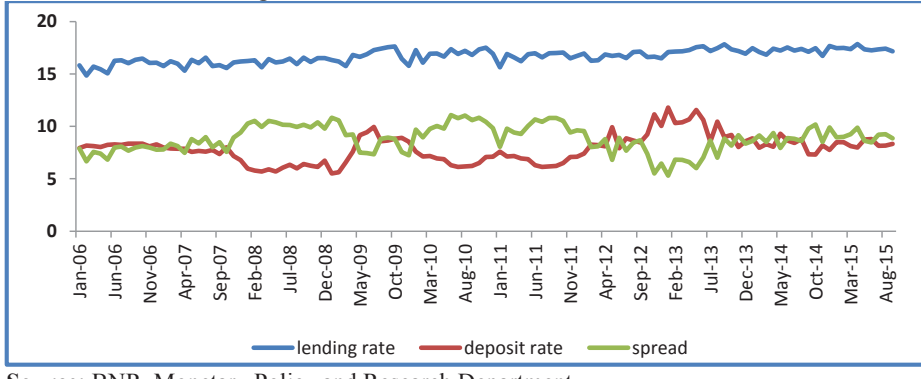
The competition and concentration in the banking sector in Rwanda has been increasing over the last decade. Herfindahl Hirschman index (HHI) calculated for assets, loans and deposits was around 0.13 in 2014) and approaching high competition levels). In addition, the Lerner index of the Rwandan banking sector has been declining since 2008, indicating improvement in the banking sector competition. This improvement is caused by various factors including entry of new banks (including foreign-owned ones) in the banking industry.

Table 1: Lerner Index

Year	2006	2007	2008	2009	2010	2011	2012	2013
Lerner Index(average)	0.48	0.42	0.45	0.41	0.39	0.38	0.32	0.29
Standard deviation	0.12	0.17	0.14	0.12	0.18	0.12	0.12	0.06

Source: BNR, Monetary Policy and Research Department

Chart 3: Interest rates spread

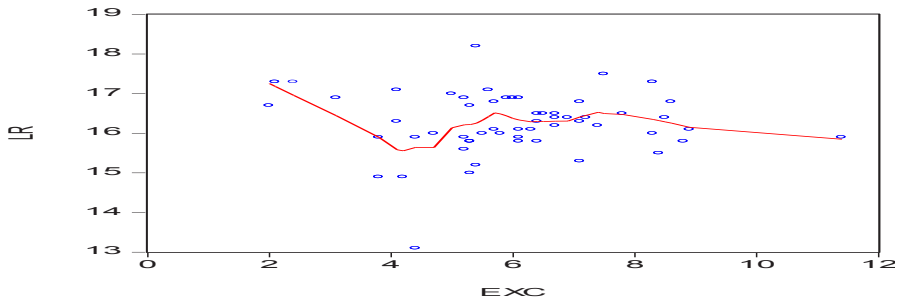


Source: BNR, Monetary Policy and Research Department

The limited level of competition in the banking system in Rwanda is also shown by the estimated liquidity preference curve for the banking sector using the locally weighted polynomial regressions of degree one. The technique is used to assess the nature of loans market. It is assumed that under a perfectly competitive loan market, excess liquidity and bank loans should become substitutes at a zero loan rate. A high level of rate of substitution indicates a less competitive sector.

The following graph shows that the liquidity preference curve for the banking sector in Rwanda becomes perfectly elastic at around 16% confirming market power of few banks. This may allow banks to set interest rates exogenously and not change them when BNR change its monetary policy stance.

Chart 4: Liquidity preference curve in the banking system



Source: BNR, Monetary Policy and Research Department

The banking sector in Rwanda has been experiencing high excess reserves since 2004 as a result of an increase in public spending, especially owing to increases in aid inflows. In a context where the financial market is not well developed, the excess liquidity has contributed to make banks indifferent to restrictive monetary policy measures aiming at reducing the need of banks to borrow from the NBR.

Thus, the BNR policy rate has been limited to opportunity cost of holding liquidity by banks instead of reflecting the margin costs of funding. In average, excess liquidity in the banking sector (liquidity in excess of reserve requirement after BNR intervention and cash in vaults in commercial banks) was 12 billion on annual basis between 2004 and 2013.

Finally, non interest rate factors in the banking sector in Rwanda limit the adjustment of lending rates to changes in policy rate. The interest rates spread in Rwanda remain high, particularly due to rigidity in lending rates. In addition to still limited competition in the sector, operating costs remain high in the banking industry in Rwanda. For example, by end march 2014, operating costs, including salaries, wages and staff costs as well as other expenses represented 61% of total expenditures of the sector.

4. Methodology

This study applied two models; the single equation and the autoregressive distributed lag model. On one hand, the single equation is the standard approach that seeks to establish the one-on-one effect of policy rates on market rates. In the second phase, this study adopted the Autoregressive Distributed-Lag Model (ARDL) which allows accounting for the presence of exogenous variable shock to endogenous variable and the importance of stickiness of the dependent variable in adjustment to the long-run equilibrium.

4.1 Single equation approach

The assessment of interest rate pass- through is generally based on a marginal pricing model which considers that a bank set an interest rate equals to the marginal cost of funding approximated by a market interest rate and a constant mark-up (Tieman, 2004, De Bondt, 2002, Borio, 1997).

$$MR_t = \alpha_1 + \alpha_2 PR_t + \varepsilon_t \quad (1)$$

Where MR_t is the market rate (loan and deposit rates), PR_t is the policy rate, α_1 is a markup and α_2 is the elasticity of market rate with respect to policy rate, measuring the long run pass through.

The equation (1) describes a long term relationship between policy rate and market rates and does not take into consideration the time factor for banks to adjust their interest rates. For example, medium- and long-term rates are primarily guided by expectations of future short-term rates and not the changes in current short term interest rates. In addition, average lending rates will adapt gradually, as new loans replace old ones.

Thus, to allow a gradual adjustment of market rates to the new policy rates we consider the equation (1) as the long run relationship around which short term dynamics adjust. This corresponds to error correction models linked to cointegration concept:

$$\Delta MR_t = \gamma_1 + \gamma_2 \Delta PR_{t-1} + \gamma_3 (MR_{t-1} - \alpha_2 PR_{t-1} - \alpha_1) + v_t \quad (2)$$

The coefficient γ_3 indicates the speed of adjustment of the short run dynamics to the long run equilibrium relationship described by the equation (1). A high level of γ_3 indicates a faster market response to the policy rate. α_2 Stands for the long- run pass-through. We estimate the equation (2) to test the interest rate pass-through in Rwanda, using monthly data running from April 2008 to September 2015.

4.2 The Autoregressive Distributed Lag Model

This study adopted the ARDL used in Sheefeni Sheefeni (2013) specified as:

$$MR_t = \alpha_1 + \alpha_2 PR_t + \alpha_3 MR_{t-1} + \alpha_4 PR_{t-1} + \varepsilon_t \quad (3)$$

Variables are defined as before. Equation 3 can be re-parameterized as an error correction term and gives:

$$\Delta MR_t = \alpha_2 \Delta PR_t + \gamma_{32}(MR_{t-1} - \beta_2 PR_{t-1} - \beta_1) + \varepsilon_t \quad (4)$$

Where:

$\gamma_{32} = \alpha_3 - 1$ is the speed of adjustment

$\beta_2 = \frac{\alpha_2 + \alpha_4}{1 - \alpha_3}$ is the degree of the pass-through in the long-run.

We included in the equation 3 a variable to capture the developments in the financial sector structure using the ratio of total bank deposits over gross domestic product (GDP) as a proxy basing on the empirical evidence of its impact on the degree of the pass-through.

4.3 Data source

We use monthly data from 2008 to 2015. All data are from the BNR. The dependent variables are the deposit rates and the lending rates applied by commercial banks. We considered the deposit rates from one-month maturity to 12-months maturity and short-term and long-term lending rates. The explanatory variables are the T-bills rates of all available maturities and the repo rates.

The data are in percentage rates and computed as weighted averages. For the last four years, the 13- has dominated other maturities on the money market except in 2015 followed by the 26-week T-bills as showed in Table 2.

Table 2: Stock of T-bills by maturity (in millions of FRW)

T-bills	2012	2013	2014	2015
4-week T-bills	226,310	444,037	277,222	339,312
13-week T-bills	278,190	565,459	713,480	696,808
26-week T-bills	237,506	407,883	590,474	756,522
52-week T-bills	201,170	211,748	327,755	566,424
total	1,086,328	1,629,748	1,092,866	2,359,067

Source: BNR, Monetary Policy and Research Department

5. Empirical results

5.1 Interest rate pass- through to deposit rates

The estimation of model 1 (see appendix 1) seeks to elucidate the impact of policy rates using indirect short-term monetary instruments T-bills. The estimation results suggest the existence of the policy interest rates pass-through (proxies by the T-bills rates) ranging between 0.14 and 0.45 for the long-run equilibrium.

This is a weaker pass-through compared to that found by Okello (2013) in Uganda and Namibia hovering around 0.43 and 0.90 respectively. Only the 3-months deposit rates react to only the 16-weeks T-bills rates. Other T-bills maturities are not statistically significant. This may be related to the fact that the 16-weeks T-bills dominates the transactions in money markets as shown in table 2.

The dynamics in the short run models show a limited pass-through of 0.15 but in the range of what Sheefeni Sheefni (2013) found in Namibia at the range of 0.26 to 0.45. The three-month deposits rates adjust at a rate of 38% to shocks in 16-weeks T-bills rates towards the long run equilibrium.

This low level of pass-through of T-bill rates to deposit rates is highly related to the current structure of the deposit markets in Rwanda dominated by few biggest institutional investors who have some market power to influence the deposit rates. The small effect is identified because some of these institutions do

sometimes participate on money markets and do likely weigh developments in money and deposit markets in the investment decision process. However, the level of substitution between the two markets is still low and does not highly involve small companies and individual savers.

5.2 Interest rate pass - through to lending rates

The degree of pass-through of money-market rates to bank lending rates is very small around 0.06 lower than that of some developing economies like Uganda and Namibia that evolving above 0.55 and 0.70 respectively.

The T-bills rates are passed to only long-term lending rates and the latter is responsive to all types of T-bills rates but only in the long-run. In the short-run, they solely react to the 16-weeks and the 52-weeks T-bills rates and the speed of adjustment is high at around 0.92. Yet again, the pass-through is identified after allowing the short-run changes in lending rates to depend on its past values and the level of financial structure attained in the last two quarters (See appendix 1, model 2&3).

Furthermore, the Autoregressive Distributed Lag (ADL) model was also used to examine the long and the short term dynamics between the T-bills rates and the long term lending rates as in Sheefeni (2013). The ADL model reveals that the 4-weeks T-bills rates have an effect on lending rates in the long and the short run but the long run effect is very minimal around 0.097. The short run effect is around 0.19 and any disturbance to the system is corrected immediately.

These results suggest that banks have much market power and the demand for bank loans is quite inelastic vis à vis lending rates. The pass-through is only present after controlling for the financial structure measured by the ratio of total bank deposits to GDP.

In this line, the low degree of substitution between bank loans and other sources of finance like equity and corporate bond makes banks the only sources of funds. This may indicate that the pass-through of policy rates will become larger as the financial structure becomes more developed.

6. Conclusions and Policy Recommendations

The BNR together with other regional central banks opted for using interest rate as operating target by 2018 basing on some challenges related to the current monetary framework. This study sought to find out how fast and to what extent changes in BNR bank rate are transmitted to market rates (deposit and lending rates) as the first building block for the interest rate channel of monetary transmission.

The findings suggest that only the 16-weeks T-bills rates have an effect on deposit rates in the long and the short run but the long run effect is very minimal oscillating around 0.14 and 0.45. The short run effect is small around 0.15. The incomplete policy interest rate pass- through to market rates is observed to be linked to evolution of the financial sector in Rwanda and the degree of financial awareness to increase the uptake of innovations achieved. The study suggests that:

There need for more efforts in developing the capital markets (Equity, corporate bonds markets), development of new products like longer term maturity deposits. In addition, management of liquidity should be improved to support the development of the interbank market which may help to reduce excess liquidity in the banking system. Authorities should continue to ensure the proper supervision and monitoring; for instance the level of non-performing loans because high level of non-performing loans may crowd out new loans and limit the impact of monetary policy.

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Appendix 1: Estimation results

Long run Model 1: Deposit rate = c(1)+ c(2)*T-bill rate										
ECM 1: d(deposit rate) = c(1)+ c(2)*d(T-bill rate) + γ*ecm(-1)										
Deposit rate/Maturity	**T-bill/maturity**	**Coefficient**	**Estimate**	**t-statistic**	**Adj. R-squared**	**Cointegration**	**ECM**	**Coefficient**	**Estimate**	**t-statistic**
1mdr	3m	C(1)	3.60	6.7	0.051	yes	ECM	C(1)	0.02	0.19
		C(2)	0.148	2.14				C(2)	1.04	0.19
								gamma	-0.61	-6.04
	6m	C(1)	3.60	6.3	0.054	yes	ECM	C(1)	0.02	0.15
		C(2)	0.148	2.130				C(2)	0.09	1.11
								gamma	-0.60	-6.11
	Weighted	C(1)	3.48	5.6	0.03	yes	ECM	C(1)	0.02	0.14
		C(2)	0.16	2				C(2)	-0.14	-0.73
								gamma	-0.61	-6.23
3mdr	1m	C(1)	3.722	5.18			ECM	C(1)	0.03	0.25
		C(2)	0.43	4.26				C(2)	0.08	0.79
								gamma	-0.38	-4.86
	3m	C(1)	3.1	3.82	0.289227	yes	ECM	C(1)	0.02	0.17
		C(2)	0.4564	4.56				C(2)	0.15	1.72
								gamma	-0.38	-4.58
	6m	C(1)	2.806	3.285	0.325	yes	ECM	C(1)	0.03	0.22
		C(2)	0.502	4.646				C(2)	0.25	1.23
								gamma	-0.39	-4.47
	Weighted	C(1)	2.8	3.28	0.31	yes	ECM	C(1)	0.03	0.41
		C(2)	0.5	4.64				C(2)	0.01	0.16
								gamma	-0.20	-3.39
WDPR	1m	C(1)	6.18	8.49	0.09	yes	ECM	C(1)	0.03	0.51
		C(2)	0.26	2.55				C(2)	0.01	0.16
								gamma	-0.20	-3.38
	Weighted	C(1)	5.43	6.28	0.18	yes	ECM	C(1)	0.03	0.40
		C(2)	0.33	3.018				C(2)	0.11	0.82
								gamma	-0.20	-3.25
6mdr	1m	C(1)	6.076	6.95			ECM	C(1)	-0.15	-0.43
		C(2)	0.293	2.38				C(2)	0.03	0.57
								gamma	-0.26	-3.81
	3m	C(1)	5.6	6.29	0.119	yes	ECM	C(1)	0.03	0.27
		C(2)	0.33	2.87				C(2)	-0.21	-0.95
								gamma	-0.29	-4.09
	6m	C(1)	5.22	5.41	0.110983	yes	ECM	C(1)	0.03	0.25
		C(2)	0.37	3.08				C(2)	-0.06	-0.67

Long run Model 1: Deposit rate = c(1)+ c(2)*T-bill rate										
ECM 1: d(deposit rate) = c(1)+ c(2)*d(T-bill rate) + γ*ecm(-1)										
Deposit rate/Maturity	**T-bill/maturity**	**Coefficient**	**Estimate**	**t-statistic**	**Adj. R-squared**	**Cointegration**	**ECM**	**Coefficient**	**Estimate**	**t-statistic**
								gamma	-0.28	-3.95
	12m	C(1)	4.06	4.00	0.27217	yes	ECM	C(1)	0.02	0.20
		C(2)	0.51	4.12				C(2)	0.03	0.15
								gamma	-0.31	-4.09
	Weighted	C(1)	5.13	4.95	0.121854	yes	ECM	C(1)	0.03	0.78
		C(2)	0.38	2.93				C(2)	-0.02	0.91
								gamma	-0.27	0.00
12mdr	1m	C(1)	7.26	9.01	0.103986	yes	ECM	C(1)	0.03	0.30
		C(2)	0.28	2.46				C(2)	0.02	0.21
								gamma	-0.21	-3.21
	3m	C(1)	6.92	8.32	0.176824	yes	ECM	C(1)	0.03	0.28
		C(2)	0.30	2.80				C(2)	0.02	0.14
								gamma	-0.22	-3.28
	6m	C(1)	6.47	7.74	0.205683	yes	ECM	C(1)	0.03	0.28
		C(2)	0.35	3.36				C(2)	0.09	1.36
								gamma	-0.22	-3.30
	12m	C(1)	5.67	6.31	0.305005	yes	ECM	C(1)	0.02	0.25
		C(2)	0.44	4.02				C(2)	0.18	1.22
								gamma	-0.23	-3.21
	Weighted	C(1)	6.46	6.80	0.184547	yes	ECM	C(1)	0.03	0.30
		C(2)	0.35	2.93				C(2)	0.14	0.89
								gamma	-0.21	-3.23

Model 2: Lending rate = c(1)+ c(2)*T-bill rate + c(3)*Total deposits to GDP ratio										
ECM 2: d(lending rate) = c(1)+ c(2)*lending rate(-1) + c(3)*d(T-bill rate) + c(4)*Total deposits to GDP ratio(-2) + γ*ecm(-1)										
							ECM			
Long term lending rates	3m	C(1)	10.46	22.17	0.618989	yes	ECM	C(1)	2.38	0.50
		C(2)	0.06	1.99				C(2)	-0.22	-0.53
		C(3)	6.33	13.21				C(3)	0.05	0.56
								C(4)	1.56	0.61
								gamma	-0.93	-2.48
	6m	C(1)	10.49	22.69	0.614482	yes	ECM	C(1)	2.69	0.58
		C(2)	0.06	1.96				C(2)	-0.25	-0.61
		C(3)	6.28	13.32				C(3)	0.06	0.85
								C(4)	1.71	0.68
								gamma	-0.91	-2.45

Model 3:Lending rate = c(1)+ c(2)*T-bill rate + c(3)*Lending rate(-1) + c(4)*T-bill rate(-1) + c(5)*Lending rate(-2) + c(6)*T-bill rate(-2)							
ECM 3: d(lending rate) = c(7)*d(T-bill rate) + c(8)*[Lending rate(-k_i)- c(9)*T-bill-rate(-j_i)] with i = 2							
c(8)= c(3)+c(5)-1 and c(9)= (c(4) + c(6))/(1-(c(3)+c(5))							
Deposit rate/Maturity	**T-bill/maturity**	**Coefficient**	**Estimate**	**t-statistic**	**ECM**	**Coefficient**	**Estimate**
Long term lending rates	T-bill1	c(7)	0.190712	Significant at 10%		c(8)	-1.8027
		c(9)	0.009707				
	T-bill12	c(7)	0.29325	Not significant		c(8)	-1.9281
		c(9)	0.052625				

Appendix 2: Selected indicators of financial sector development in EAC countries

	Uganda			Kenya			Tanzania			Rwanda		
	CPSY	MY	TDY	CPSY	MY	TDY	CPSY	MY	TDY	CPSY	MY	TDY
2000	6.2	19.2	14.6	37.2	26.3	32.7				10.6	20.4	15.5
2001	7.1	19.6	14.9	36.1	23.2	31.7	5.4	20.6	16.8	10.3	17.6	15.7
2002	7.9	17.2	13.3	39.1	23.9	33.9	6.9	22.6	18.5	10.7	18.1	16.7
2003	8.4	17.6	13.6	39.9	23.3	35.0	8.2	23	19.2	11.9	16.9	15
2004	8.1	17.3	13.5	40.1	25.8	35.2	9.4	22.6	18.6	10.6	15.5	14.1
2005	8.6	17.3	13.4	39.4	25.4	34.7	10.4	26.6	22.3	11.3	15.2	16
2006	10.1	18.0	13.6	35.1	22.1	31.0	12.9	28.8	24.3	12.1	18.7	17.9
2007	10.2	18.9	14.6	36.1	23.4	31.7	15	29.7	25.7	12.5	18.4	17.9
2008	13.9	20.5	16.1	36.3	26.1	32.5	18.4	30.1	25.9	13.1	15.5	15.9
2009	13.3	20.1	16.1	36.5	25.8	33.0	17.7	31.1	27.8	12.1	17.8	15.1
2010	15.7	25.5	20.8	40.1	28.0	36.2	18.6	34.1	30.2	12.1	18.8	16
2011	18.6	23.0	18.5	40.6	31.2	37.0	20.3	34.7	30.2	13.2	20.3	17.6
2012	16.2	22.8	18.6	40.6	30.2	37.1	20.1	32.8	28.7	15.6	20.3	17.9
2013	14.4	22.2	18.3	42.0	32.4	38.5	19.5	30.3	26.5	15.7	21.3	18.9
Average	11.3	19.9	15.7	38.5	26.2	34.3	14.1	28.2	24.2	12.3	18.2	16.4

Optimal excess liquidity in the Rwandan banking sector: Empirical analysis

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Abstract

The banking system in Rwanda has been building up high levels of excess reserves, and this has been posing a challenge for monetary policy transmission mechanism and limiting the effectiveness of use of alternative interest rate operating target amid unstable money demand function.

The paper estimates banks' demand function for reserves from which an optimal level of excess reserves is directly derived. Using a Tobit model, empirical findings have revealed that the demand for reserves is significantly explained by the level of total deposits in the banking system, repo rate which is a proxy for interest rate on short term maturity assets and the penalty rate applied to banks whose reserves fall below the required level. Based on simulation results, the paper recommends to mop up excessive liquidity until excess reserves fall within a band spanning from 20% to 30% above the required reserves, which corresponds to a repo rate band of 5.28% to 4.04%.

Key words: Excess reserves, required reserves, interest rates, monetary policy.
JEL Classification: G21, E43, E52

1. Introduction

The National Bank of Rwanda (BNR) implements its monetary policy under a monetary targeting regime since 1997 using open market operations to steer the level of excess reserves aimed at impacting the monetary aggregates via the reserve money and assuming the stability and predictability of money multiplier and money demand.

However, the complexity of financial systems has made money multiplier and velocity unstable and therefore compelling most central banks to abandon the reserve money program, shifting to the use of interest rate as a tool of managing liquidity in the banking sector. Central banks supply reserves money in a way that money market rates more close to central bank rates. In efforts to harmonize monetary policy operations, EAC central banks have committed to all shift to more price based monetary policy framework by end 2018 as a transition to the adoption of inflation target before the use of a common currency in 2024. In this new way of implementing monetary policy, managing short term interest rates becomes of key importance in the monetary policy transmission mechanism (Vyshenevska, 2015; Tom Bernhardsen *et al*. 2010).

Existing literature indicates that much excess of liquidity in the banking sector may limit the effectiveness of monetary policy limiting the reaction of banks to changes in central bank rate. This is likely to have adverse consequences for the ability of monetary policy to influence demand conditions and, thus, to stabilize the economy. Agénor, Aizenman and Hoffmaister (2004) noted that if banks already hold liquidity in excess of requirements, any attempt by the monetary authorities to increase liquidity to stimulate aggregate demand will be inefficient. In addition, it was argued that in the presence of excess bank liquidity, it becomes difficult for central banks to regulate the money supply using the required reserve ratio and the money multiplier (Aryeetey, 1998).

Accumulation of non-remunerated reserves may be a result of commercial banks' optimizing behavior. It can results from contraction in the supply of credit by banks, and not due to a reduction in the demand for credit. Hence, their results suggest that the build-up of reserves can be not excessive in the sense that it exceeds commercial banks' desired level of reserve holdings. Different factors have been identified as key reasons for banks to hold excess liquidity. They include uncertainty or risk of default, institutional factors, poorly developed interbank markets which limits banks to borrow in order to cover contingencies, problems related to payments system and difficulties encountered by banks in tracking their position at the central bank which may require them to hold reserves above the statutory limits (Agénor, Aizenman, and Hoffmaister, 2004).

However, build-up of excess liquidity may not necessarily be voluntary and results from a reduction in the demand for credit as a result of the contraction in aggregate demand. This, in certain conditions, commercial banks may hold involuntary excess liquidity (Hallward-Driemeier, 1999; Wyplosz, 2005). In this case, any attempts by central banks to boost credit demand by lowering the cost of borrowing will be largely ineffective. An expansionary monetary policy would simply increase the level of unwanted excess reserves in commercial banks and not lead to an expansion of lending. Similarly, contractionary monetary policy will simply cause banks to reduce their unwanted reserves, and will only affect monetary policy if it reduces reserves to a level below that demanded by banks for precautionary purposes (O'Connell, 2005). Furthermore, when a commercial bank system is experiencing excessive liquidity, central bank rates become an opportunity cost instead of reflecting the marginal cost of funding for commercial banks.

This raise the issue of determining what would be an optimal level of banking excess liquidity to facilitate the monetary transmission mechanism. That is what this research is intended to do. In other words, this research will propose a methodology of estimating the optimal level of excess liquidity in the banking sector in Rwanda in line with the BNR objective of moving from reserve money program to the use of interest rate as operating target. The use of interest rate requires the money market to operate smoothly so that changes in the central bank policy rate affect the yield curve. Thus, the money market has to be liquid and deep across maturities and commercial banks' liquidity managed in a way to allow strong interest rate pass through. In addition, monetary management has to ensure that money market conditions remain in line with monetary policy stance (Alexandre Chailloux et al, 2009).

The rest of the paper is structured as follows: section 2 develops the literature review on the relationship between excess reserves and money market interest rates, section 3 presents monetary policy framework in Rwanda, section 4 scans the model specification and data discussions, section 5 presents empirical findings and simulation results, and section 6 concludes.

2. Literature review

In emerging market economies as well as in developing countries, central banks have been shifting from monetary targeting frameworks to inflationary targeting. Monetary targeting regimes in low-income countries (LICs) typically have focused on controlling the quantity of liquidity and credit available to the economy both in the short run and over the medium term, while inflation targeting regimes have focused on controlling the price of liquidity and credit (Nils Maehile, 2014).

However, the monetary targeting practice in many LICs differs from the past advanced-country monetary targeting frameworks. In the latter group, short-term interest rates and not reserve money in most cases served as the de facto operational target for the daily operations while monetary aggregates, including reserve money and reserves, served as intermediate targets. Being the ultimate supplier of liquidity, central banks have been in a pole position to exert their influence on the overnight interest rate, and thus short-term interest rates through their influence on market settlement balances.

Monetary operations such repurchase agreements operations, reverse repurchase agreements operations, T-bills, standing facilities, etc… are the most used tools to influence excess reserves of money depository banks. In their study of the interbank markets for overnight loans of the major industrial countries, Bartolini *et al.* (2002) found that central banks' operating procedures and intervention styles have a significant impact on the short-term interest rates' day-to-day behavior. According to Neyer and Wiemers (2003), an increase in the central bank rate leads to a likewise increase in the interbank market rate and that there is a positive relationship between the total liquidity needs of the banking sector and the interbank market rate.

In their discussions on the demand for and supply of reserves, and determination of market rates, Benjamin M. Friedman and Kenneth N. Kuttner (2010), argued that what is straightforward in this concept of reserves held by banks, on deposit at the central bank, are a liability of the central bank, and that the central bank has a monopoly over the supply of its own liabilities and hence can change that supply as policymakers see fit. What is less obvious, and in some aspects specific to the details of individual countries' banking systems, is why banks hold these central bank liabilities as assets in the first place.

The issue of excess reserves in the banking systems has been a troubling development for many central banks at least since the financial crisis period. For the case of US, reserves started to increase dramatically at the end of 2008 (Huberto and Alexander (2012). Todd and James (2009) argue that the buildup of excess reserves in the banking system during the financial crisis reflects the scale of the Fed's policy initiatives, but conveys no information about the initiatives' effects on bank lending or on the economy as a whole.

In their paper, Edlin and Jaffee (2009) argue that the then high levels of excess reserves were resulting from a continuation of credit crunch while Todd and James (2009) report that some commentators see the increase as evidence that banks are hoarding funds rather than lending them out.

The issue is seen as an alarming development to an extent that Sumner (2009) advises to place a tax on excess reserves while Dasgupta (2009) proposes to set a ceiling of excess reserves banks are allowed to hold. In fact, one would qualify the proposals as being extremely opposite to the current practices of some central banks – such as the Fed and the Bank of Jamaica - that pay interest to excess reserves.

About the Bank of Jamaica, Karen (2012) reported that the Jamaican banking system was experiencing a situation of excess reserves since the past two decades. The author argues that reserves provide a good position to respond to liquidity shocks but also he raises questions as to whether or not such high levels of excess reserves present challenges to the Central Bank in its monetary policy decisions. He claims that even in the context of extremely tight monetary policy stance, banks have easily been able to extend credits.

In the Eurozone the issue of excess reserves also raised some debates. Ulrich *et al.* (2004) study the impact that changes to the operational framework for monetary policy implementation have on the level and volatility of excess reserves. Their simulation results have shown that excess reserves may increase considerably under some changes to the operational framework, but also that their volatility and hence unpredictability could.

In Japan, Ogawa (2004) reported that one of the factors explaining the demand for excess Reserves in Japan is a low short-term interest rate, or call rate and proposed that excess reserve holdings in Japan may be halved by raising the call rate to its level prior to the zero-interest-rate policy applied by the bank of Japan and by reducing the bad loans ratio by 50%. However, Ulrich *et al.* (2004) point out that:

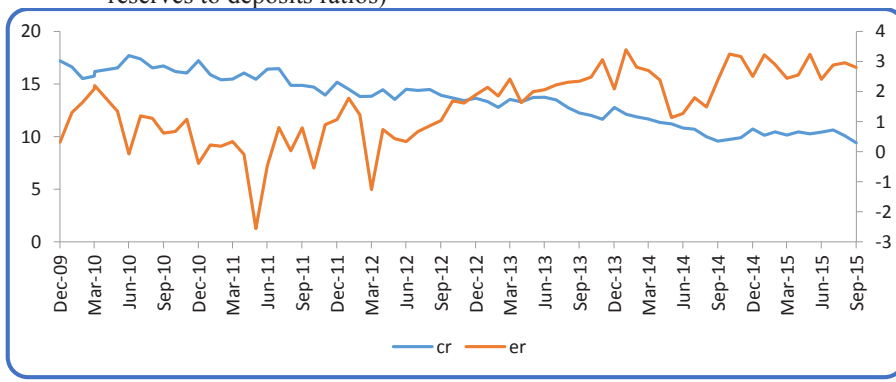
> *"the resulting negative correlation between interest rates and excess reserves is not the basis for an excess reserves channel of monetary policy transmission because the excess reserves in the model are nothing that a bank could use to expand its loans and hence to create additional money. Excess reserves are not a stable quantity at the level of individual banks, but just a stochastic ex-post residual from payment shocks. Therefore, it does not make any economic sense to expect individual banks to expand loans if this residual increases on average."*

3. Monetary policy framework in Rwanda

The National Bank of Rwanda implements its monetary policy under a monetary policy regime with the ultimate objective of achieving price stability. To achieve this objective, BNR controls the broad money supply (M3), the nominal anchor, via monetary base assuming stable and predictable money multiplier and money demand.

However, recently there have been signs of weaknesses in the stability of both money multiplier and velocity of money. For instance, the instability of money multiplier is caused by the developments of its two big components: the currency to deposit ratio and the excess reserves to deposit ratio. The currency to deposit ratio (cr) has been declining over time with the expansion of the financial inclusion, particularly the extension of the banking sector network and the development of microfinance institutions. The excess reserves to deposit ratio (er) has been more volatile over time due to BNR interventions on the money market. In the period under review, the coefficient of variation of excess reserves was 91.7%, higher than the one of deposits (32.0%) and currency in circulation (15.6%). Excess liquidity has been growing in line with the monetary policy stance adopted since the second half of 2013. As a result, money market interest rates have been declining progressively over time.

Figure 1: Developments of money multiplier components (currency and excess reserves to deposits ratios)

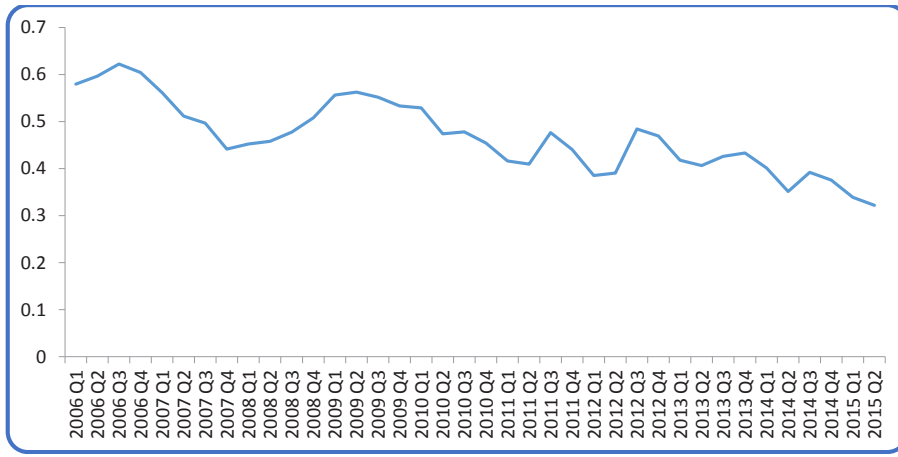


Source: By authors using data collected from BNR

In regards to the velocity of money, which is nominal GDP to broad money; the ratio has been declining over time due to the development in financial system in Rwanda which led to high increase of the broad money (M3). This is another

indication of challenges in the current monetary framework, calling for the adoption of more price based monetary policy.

Figure 2: Velocity of money

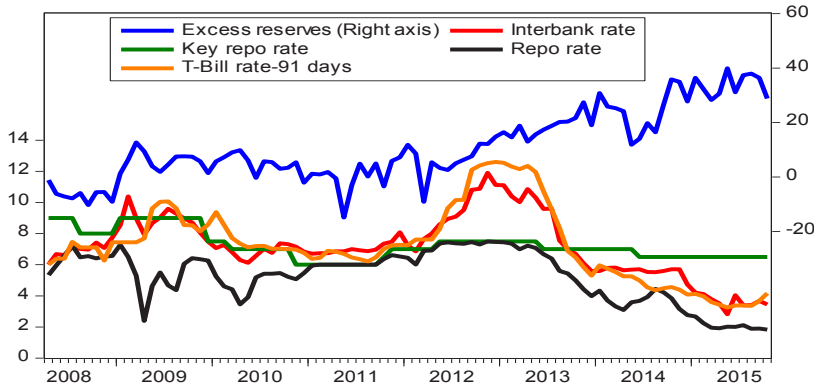


Source: By authors using data collected from BNR

To take into consideration the effects of financial sector development on monetary aggregates, BNR adopted a reserve money band, providing more flexibility and reducing some distortions in money market interest rates, thus improving the effectiveness of monetary policy. The new operational target started in November 2012, and the band was set ± 2% from the central target of reserve money.

This gives more room to BNR to implement an accommodative monetary policy and supports the development of interbank market, which is key for monetary transmission mechanism. As a result, repo operations outstanding and money market rates declined creating much excess liquidity in the banking sector.

Figure 3: Excess reserves (in billions of FRW) versus money market interest rates



Source: By authors using data collected from BNR

For better understanding, we split the period into two ones and we realized that the strongest and significant evidence of an inverse association is provided by the data for the post-period of introduction of reserve money band. The correlation coefficient between excess reserves and all money market interests such as interbank rate, key repo rate, repo rate and the 91 days T-bills rate, has been negative and above 70.0%.

This analysis indicates that by keeping optimal level of excess liquidity, BNR is able to move money market rates close to its current key repo rate. And this is a very good signal in case the central bank may decide to steer short-term interest rates as new operating targets.

Table 1: Correlation between excess reserves and all rates (Nov-12 to Oct-15)

	EXCESS_RESERVES	INTERBANK_RATE	KRR	REPO_RATE	TB_91
EXCESS_RESERVES	1	**-0.773**	**-0.709**	**-0.780**	**-0.725**
INTERBANK_RATE	**-0.773**	1	0.896	0.978	0.979
KRR	**-0.709**	0.896	1	0.877	0.924
REPO_RATE	**-0.780**	0.978	0.877	1	0.956
TB_91	**-0.725**	0.979	0.924	0.956	1

Source: By Authors

Furthermore, pairwise Granger causality test has been performed and the results support the existence of one way causality spanning from excess reserves to interbank rate and repo rate. However, there is no indication of causality between excess reserves and both the T-bills rates and central bank rate. In the section below, we present the methodology to be used to determine the optimal level of excess reserves in the Rwandan banking sector.

4. Model specification and data discussion

4.1 Model specification

The model of reserve demands (see Freixas and Rochet, 1997) stipulates that commercial banks allocate a given amount of deposits to interest rate bearing asset and to reserves held at the central bank bearing no interest. Formally, this implies that commercial banks maximize income generated by interest rate bearing assets by keeping their reserves at a minimum required level. In such extreme case, the Rwandan commercial banking system would have the following mathematical model:

$$R_t - \delta_t D_t = 0 \quad (1)$$

Where R_t: total reserves of the commercial banks held in the Central Bank at time *t*;

δ_t: required reserve ratio at time *t*;

D_t: total deposits in the commercial banking system at time *t*.

However, equation (1) puts commercial banks in a situation of high risk as they may fail to respond to unanticipated large withdrawals of deposits. Therefore, it is rational that banks accept to forego a certain portion of the potential maximum profit to avoid high cost that can be incurred in case they are unable

to meet large unanticipated withdrawals of deposits. Therefore, the objective function for commercial banks' reserves is as follow:

$$r_l(D_t - R_t) - r_p E\left[Max\ D_t\left(0, \tilde{\chi}_t - R_t\right)\right] \quad (2)$$

Under-constraint of

$R_t = \delta_t D_t$

Where:

r_l is the interest rate on the interest-bearing asset[4];

r_p is the penalty rate in case commercial bank reserves fall below the required level;

$\tilde{\chi}_t$ is the stochastic amount of withdrawals.

A Lagrangian function is derived from equations (2) and (3) to form equation (4) below:

$$L(R_t, \lambda) = r_l(D_t - R_t) - r_p E\left[Max\ D_t\left(0, \tilde{\chi}_t - R_t\right)\right] + \lambda(R_t - \delta_t D_t) \quad (4)$$

Equation (4) was solved and transformed by Ogawa (2004) to yield the following equation:

$$logR_t = logX_0 - \frac{1}{\theta}\log\left(\frac{R_l - \lambda}{R_p}\right) \quad (5)$$

Where X_0 is expressed as a function of deposits and the ratio of nonperforming loans as:

$$X_0 = \alpha D^{\beta} NPL^{\tau} \quad (6)$$

Where: $\alpha > 0;\ \beta > 0;\ \tau > 0$

Substituting equation (6) into (5) we have the following modified optimal reserve demand function:

[4] The paper alternatively uses the repo rate of 7 days maturity and 7 days interbank rate for robustness check.

$$logR_t = log\alpha + \beta logD_t + \gamma logNPL - \frac{1}{\theta}\log\left(\frac{R_l - \lambda}{R_p}\right) \quad (7)$$

The optimal level of excess reserves is therefore computed as being the difference between optimal reserves obtained from equation (7) and the required reserves.

4.2 Data discussion

Quarterly data covering the period 2006Q1 to 2015Q3 have been used to estimate the optimal level of reserve demand function in Rwanda. All the data defined below have been collected from the National bank of Rwanda. They include banks reserves at BNR (RES), excess reserves (Excess-res), reserve requirement ratio (RRR), repo interest rate (RL_repo), 7 days interbank interest rate (Rl_inter7), penalty rate (RP) and non-performing loans (NPL)**.** Their descriptive statistics are depicted in Table 2.

Table 2: Descriptive statistics

	Obs.	Mean	Median	Max.	Min.	Std. Dev.
EXCESS_RES	39	7.4	2.6	38.4	-10.3	12.8
RRR	39	6.0	5.0	8.0	5.0	1.4
RES	39	43.9	30.1	111.3	11.3	28.2
NPL	39	11.8	10.7	25.6	5.8	5.9
RL_INTER7	39	6.9	6.5	10.0	3.5	1.8
RL_REPO	39	5.8	6.0	9.0	1.9	1.8
RP	39	16.6	16.5	18.0	15.0	1.1
KRR	39	7.6	7.5	9.0	6.0	1.1

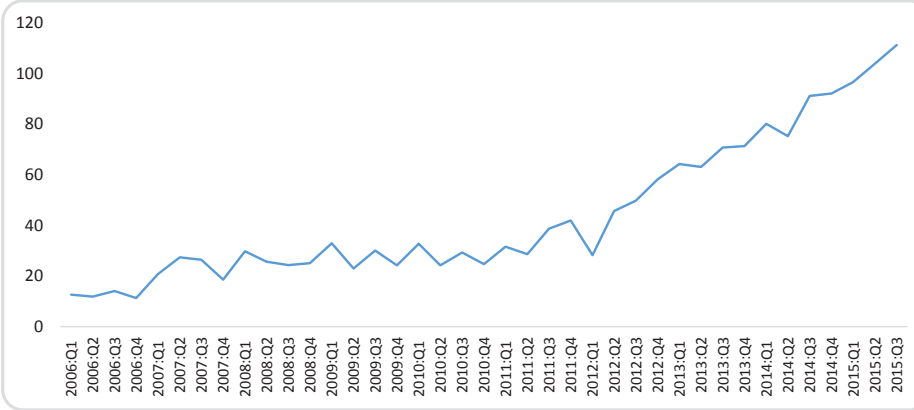
Source: By the authors using data from BNR

a. Banks reserves at BNR (RES)

Banks reserves at BNR are the total closing balances of commercial banks or depository money banks at the central bank. Figure 1 below shows that for the period under review, banks reserves have been expanding in line with the banking sector development as well as economic growth. The chart indicates a

more significant increase since the second quarter of 2013, following the accommodative monetary policy stance adopted by the central bank since then.

Fig.4: Evolution of banks reserves at BNR



Source: By the authors using data from BNR

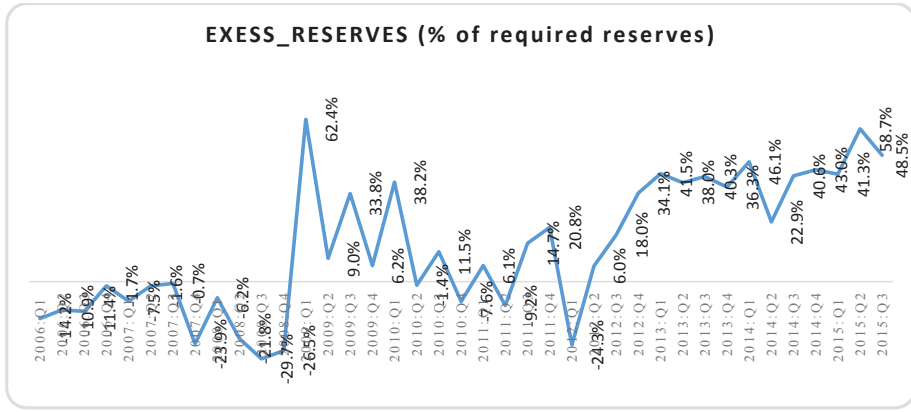
b. Reserve requirement ratio

Reserve requirement ratio is the ratio that is applicable to the prescribed liabilities of commercial banks. Since February 2009 the ratio stands at 5% after it was revised down from 8%.

c. Excess reserves (Excess-res)

Excess reserves stand for those reserves above the required reserves at the central bank, which means the difference between total commercial banks closing balances and required reserves. Since 2013, reserves above the required reserves have been averaging around 40% above the required reserves and consequently, money market interest rates have been declining to reach its lowest level of 1.9% in 2015Q3.

Figure 5: Evolution of banks excess reserves

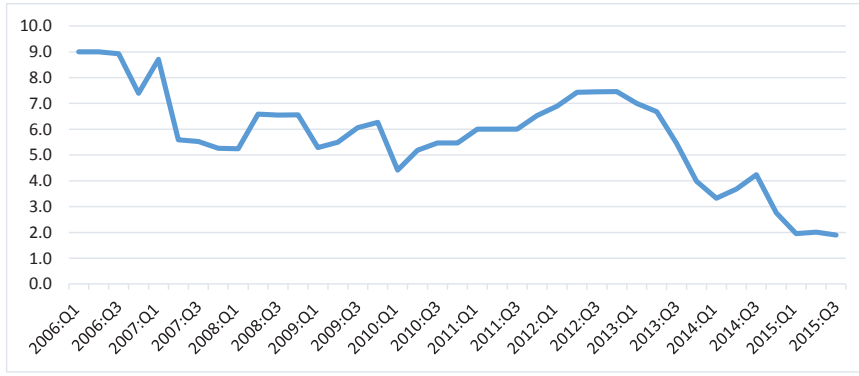


Source: By the authors using data from BNR

d. Repo interest rate

Repo rate is the interest rate that the central bank pays on the banks' investments in the short-term security called "repurchase agreements operations" of 7 days maturity. This monetary policy instrument serves for mopping the liquidity up from the banking system. As mentioned above, the repo rate has been evolving in opposite direction with the level of excess reserves, stressing the negative correlation between the two.

Figure 6: Evolution of repo interest rate

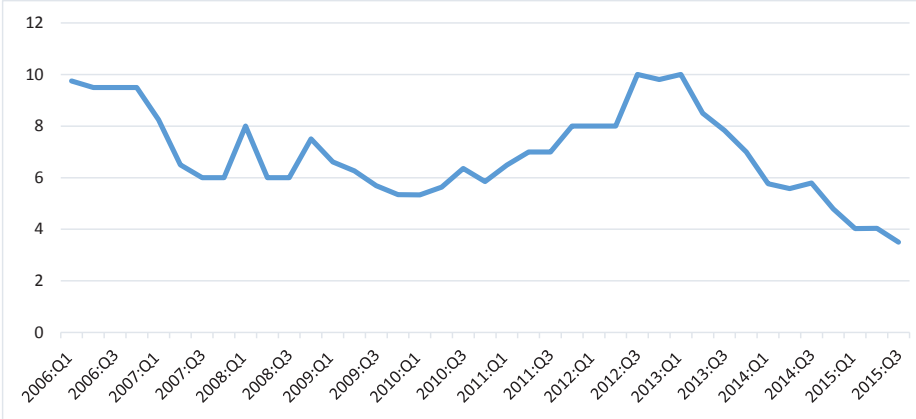


Source: By the authors using data from BNR

e. Seven (7) days interbank interest rate

Seven (7) days interbank rate is the interest rate charged on loans between banks with the maturity of 7 days. Like the repo rate, the 7 days interbank rate has also been declining since the second quarter of 2015 indicating a negative relationship it has with excess liquidity.

Figure 7: Evolution of 7 days interbank interest rate



Source: By the authors using data from BNR

f. Penalty rate

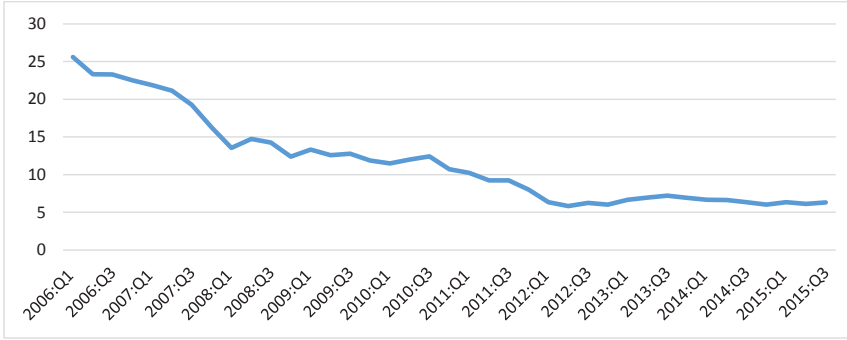
Penalty rate is the rate at which the central bank fines any bank which does not comply with minimum reserve requirement. It is calculated as KRR+4%+5%; KRR being the key repo rate. With the current KRR of 6.5%, the penalty rate stands at 15.5%.

g. Non-performing loan

Non-performing loan (NPL) is the amount of loans in default of payment. The NPL ratio is calculated as the amount of non-performing loans over total loans.

For the period under review, the NPL ratio has declined significantly from 25.6% in 2006Q1 to 6.3% in 2015Q3.

Figure 8: Evolution of the non-performing loan



Source: By the authors using data from BNR

5. Empirical findings and simulation results

The series used in the empirical model, have been subjected to unit root test using Augmented Dickey –Fuller test. Results reported in appendix 1 has revealed that all the series are integrated of order one (I~(1))[5]. The following step was to test for cointegrating relationship among variables. The paper uses the Johansen (1991, 1995) methodology which has evidenced the existence of one cointegrating equation among the variables.

Indeed, Table 8 in the appendix shows that both the trace and maximum Eigenvalue have indicated one cointegrating equation which makes it possible to apply a single equation approach. Following Ogawa (2004), we estimated the reserve demand function using a Tobit model and found the following results[6].

[5] However, it is worth mentioning that the ratio of the repo rate (or 7 days interbank rate) to the penalty rate is stationary.

[6] Detailed results are found in Table 4 of the appendix. Equation (6) is without NPL which is found to be non-significant while $R_L$stands for repo rate as it has generated more robust results as compared to the 7 days interbank rate.

$$log\hat{R}_t = 1.003 logD_t - 0.299 \log\left(\frac{R_l}{R_p}\right) - 3.059 \quad (6)$$

$$(0.07) \qquad (0.10) \qquad (0.39)$$

Note: Numbers in (.) are standard errors of the corresponding estimates.

Where $\hat{R}_t$ is the optimal level of commercial banks' reserves at time *t*

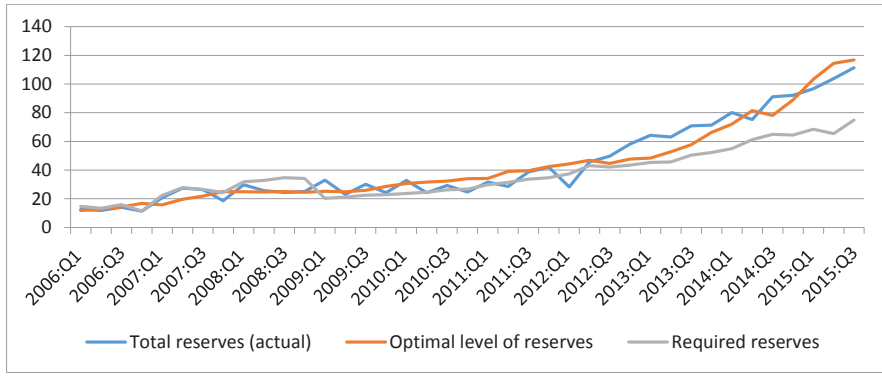
Estimation results reported in equation (6) indicate that parameter estimates have expected signs as well as statistically significant at 5% level of significance. The elasticity of deposit with respect to reserve demand is found to be 1 which indicates a one on one correlation between the two variables.

Indeed, these results show that in terms of proportion, changes in bank reserves perfectly correspond to changes in their client's deposits. This can be interpreted that deposit, reserves and required reserves grow at the same rate implying an increasing positive excess reserves over time.

As expected, the same equation shows that the repo rate is negatively related to reserves demand while the penalty rate is positively related to the later. This means that banks are more willing to invest in repo as its return increases, while avoiding negative reserves to prevent penalty.

Based on the estimated parameters of the optimal equation (6), the optimal level of commercial banks' reserves ($\hat{R}_t$) has been computed for each time *t*. On the other hand, the optimal level of excess reserves is computed by subtracting the required reserves from the optimal reserves ($\hat{R}_t$) of the banking sector.

Figure 9: Evolution of reserves (actual, optimal and required reserves)

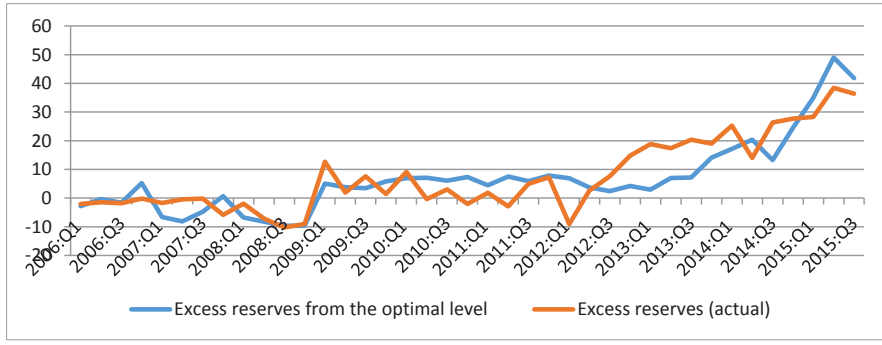


Source: By the authors using data from BNR and estimates

The trends show a close co-movement between actual and optimal levels of reserves. This shared trend between the two series indicate that the level of reserves that banks decide to hold is around the optimal level and so the actual excess reserves are mostly close to their optimal level.

As far as excess reserves are concerned, it is worth mentioning that for the period spanning from 2010:Q2 to 2012:Q2 the actual excess reserves were evolving below the optimal level but since then, with the exception of 2014:Q2, the situation reversed with the banking system recording excess reserves above the optimal level until 2015:Q1.

Figure 10: Evolution of excess reserves (actual and optimal levels)



Source: By the authors using data from BNR

Further analysis has shown that the recent trend of excess reserves is being guided by a very low level of repo rate. For instance, the repo rate has decreased from 4.2% in 2014Q3 to reach 1.9% in 2015Q3, a decrease which implies a 15.9% increase in optimal reserves other things held constant.

5.2 Simulation results

In this subsection, we have simulated different scenarios relating reserves (and so excess reserves) with repo/penalty rate ratio with the aim of guiding monetary policy makers in the management of excess liquidity. The simulation consist of keeping variables to their actual levels and we derive a repo rate which is consistent with different levels of excess reserves; namely 0%, 10%, 20%, 30%, 40% and 50% above the required reserves for the three quarters of 2015.

However, it was kept in mind that a 0% excess reserve above the required level would be non-rational as banks will be running the risk of being unable to respond to unanticipated high demand.

Therefore, a rational bank is expected to have positive excess reserves. For example, Ogawa (2004) used data from the Japanese banking sector and identified a bank as holding excess reserves in case its reserves exceed the required reserves by at least 10%. However, for robustness check he also used what he calls a more conservative definition of excess reserves which considers that only banks with actual reserves exceeding the required reserves by 50% are identified as holding excess reserves.and sometimes researchers consider that banks hold excess reserves in case their reserves are at least 10% above the required levels.

Table 3: Different scenario relating excess reserves to repo rate

Reserve level	Repo rate			
	2015:Q1	2015:Q2	2015:Q3	Average 2015
0 % above the required reserves	*7.75*	*13.01*	*8.36*	***9.71***
10 % above the required reserves	*5.64*	*9.46*	*6.08*	***7.06***
20 % above the required reserves	*4.21*	*7.08*	*4.55*	***5.28***
30 % above the required reserves	*3.23*	*5.42*	*3.48*	***4.04***
40 % above the required reserves	*2.52*	*4.23*	*2.72*	***3.16***
50 % above the required reserves	*2.00*	*3.36*	*2.16*	***2.51***

Source: By authors

Table 3 shows different scenarios of excess reserves and corresponding repo rates keeping other variables to their recorded actual levels. Simulation results indicate that reserves that are 20% & 30% above the required level are respectively consistent with repo rates of 5.28% and 4.04%. This range of repo rate is 1.22% to 2.46% below the KRR of 6.5%[7]. This being the case, one would conclude that the objective to have a small margin between the KRR and the repo rate is consistent with reserves that are 20% and 30% above the required level.

[7] The objective of the National Bank of Rwanda is to have repo rates which are close to the KRR.

6. Conclusion

Since recently, Rwandan banks have recorded increasing excess reserves that stood around 40% above the required reserves in September 2015. This being the case, the objective of the paper was to estimate banks' demand function for reserves from which an optimal level of excess reserves is directly derived. Using a Tobit model, empirical findings have revealed that the demand for reserves is significantly explained by the level of total deposits in the banking system, repo rate which is a proxy for interest rate on short term maturity assets and the penalty rate applied to banks which reserves fall below the required level. As expected reserves of commercial banks are positively related to deposits liabilities in the banking system and the penalty rate, while it is negatively related to the repo rate.

Using elasticities obtained from the optimal demand function for reserves, different scenarios relating reserves with repo rate have been simulated. Based on simulation results, the paper recommends to mop up excessive liquidity until excess reserves fall within a band spanning from 20% to 30% above the required reserves, which corresponds to a repo rate band of 5.28% to 4.04%. Moreover, it is recommended that further investigations be done by using panel with the aim of capturing each banks' behaviour.

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Appendixes

Table 4: Causality test

Pairwise Granger Causality Tests
Date: 02/11/16 Time: 19:07
Sample: 2008M04 2015M10
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
INTERBANK_RATE does not Granger Cause EXCESS_RESERVES	89	2.11920	0.1265
EXCESS_RESERVES does not Granger Cause INTERBANK_RATE		5.40640	0.0062
KRR does not Granger Cause EXCESS_RESERVES	89	0.75416	0.4736
EXCESS_RESERVES does not Granger Cause KRR		0.61548	0.5428
REPO_RATE does not Granger Cause EXCESS_RESERVES	89	0.74495	0.4779
EXCESS_RESERVES does not Granger Cause REPO_RATE		6.35785	0.0027
TB_91 does not Granger Cause EXCESS_RESERVES	89	0.00121	0.9988
EXCESS_RESERVES does not Granger Cause TB_91		1.27384	0.2851

Table 5: Augmented Dickey Fuller test (at level)

Variable	Deterministic structure	ADF-calculated	ADF-critical			Conclusion
			10%	5%	1%	
Reserves	Trend & Intercept	-2.26	-3.20	-3.53	-4.22	Non stationary
	Intercept					
	None					
Deposits	Trend & Intercept	-3.15	-3.19	-3.53	-4.21	Non stationary
	Intercept					
	None					
Repo rate	Trend & Intercept	-1.03	-3.19	-3.53	-4.21	Non stationary
	Intercept					
	None					
Interbank rate	Trend & Intercept	-1.09	-3.19	-3.53	-4.21	Non stationary
	Intercept					
	None					
Penalty rate	Trend & Intercept	-1.99	-3.19	-3.53	-4.21	Non stationary
	Intercept					
	None					
NPL	Trend & Intercept	-1.67	-3.19	-3.53	-4.21	Non stationary
	Intercept					
	None					

Table 6: Augmented Dickey Fuller test (at first difference)

Variable	Deterministic structure	ADF-calculated	ADF-critical			Conclusion
			10%	5%	1%	
Reserves	Trend & Intercept					I(1)
	Intercept	-10.89	-2.61	-2.94	-3.62	
	None					
Deposits	Trend & Intercept					I(1)
	Intercept	-6.95	-2.61	-2.94	-3.62	
	None					
Repo rate	Trend & Intercept					I(1)
	Intercept					
	None	-5.63	-1.61	-1.95	-2.62	
Interbank rate	Trend & Intercept	-5.88	-3.20	-3.53	-4.22	I(1)
	Intercept					
	None					
Penalty rate	Trend & Intercept					I(1)
	Intercept					
	None	-5.41	-1.61	-1.95	-2.62	
NPL	Trend & Intercept					I(1)
	Intercept	-5.32	-2.61	-2.94	-3.62	
	None					

Table 7: Lag order selection

VAR Lag Order Selection Criteria
Endogenous variables: LRSVS LDEP LRL_REPO_RP LNPL
Exogenous variables: C
Date: 02/11/16 Time: 16:43
Sample: 2006Q1 2015Q3
Included observations: 36

Lag	LogL	LR	FPE	AIC	SC	HQ
0	6.814060	NA	1.01e-05	-0.156337	0.019610	-0.094927
1	141.4223	231.8253*	1.39e-08*	-6.745683*	-5.865950*	-6.438633*
2	149.0703	11.47196	2.30e-08	-6.281682	-4.698163	-5.728991
3	154.0215	6.326515	4.65e-08	-5.667858	-3.380553	-4.869528

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 8: Johansen cointegration test

Date: 02/11/16 Time: 16:49
Sample (adjusted): 2006Q3 2015Q3
Included observations: 37 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LRSVS LDEP LRL_REPO_RP LNPL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.595739	59.15556	54.07904	0.0165
At most 1	0.333972	25.64482	35.19275	0.3621
At most 2	0.205046	10.60713	20.26184	0.5803
At most 3	0.055602	2.116692	9.164546	0.7544

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.595739	33.51074	28.58808	0.0108
At most 1	0.333972	15.03769	22.29962	0.3720
At most 2	0.205046	8.490441	15.89210	0.4903
At most 3	0.055602	2.116692	9.164546	0.7544

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LRSVS	LDEP	LRL_REPO_RP	LNPL	C
-0.760731	-8.074091	-3.168121	-8.894624	69.41865
6.993072	-3.617055	2.624442	2.963852	-7.004806
3.445768	-10.33631	-2.259805	-6.237090	65.52165
-0.131456	1.338407	-1.265302	3.507903	-17.68889

Unrestricted Adjustment Coefficients (alpha):

D(LRSVS)	-0.048417	-0.059188	-0.034514	-0.031059
D(LDEP)	-0.020936	-0.009685	0.020834	0.003323
D(LRL_REPO_RP)	0.082881	-0.055457	0.016560	0.017873
D(LNPL)	0.032363	0.003118	0.004106	-0.015319

Table 9: Empirical results using TOBIT

Dependent Variable: LRSVS
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)
Date: 12/12/15 Time: 18:05
Sample: 2006Q1 2015Q3
Included observations: 39
Left censoring (indicator) is always zero
Convergence achieved after 4 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LDEP	1.003334	0.072073	13.92102	0.0000
LOG(RL_REPO/RP)	-0.299485	0.103859	-2.883567	0.0039
C	-3.059406	0.397446	-7.697660	0.0000
Error Distribution				
SCALE:C(4)	0.189128	0.021415	8.831761	0.0000

Mean dependent var	3.589805	S.D. dependent var	0.629846
Akaike info criterion	-0.287656	Schwarz criterion	-0.117035
Log likelihood	9.609301	Hannan-Quinn criter.	-0.226439
Avg. log likelihood	0.246392		
Left censored obs	0	Right censored obs	0
Uncensored obs	39	Total obs	39

An assessment of the impact of the sectoral distribution of commercial bank credit on economic growth in Rwanda

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Abstract

Rwanda has registered robust real GDP growth of 8% on average since 2000 due to among others, the development of the financial sector that has progressively supported increased financing of the economy. However, different sectors of the economy have contributed unevenly to growth due to several reasons, including unequal access to credit by the economic sectors. While new authorized loans, as a percentage of GDP, increased from 5.2% in 2000 to 12.4% in 2015, the average sectoral share to new authorized loans in 2000-2015 stood at: 55% for the services sector, 32% for the industry sector, 11% for non-classified activities, and, 2% for agriculture. As a share of industry sector loans, new authorized loans to the mining sub-sector stood at only 0.1% on average during the same period. These numbers show that credit flow to the mining sub-sector and the agriculture sector has been too low and this is due to the different structural barriers faced by these (sub)-sectors to access sizable credit from the banking system.

Using the VAR model, the Johansen cointegration approach and the Granger-causality tests, this paper assesses the effect of the sectoral distribution of commercial banks' credit on economic growth. Results show that there is still room for commercial banks to increase the financing of the economy as evidenced by: (1) the low level of credit as a percentage of GDP; (2) the high elasticities of credit to GDP, in total and by sector; and, (3) the fact that credit is largely demand driven for all the sectors of the economy. Sectoral VARs also reveal that sectors with limited access to credit have the highest elasticities and that credit flow to these sectors is largely demand-driven. These findings reveal the need for policy makers to devise strategies aimed at easing sectoral access to credit by especially reducing credit risk in agriculture and mining. While this paper has unearthed the causal link between sectoral credit and sectoral GDP, more empirical work is needed to unpack the various sector-specific challenges hindering access to credit.

Key words: *Commercial Banking credit, Economic Growth, VAR, Cointegration, Granger-causality*

JEL classification: *C01, C32, E51, O16, G21, G28*

1. Introduction

In line with sound macroeconomic policies, a stable flow and efficient use of budget support as well as increased economic financing resulting from financial sector development, the Rwandan economy has registered robust growth over the years after the 1994 war and genocide, with average real GDP growth standing at 8.0% for the last fifteen years since 2000.

The structural composition of the economy has also undergone some changes, with the service sector gradually replacing the agriculture sector in terms of driving growth. In real terms, the share of the agriculture sector GDP to total real GDP declined from an average of 42.2% in 1999-2004 to 33.8% in 2005-2014 whereas that of the service sector GDP increased from 38.0% in 1999-2004 to 45.7% in 2005-2014.

Despite increasing from an average of 12.0% in 1999-2004 to 13.8% in 2005-2014, the share of the industry sector GDP has remained quite low, standing at 13.1% on average since 1999 to 2014. The share of taxes less subsidies, the fourth component of sectoral GDP disaggregation, decreased on average from 7.8% to 6.7% during the same period.

Generally, out of the 8.0% growth in real GDP recorded since 2000, 43% came from the service sector, 37% from the agriculture sector, 13% from the industry sector, and 7% from taxes less subsidies. These figures point out a very important yet often overlooked reality that growth is varied across sectors. From the macroeconomic policy stand point, it is imperative to understand why sectoral contribution to growth has been uneven to help policy makers unpack the challenges faced by these sectors with the aim of unlocking their potential to ensure a sustainable and balanced growth path.

The role of credit in fueling growth has been well documented in both developed and emerging countries, thus putting monetary policy at the forefront in terms of shaping the growth path of a particular economy. Monetary policy affects the real economy mostly via the credit channel, which is typically an indirect channel as credit flow to the economy first impacts the level of investments before influencing economic growth and development (Bernanke and Gertler, 1995).

A well-developed financial sector facilitates the efficient allocation of financial resources to various competing real sector activities and thus leading to economic growth. The relationship between GDP growth and bank credit is most pronounced in developed countries with well-developed capital markets and levels of bank credit well above 100 percent of GDP. For most developing economies, capital markets are less developed and bank credit as a percentage of GDP is quite low, standing below 50% (Dehesa et al., 2007). For the Rwandan case, commercial banks' lending to the private sector, though still low, has helped to propel economic growth over the past. As a percentage of GDP, outstanding credit to the private sector increased from 10.5% in 2000 to 16.8% in 2014.

Given the importance of private sector credit from commercial banks, this paper focuses on analyzing the effect of the sectoral distribution of commercial banks' lending on economic growth in Rwanda. As noted by AVINASH RAMLOGAN et al. (2010), the relationship between credit and economic growth can be two-way: when credit responds positively to growth, it is said to be demand-following. Conversely, when economic growth is stimulated by high credit, it is said to be supply-leading. Using the VAR model, the Johansen cointegration approach and the Granger-causality tests, this paper assesses the existence and direction of the relationship between commercial banks' credit and economic

growth. In the context of the unequal distribution of credit among the different sectors of the economy and the unequal contribution of these sectors to economic growth, the paper goes further to examine the relationship between credit and economic growth by sector.

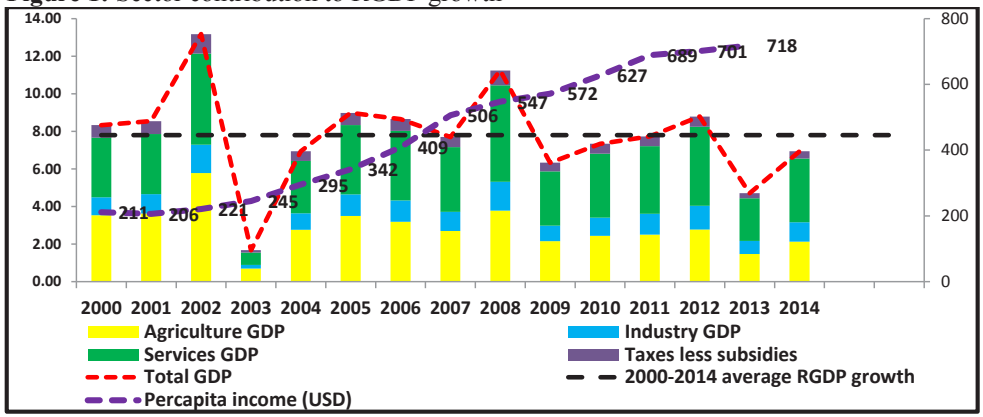
This paper is organized into 6 sections: section one covers the introduction, followed by section two which discusses the main trends in sectoral distribution of credit and economic growth in Rwanda. The third section covers selected empirical and theoretical literature on the subject matter, followed by section four, which deals with the methodology used and data sources, section five presents a discussion of the empirical results while section six gives conclusions and policy recommendations.

2. Main trends in private sector credit and economic growth Rwanda

Rwanda has registered robust growth over the past, with real GDP growth averaging around 8% between 2000 and 2014. Until 2004, the agriculture sector was the main engine of growth, with a contribution of 40-44 percent to total real GDP growth. Since 2005, the service sector replaced the agriculture sector though both of them have remained important.

Growth has been quite inclusive and has also averagely led to improved welfare, as reflected by the increase in percapita income from 211 USD in 2001 to 718 USD in 2014 and by the fall in poverty from 60.4% in 2000/01 to 39.1% in 2013/14 (NISR, 2015).

Figure 1: Sector contribution to RGDP growth



Source: NISR (2015)

In terms of employment, the percentage of non-farm wage earners has increased from 10.9% in 2000/2001 to 19.6% in 2013/14 while the percentage of small-scale independent farmers has dropped from 71.3% to 58% during the same period. Despite the shift from farm to non-farm employment, it is clear that farm employment is still very important.

Economic growth is closely linked to the intricacies of the financial system. A well developed and efficient financial system helps in allocating financial resources to the best uses in the real sector, thereby promoting economic growth. As the real sector grows, the demand for financing increases and in this way the financial sector grows in tandem with the economy, signifying a possible two way causal relationship between finance and growth. In developed countries, financing generally flows both from the banking system and the capital markets, while in most developing and transition economies the capital markets lag behind, which shifts the burden of financing to the banking system (Dehesa et al., 2007).

Following the entry of new banks, Rwanda's financial sector has grown more rapidly over the recent past, both in terms of size and efficiency. This is in line

with the government objective of ensuring the financial inclusion of all Rwandans (Kigabo & Nyalihama, 2015). As a result, credit to the private sector has increased over the years and thus significantly contributed to growth in Rwanda (Kigabo et al., 2015). Private sector credit as a percentage of GDP increased from 10% in 2004-2008 to 16.8% in 2014. Though these figures are quite low compared to Sub-Saharan Africa, they are quite high in the EAC context as shown in table 1 below.

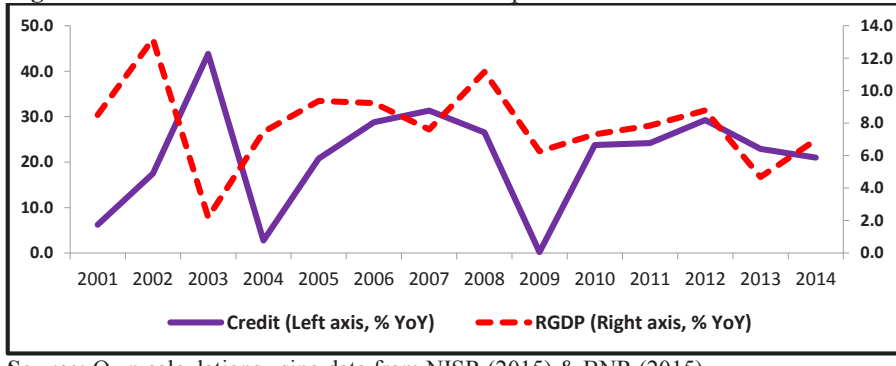
Table 1: Private Sector credit (% of GDP)

	2004-08	2009	2010	2011	2012	2013	2014
Rwanda	10	11.9	11.9	13.1	15.3	15.6	16.8
Uganda	8.2	10.6	12.9	13.7	13.2	13	13.7
Kenya	23.5	25.8	28	31.2	30.1	32.6	35.2
Tanzania	10	13.2	13.7	14.4	14.7	14.6	15.6
Burundi	14.1	13.7	15.5	18.1	16.8	15.6	15
Sub-Saharan	28.5	32.8	29.3	28	28.1	27.9	28.1

Source: IMF Regional economic outlook: Sub-Saharan Africa (Oct. 2015)

Credit growth in Rwanda has generally been commoving with the growth in real GDP since 2001 as indicated in figure 2. The empirical question is to find out the direction of causality, which is one of the objectives of this study.

Figure 2: Growth in real GDP and credit to the private sector



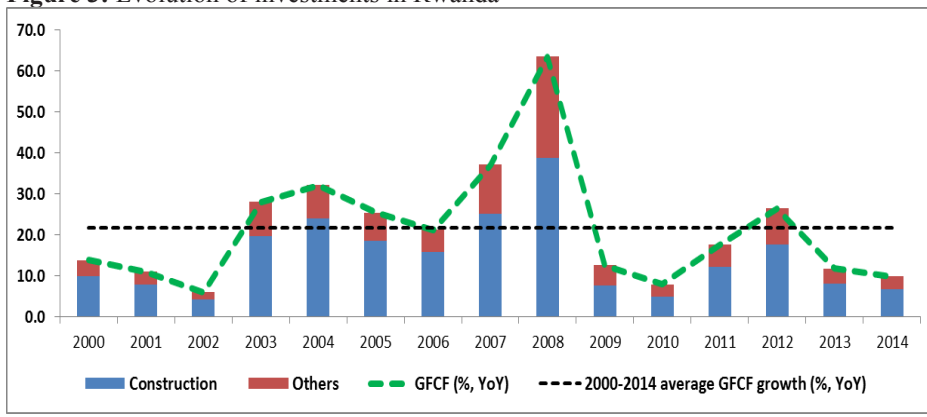
Source: Own calculations using data from NISR (2015) & BNR (2015)

The credit channel of the monetary policy transmission mechanism stipulates that credit to the private sector affects economic growth by first stimulating

investment (Mishkin, 1995; Bernanke & Gertler, 1995). In the context of Rwanda, gross fixed capital formation is generally dominated by investments in construction with an average share of 69.2% in 1999- 2014. In 2000-2014, gross fixed capital formation grew by 22% of which 68% was accounted for by construction investments and the remaining 32% by other investments.

Apart from the fact that the investment data are not adequately disaggregated in Rwanda's national accounts data set, investment as a share of GDP is still low. This may weaken the link between investment and economic growth.

Figure 3: Evolution of investments in Rwanda

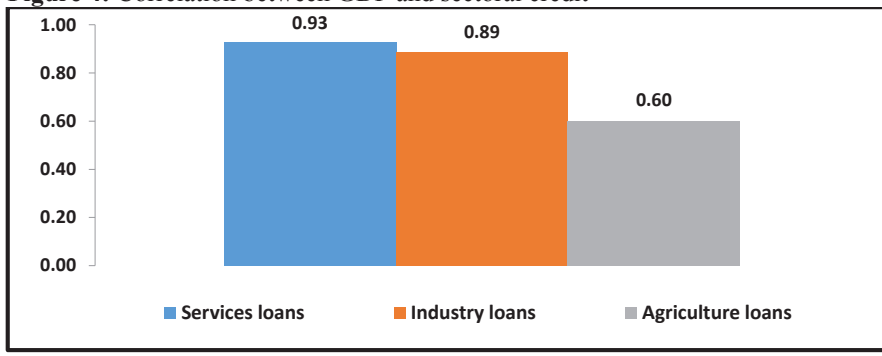


Source: NISR (2015)

Much as sectoral contribution to GDP growth has been uneven, credit flow to different sectors of the economy has also shown disparities. Between 2000Q1 and 2015Q1, the average share of new authorized sectoral credit in total new authorized loans stood at a paltry 2.9% for the agriculture sector, 61.5% for the services sector and 35.6% for the industry sector.

Simple correlation analysis shows that the correlation between new authorized loans (FRW billions) to the services sector and Real GDP (FRW billions) stands at 0.93% in 2006Q1-2015Q2, followed by that for industry with 0.89 and for agriculture with 0.6.

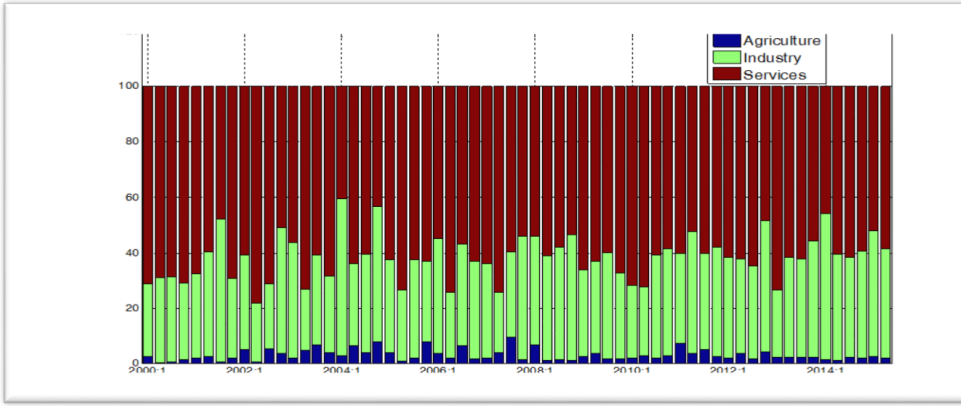
Figure 4: Correlation between GDP and sectoral credit



Source: Own calculations

While correlation between GDP and sector credit is positive, it is important to establish causation. Given the unequal share of credit among sectors and the varying correlation coefficients, it is imperative to know how sectoral credit distribution has impacted economic growth and development over time and this is addressed in this paper by estimating sectoral VAR models relating sectoral economic activity to sectoral credit.

Figure 5: Share to new authorized sectoral credit

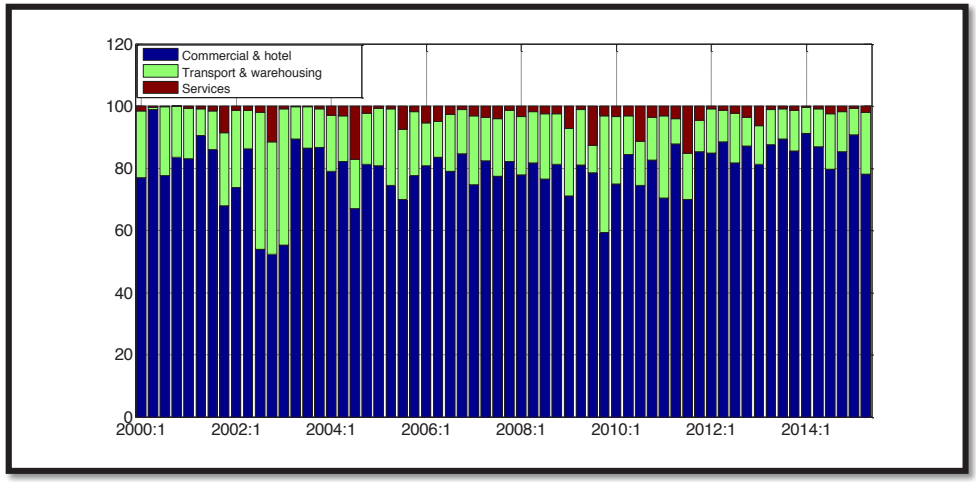


Source: BNR (2015)

Loans to the services sector are dominated by those that flow to commerce and hotels, followed by loans to transport and warehousing. The average share of loans to commerce and hotels stood at 79.7% in 2000Q1-2015Q2, followed by

that for transport and warehousing (17.0%) and the remaining 3.3% for loans to finance services offered to the community.

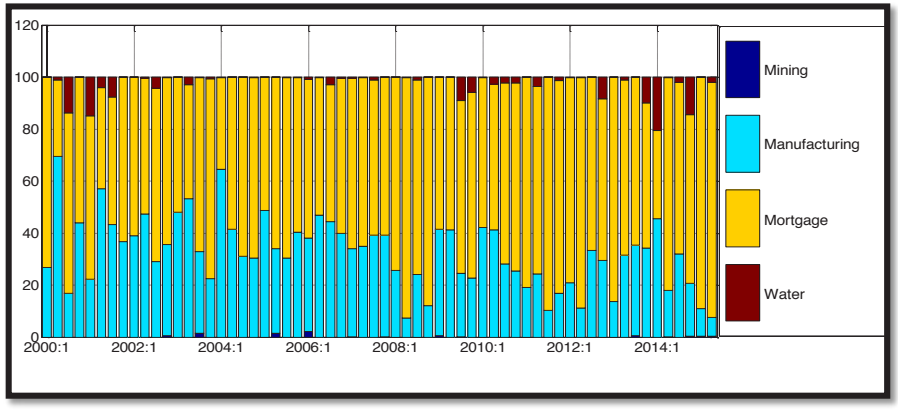
Figure 6: New authorized loans to the services sector



Source: BNR (2015)

With regard to new authorized loans to the industry sector, loans for mortgages and manufacturing have the biggest shares, standing at 65.2% and 32.4% on average in 2000Q1-2015Q2 respectively.

Figure 7: New authorized loans to the Industry sector



Source: BNR (2015)

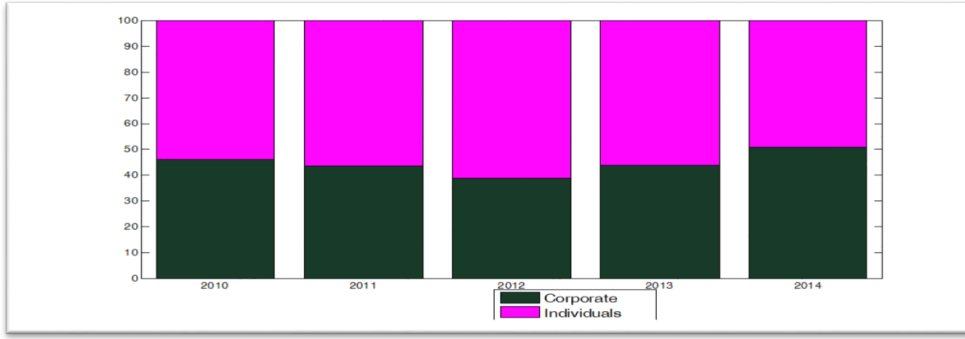
Taking both non-classified personal loans and loans to finance services offered to the community as consumption loans, it is clear that most of the loans in Rwanda since 2000 were mainly directed to productive investments and mortgages. The share of non-residential investment loans stood at 67% in 2000Q1-2015Q2 whereas the share of residential investment loans averaged 20% and the remaining 13% was for consumption loans. The dominance of investment loans explains the comovement between real GDP growth and credit growth presented in figure 2.

Figure 7: New authorized loans by purpose

Source: BNR (2015)

Despite the dominance of services and industry in terms of attracting credit, the latter seems almost evenly spread between two groups of borrowers: individuals and corporates, with the share of individuals' loans standing at 55.5% on average in 2010-2014 compared to 44.5% for corporates.

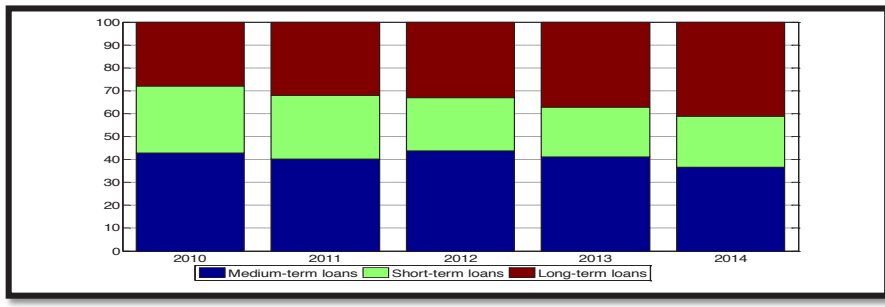
Figure 8: Distribution of outstanding loans by borrower type



Source: BNR (2015)

Outstanding credit is generally dominated by medium-term (more than 1 year but less than five years) and long-term (five years and above) loans, with respective average shares of 41% and 34% in 2010-2014 compared to 25% for short-term (12 months and below) loans. This trend poses challenges in terms of the sustainability of the credit market due to the mismatch between mostly short-term deposits and long-term loans. However, the dominance of medium-term and long-term credit is very important to support sustainable economic growth through financing of long-term investments.

Figure 9: Distribution of outstanding loans by maturity



Source: BNR (2015)

3. Literature review

3.1 Selected theoretical literature

The importance of the financial sector in terms of propelling growth is well recognized, even by early economists who support the "finance-led growth" hypothesis (Joseph Schumpeter, 1911). The intermediation role played by banks in terms of mobilizing savings and channeling these funds to productive investments has for long been seen as a major pillar of economic growth (Mc Kinnon, 1973; Shaw, 1973; Fry, 1998; King & Levine, 1993).

However, for credit to impact growth, it has to be efficiently allocated to productive sectors. The role of financial institutions is particularly underscored due to their ability to efficiently allocate credit to productive investments, mostly in the private sector, as these are perceived to be more relevant in terms of propelling growth. This is in contrast to allocation of huge sums of credit to the public sector whose investments are often marred with inefficiencies as they are prone to wastages and politically motivated programs and are often less significant for growth (Beck et al, 2005; Boyreau-Debray, 2003).

Theoretically, most contemporary work on the relationship between credit and economic growth uses two main approaches. The first approach analyzes the credit channel of the monetary policy transmission mechanism, under which credit has an indirect effect on economic growth (Bernanke and Gertler, 1995). The second approach, considers credit as one of the economic resources and therefore an important argument in the growth model (Kiyotakiand Moore, 1997; Campbell, 2006). As argued by the proponents of the credit channel such as Bernanke and Gertler (995), credit to private sector has an indirect effect on economic growth since it has to first affect investment. With monetary policy tightening, the bank lending channel implies that money supply falls and thus

adversely affecting bank deposits. The fall in deposits ultimately leads to the contraction in lending, resulting into lower investments and reduced economic growth.

Nonetheless, scholars have contrasting views on the direction of causality between credit and economic growth. Some scholars support the two-way causality hypothesis, where credit is considered as both supply-leading and demand following. In the supply leading context, it is argued that financial sector development leads to credit expansion which in turn positively affects economic growth. This happens because financial sector development enhances increased mobilization of savings, improves the allocation of loanable funds and promotes capital accumulation (Gurley & Shaw, 1995; Goldsmith, 1969; McKinnon, 1973; Shaw, 1973; Beck et al., 2000). Indeed, financial intermediaries are quite efficient in terms of collecting and analyzing information, which helps them to efficiently allocate resources to the most productive investments thereby positively impacting growth (Greenwood & Jovanovic, 1990).

However, for bank lending to effectively affect growth, it has to come with affordable restrictions in form of lower inter-bank and inter-branch restrictions (Jayratne & Strachan, 1996) and lower collateral constraints such as reduced down payments and lower rates of amortization (Hercowitz, 2005). Given the lags in the monetary transmission mechanism, the effect of credit on economic growth often materializes in the long run (King & Levine, 1993).

Conversely, the demand following view postulates that it is actually increased demand for financing, resulting from vibrant economic activities, that leads to credit expansion. The demand following view was emphasized by Robinson (1952) who argued that financial sector development responds positively to economic growth as the latter leads to increased demand for financial services.

The same view is held by Harrison (1999) who argues that economic growth spurs the development of the financial sector since it encourages entry of new banks in the industry. The latter reduces transaction costs and increases financial inclusion as the average distance between banks and clients shortens. In other words, credit expansion tends to be pro-cyclical since economic growth moves in tandem with economic financing. Higher economic growth attracts more lending as banks tend to relax their criteria during good times and lend to both good and bad projects. This however may lead to the increase in non-performing loans especially when the bad times arrive, leading to contraction of credit (Dell'Ariccia & Marquez, 2006; Rajan, 1994).

The approach that views credit as an input in the growth model builds on the neo-classical growth model (Solow, 1956; King & Levine, 1993) or on some variety of an accelerator model (Kiyotaki& Moore, 1997; Campbell, 2006). In the growth model framework, access to credit helps to boost the level of technological innovation portending positive effects on economic growth. In other words, credit expansion facilitates expansion of businesses to economically inefficient scales (Trew 2006).

3.2. Selected empirical literature

Various empirical approaches have been used by scholars to assess the impact of credit on economic growth across the world. However, most empirical studies focus on the cross-country financial development-economic growth nexus and thus fail to account for the country-specific differences (Ang, 2008).

Using a multivariate GARCH framework, Maria Grydaki and Dirk Bezemer (2012) note that financial innovations enhance credit expansion, which in turn leads to economic growth especially during the period of the great moderation. Another study on the U.S conducted by Swiston (2008) that uses a VAR (2)

model concedes that credit growth accounts for about 20% to the growth of the US economy.

Using cross-country data for 77 countries, King and Levin (1993) find a strong positive effect of credit on economic growth. Similar findings are documented in Levine, Loayza and Beck (2000). However, after re-examining the findings of Levine, Loayza and Beck (2000), Favara (2003) indicates that the credit-growth nexus is at best weak.

Beck and Levine (2004) used panel data for 40 countries spanning the period 1986-1998 to examine the impact of financial sector development on economic growth. Their findings indicate that financial sector development plays a positive and significant role in influencing economic growth, even when selected control variables were added to the model. However, the relationship between financial variables and economic growth broke down, in particular for the banking variable when using annual data (Beck and Levine, 2004). They tentatively suggest that this was due to "credit surges" that had also been found to be good predictors of banking crises and subsequent economic slump.

Using sectoral panel data, Maureen W. et al. (2012) used a modified neo-classical growth model to assess the impact of private sector credit on economic growth in Kenya. They noted that the notable progress made in terms of financial sector development and credit expansion in Kenya over the past has contributed positively albeit unevenly to sectoral economic growth in line with the varied credit flow to different sectors of the economy.

Rwanda's financial sector has greatly expanded, with the number of banks reaching 16, of which 10 are commercial banks. In addition, the number of microfinance institutions has reached 492. In 1995, there were only five banking institutions. The financial sector is dominated by the banking sector (Kigabo & Nyalihama, 2015). Given the noticeable development of the financial sector,

Kigabo, Okello & Mutuyimana (2015) found a positive relationship between credit and economic growth, with the direction of causality running from credit to growth. Until now however, no empirical study has been undertaken to assess the impact of sectoral distribution of credit on economic growth. This paper assesses the effect of sectoral distribution of commercial bank credit on economic growth.

4. Methodology and data sources

To be able to test for the existence of a causal relationship between (sectoral) credit and (sectoral) economic growth as well as the direction of this causality, we follow the approach used by AVINASH RAMLOGAN et al. (2010) and Nicholls and Birchwood (1998), albeit with modifications.

These authors use the VAR/VECM approach. They first test for causality and direction of causality between total investment (gross capital formation) and total private sector credit and proceed to do the same for sectoral credit versus sectoral investment, both in the long-run and the short-run. They used the Johansen cointegration technique to test for the long-run relationship between credit and economic growth (proxied by gross fixed capital formation). To test for the short-run causal relationship between credit and growth, these authors used the VECM approach. These authors justify the use of total and sectoral investment instead of total and sector real GDP due to the fact that the relationship between credit and economic growth is an indirect one, with investment standing in between.

In this study, we use data on total/sectoral GDP basing on two reasons. First, gross capital formation is not adequately disaggregated in Rwanda's national accounts: its sub-components are "construction" and "others", with the latter lumping together other forms of investment other than construction. Indeed,

allowing for some lags in the transmission mechanism can suffice to unearth a significant relationship between credit and growth.

Taking note of the possibility of directly investigating the relationship between credit and economic growth, this paper goes further to test for existence and direction of causality between these two macroeconomic variables but only in the long-run.

Following the AVINASH RAMLOGAN et al. (2010) approach, we specify the long-run VAR models as follows:

$$Y_t = \sum_{i=1}^{k} A_1 Y_{t-i} + U_t$$

Where by (Y_t) represents a vector of all contemporaneous values in the model, A_1 is the matrix of all the coefficients to be estimated, Y_{t-i} represents a vector of lagged values in the model and U_t stands for the vector of error terms. Given that the causality between credit and real GDP is often assumed to occur in the long-run, we use the Granger-causality test instead. The approach starts by testing for the stationarity of the individual time series before checking for the existence of a long run relationship (i.e. cointegration) between them.

The data used in this paper run from 2006Q1 to 2015Q2 and this is conditioned on the availability of reliable quarterly GDP data. The data on GDP were obtained from the National Institute of Statistics (NISR) of Rwanda while data on new authorized were sourced from the National Bank of Rwanda (BNR). Note that since classifications for GDP and credit data are different, we reclassified the latter to match the former. In this respect we use data on new authorized for agriculture as credit to the agriculture sector; the sum, of new authorized loans for manufacturing, mortgages as well as water and energy activities, is used as credit to the industry sector. Finally, credit going to

commerce and hotels, transport and warehousing and OFI and insurance are all grouped into credit to the services sector.

Since new authorized loans data are available on monthly basis, the quarterly figures are obtained by taking the sum of monthly figures within a quarter. Finally, both credit and real GDP data are log-transformed prior to making relevant estimations so as to get short-run and long-run elasticities.

5. Discussion of empirical results

Before presenting the results of the empirical short-run and long-run models, we first test for stationarity of the individual variables: that is, logs of credit to the private sector and real GDP. As expected, the logarithms of all variables are trend stationary.

Table 2: Augmented Dickey-Fuller unit root test

			Critical values					
Variable label	**Exogenous**	**Lags**	**1%**	**5%**	**10%**	**T-statistic**	**P-value**	**integration**
LRGDP	Intercept & trend	1	-4.23	-3.54	-3.20	-7.27	0.0000	I(0)
LAGRICULTURE	Intercept & trend	1	-4.23	-3.54	-3.20	-12.66	0.0000	I(0)
LINDUSTRY	Intercept & trend	1	-4.24	-3.54	-3.20	-6.44	0.0000	I(0)
LSERVICES	Intercept & trend	0	-4.23	-3.54	-3.20	-5.16	0.0009	I(0)
LCRDT_AGRICULTURE	Intercept & trend	0	-4.23	-3.54	-3.20	-5.97	0.0001	I(0)
LCRDT_INDUSTRY	Intercept & trend	0	-4.23	-3.54	-3.20	-5.62	0.0002	I(0)
LCRDT_SERVICES	Intercept & trend	0	-4.23	-3.54	-3.20	-5.48	0.0004	I(0)
LCRDT_TOTAL	Intercept & trend	0	-4.23	-3.54	-3.20	-4.98	0.0014	I(0)

Despite being trend stationary, it is important to test if the variables of interest have a common trend in the long-run, since stationarity itself does not guarantee cointegration.

5.1 Causality between total credit and total real GDP

Using the Johansen procedure, both the trace statistic and the max-Eigen value tests indicate that real GDP (LRGDP) and total new authorized loans (LCRDT_TOTAL) are cointegrated at 5%.

Table 3: Cointegration between Real GDP and Credit

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.482715	24.51867	15.49471	0.0017
At most 1	0.021675	0.788875	3.841466	0.3744

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.482715	23.72979	14.26460	0.0012
At most 1	0.021675	0.788875	3.841466	0.3744

**** Both the Trace and Maximum-Eigen value tests confirm that credit and growth are cointegrated at 5%***

Using the Granger causality test, we test for the direction of causality between economic growth and credit. Results show that there is a two-way causal relationship between real GDP and credit. However, causality running from growth to credit seems to be more significant.

Table 4: Granger causality test between credit and real GDP

Null Hypothesis:	Obs	F-Statistic	Prob.
LCRDT_TOTAL does not Granger Cause LRGDP	36	4.74426	0.0159
LRGDP does not Granger Cause LCRDT_TOTAL		6.58197	0.0041

To confirm the Granger-causality tests, we estimate the VAR model for total credit and real GDP. The optimal lag is 1 as favored by all the information criteria.

Table 5: Lag selection for VAR between credit and growth

Lag	LogL	LR	FPE	AIC	SC	HQ
0	23.22569	NA	0.001054	-1.179205	-1.091232	-1.148500
1	89.37190	121.2680*	3.34e-05*	-4.631772*	-4.367852*	-4.539657*
2	93.17063	6.542257	3.39e-05	-4.620590	-4.180724	-4.467065

The estimated VAR models show that indeed there is a two-way causal relationship between credit and real GDP. The long run effect of credit to growth is positive, significant but very small: if credit goes up by 1%, real GDP grows by 0.09%. In the credit model, there is a significantly positive more than

one-to-one relationship between credit and economic growth: if real GDP increases by 1%, credit grows by 1.4%. These results suggest that despite the existence of a two-way causal relationship between credit and growth, credit can be seen to be mostly demand following. The high growth realized over the past has helped to create higher demand for loans from the banking system.

Table 6: VAR model relating credit and real GDP

	LRGDP	LCRDT_TOTAL
LRGDP(-1)	0.707267	1.431899
	(0.08669)	(0.47888)
	[8.15866]	[2.99007]
LCRDT_TOTAL(-1)	0.090232	0.447752
	(0.03051)	(0.16852)
	[2.95781]	[2.65692]
C	1.636153	-7.397971
	(0.47089)	(2.60128)
	[3.47459]	[-2.84397]

Standard errors in ( ) & t-statistics in [ ]

5.2 Causality between agricultural credit and real agricultural GDP

After testing for the long-run causal relationship between total credit and total real GDP, we do the same exercise on sectoral credit versus sectoral real GDP. To begin with, we test for cointegration between agricultural credit and agricultural GDP.

Table 7: Cointegration between agricultural credit and agricultural GDP

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.280451	14.01814	13.42878	0.0824
At most 1	0.058483	2.169448	2.705545	0.1408

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.280451	11.84869	12.29652	0.1165
At most 1	0.058483	2.169448	2.705545	0.1408

The long-run relationship between real agricultural GDP and credit to the agricultural sector seems to be very weak (as per trace test) or even non-existent as indicated by the Maximum-Eigen-value test. The trace test indicates that agricultural GDP and agricultural credit are cointegrated, only at 10%. The Maximum-Eigen value test indicated that the two variables are not cointegrated. The granger causality test indicates that there is no causal relationship between agricultural credit and real agricultural GDP, which is consistent with the cointegration test results at 5%.

Table 8: Granger causality test between agricultural credit and GDP

Null Hypothesis:	Obs	F-Statistic	Prob.
LAGRICULTURE does not Granger Cause LCRDT_AGRICULTURE	36	2.14596	0.1340
LCRDT_AGRICULTURE does not Granger Cause LAGRICULTURE		1.08428	0.3506

To cross-check the conflicting results from the cointegration test and Granger-causality test, we proceed to estimate the VAR model relating agricultural credit and agricultural GDP. Before estimating the VAR, the lag selection procedure suggests that lag 1 is optimal in the real agricultural GDP versus agricultural

credit model, chosen basing on five information criteria as indicated in the table below.

Table 9: Lag selection for VAR between real agricultural GDP and agricultural credit

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-8.808823	NA	0.006250	0.600490	0.688463	0.631195
1	25.26669	62.47178*	0.001176*	-1.070372*	-0.806452*	-0.978257*
2	28.87895	6.221107	0.001205	-1.048830	-0.608964	-0.895305

The results in the long run VAR model indicate a one-way causal relationship, with real agricultural GDP significantly and positively affecting growth in agricultural credit. In other words, credit to the agricultural sector is demand following. A 1% increase in real agriculture GDP increases credit to the agricultural sector by 2.6%.

Table 10: The VAR model relating agricultural credit and real agricultural GDP

	LAGRICULTURE	LCRDT_AGRICULTURE
LAGRICULTURE(-1)	0.848306	2.556313
	(0.07866)	(0.86936)
	[10.7845]	[2.94046]
LCRDT_AGRICULTURE(-1)	0.016889	0.077441
	(0.01633)	(0.18046)
	[1.03438]	[0.42914]
C	0.870641	-14.16885
	(0.44384)	(4.90539)
	[1.96161]	[-2.88842]

Standard errors in ( ) & t-statistics in [ ]

The insignificant response of agricultural GDP to agricultural credit is consistent with the fact that only 2% of total new authorized loans went to agriculture in 2000-2015. The limited access of the agriculture sector to credit is due to the fact that the sector faces a number of challenges, including land fragmentation given that at least 80% of farmers own landholdings of less than

1 hectare, 70% of owned lands are located on hills or hillsides, impeding mechanization.

Indeed, most farmers use traditional farming methods and inputs and production is largely subject to weather conditions as well as on pests and diseases. In addition, production of export crops depends on the international commodity prices as these crops are exported with limited value addition. Credit flow to agriculture can only increase if appropriate strategies are put in place to de-risk the sector (World Bank, REU-7, 2015).

5.3 Causality between services credit and real services GDP

Using a similar approach, we test for cointegration between credit to the services sector and real services GDP. Results of both the trace and maximum-Eigen value tests indicate that the two variables are only cointegrated at 10%.

Table 11: Cointegration between services credit and services GDP

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.324649	15.39546	15.49471	0.0517
At most 1	0.034519	1.264646	3.841466	0.2608

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.324649	14.13082	14.26460	0.0525
At most 1	0.034519	1.264646	3.841466	0.2608

With regard to the direction of causality, the granger pair-wise causality confirms a two-way causal relationship between credit to the services sector and real services sector GDP at 5%.

Table 12: Granger causality test between real services GDP and credit to the service sector

Null Hypothesis:	Obs	F-Statistic	Prob.
LCRDT_SERVICES does not Granger Cause LSERVICES	36	3.39144	0.0466
LSERVICES does not Granger Cause LCRDT_SERVICES		10.2684	0.0004

The Schwartz information criterion indicates that VAR (1) is optimal. We estimate this model to verify the existence of a two-way causal relationship between real services GDP and credit to the services sector.

Table 13: Lag selection for the VAR model relating services credit and real services GDP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	13.97006	NA	0.001730	-0.684003	-0.595126	-0.653323
1	85.27342	130.3833	3.70e-05	-4.529910	-4.263278*	-4.437869
2	90.97937	9.781631*	3.37e-05*	-4.627392*	-4.183007	-4.473991*
3	93.86417	4.615686	3.61e-05	-4.563667	-3.941528	-4.348905

The VAR model shows that there is a significant strong positive effect of real services GDP on credit to the services sector, with the elasticity standing at 1.3%. Though positive and significant, the response of real services GDP to credit to the service sector is small, with the elasticity standing at 0.05%.

These findings imply that whereas there is a two-way causal relationship between services GDP and credit to the service sector, credit is more demand driven.

Table 14: The VAR model relating services credit and real services GDP

	LSERVICES	LCRDT_SERVICES
LSERVICES(-1)	0.840855	1.334322
	(0.06664)	(0.44568)
	[12.6182]	[2.99390]
LCRDT_SERVICES(-1)	0.051940	0.336660
	(0.02847)	(0.19040)
	[1.82443]	[1.76816]
C	0.794203	-5.581833
	(0.30720)	(2.05455)
	[2.58531]	[-2.71682]

Standard errors in ( ) & t-statistics in [ ]

5.4 Causality between industry credit and real industry GDP

Turning to the industry sector, both the trace test and the Maximum-Eigen value test embedded in the Johansen cointegration procedure confirm the existence of a long run relationship between credit to the industry sector and real industry sector GDP, at 5%.

Table 15: Cointegration between industry credit and industry GDP

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.440523	22.10055	15.49471	0.0044
At most 1	0.032607	1.193426	3.841466	0.2746

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.440523	20.90712	14.26460	0.0039
At most 1	0.032607	1.193426	3.841466	0.2746

The Granger- causality test shows that causality runs from real industry GDP to credit flowing to the industry sector: more activity in the industry sector attracts more financing from commercial banks in form of credit. This causal relationship is significant at 5%.

Table 16: Granger causality test between real industry GDP and credit to the industry sector

Null Hypothesis:	Obs	F-Statistic	Prob.
LCRDT_INDUSTRY does not Granger Cause LINDUSTRY	36	2.35012	0.1121
LINDUSTRY does not Granger Cause LCRDT_INDUSTRY		4.43015	0.0203

To confirm the Granger-causality test results, we estimate the long-run VAR (1) model as recommended by the Schwartz information criterion.

Table 17: Lag selection for the VAR model relating services credit and real services GDP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-0.580994	NA	0.003973	0.147485	0.236362	0.178166
1	44.45749	82.35608	0.000381	-2.197571	-1.930939*	-2.105530
2	45.30233	1.448309	0.000458	-2.017276	-1.572891	-1.863874
3	57.87710	20.11963*	0.000282*	-2.507263*	-1.885124	-2.292501*

The VAR (1) results shows that when credit to the industry sector increases by 1%, real industry GDP increases by 0.09% while a 1% increase in real industry GDP leads to a 1.8% increase in credit to the industry sector.

Table 18: The VAR model relating industry credit and real industry GDP

	LINDUSTRY	LCRDT_INDUSTRY
LINDUSTRY(-1)	0.713940	1.773178
	(0.10782)	(0.44205)
	[6.62177]	[4.01127]
LCRDT_INDUSTRY(-1)	0.088711	0.239430
	(0.04221)	(0.17307)
	[2.10151]	[1.38341]
C	1.127918	-6.134172
	(0.40367)	(1.65503)
	[2.79418]	[-3.70639]

Standard errors in ( ) & t-statistics in [ ]

This high elasticity implies that credit is largely demand driven and also that there is still potential for the industry sector in-terms of attracting commercial bank lending. The small response of industry GDP to industry credit can be attributed to the risky nature of some sub-sectors, especially mining.

Financing constraints for the mining sub-sector are due to challenges such as the fact that mining companies have no long-term contracts, almost all of these companies carry out exploitation and exploration simultaneously, giving less assurance to banks concerning ability for these companies to earn profit and be able to pay back the loans.

In addition, most mining companies are very small and practice traditional artisanal mining. This is worsened by the fact that these companies have no collateral to use in the process of contracting loans and the dependence of the sector on variations in the international prices for metals (World Bank, REU-6, 2014).

6. Conclusions and policy recommendations

Using the Johansen cointegration procedure, the long-run relationship between total/sectoral credit and total/sectoral GDP is established at least at 10%. This implies that though credit as a percentage of GDP is still low, credit and GDP tend to commove in the long-run. The magnitude of the elasticities confirms the trend of credit distribution discussed in the introduction.

Generally, elasticities show that credit has been demand-driven and that sectors that are known to have historically received less credit have higher elasticities of sectoral credit to sectoral GDP: with Agriculture (2.6%), Industry (1.7%) and Services (1.3%). In general, credit as a percentage of GDP is still low, which is consistent with a higher elasticity (1.4%) of total credit to total real GDP.

Being generally demand driven and having higher elasticities across sectors implies that there is still potential for the economic sectors to attract more credit. It is therefore the role of the government and other stakeholders to ensure that the performance of these economic sectors is sound enough to attract credit from commercial banks by for example reducing credit risk to some of these credit-constrained sectors, mainly agriculture and mining which face a number of structural problems as highlighted in sub-sections V3 and V4.

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Tax Buoyancy and Elasticity in Rwanda

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Abstract

The objective of this paper was to assess the impact of different tax policies measures implemented in Rwanda from 2006 up to the second quarter of 2015 by estimating tax buoyancy and elasticity for total tax revenue, import duties, value added taxes, excise duties and direct taxes. The results showed that all long run buoyancies and elasticities are significant at 1% significance level except the buoyancy of the import duties. In addition, for all tax types, buoyancy is higher than elasticity except for import duties, indicating that overall discretionary policy measures implemented during the last ten years (from 2006 to the second quarter of 2015) have yielded a positive impact on the tax collection in Rwanda.

Key words: Tax Revenue, Tax Buoyancy, Tax Elasticity, Tax policy measures

JEL Classification: H21, H68, C32, E62

1. Introduction

A core function of the tax system is to generate sufficient revenue to finance public expenditures that are necessary for sustainable economic growth and achievement of SDGs objectives, particularly in less developed countries (LDCs). In these countries, the need to raise more revenues against the backdrop of higher expenditures become important when compared to other sources of resource mobilization such as deficit financing and monetary creation (Yuthika Indraratna, 2003). In addition, according to World Bank (1990), for macroeconomic stability to hold, the growth in tax revenue must approximate the growth in public expenditure.

In LDCs, major taxes tend to have low elasticity and sometimes low buoyancy estimates due to economic structure where a number of economic activities remain out of the tax (Bilquess, 2004; Brima I., 2012), tax evasion, low compliance due to inefficient tax administration, corruption and high tax rates. The concept of elasticity is used to measure percentage increase in the tax revenue resulting from changes in its base caused by a percentage rise in GDP. Government actions can also affect tax revenue through various policies which affect tax base at a given time.

However, if taxes revenues lad behind growth rates, severe budget deficits are likely to emerge and this will cause the problem on sustainability of the economic growth or increase the dependency on foreign borrowing. On other hand, most of the economists argue that the high tax rates are a disincentive to work, savings and investments. An elastic tax system is desirable for developing countries in order to provide resources for government expenditures. A part from the need to mobilize resources for revenue purposes, a study of tax elasticity is also important for revenue forecasting purposes. Therefore, an examination of tax elasticity is crucial for tax policy formulation.

Rwanda has achieved good progress in terms of tax collection though its tax to GDP ratio is still low about 15.0% in 2015 from 12.5% of GDP in 2010 and lower than most of developing countries and 25% of GDP embedded in the convergence criteria in the EAC monetary union. To raise this ratio, the GoR has been implementing different policy measures to raise it such as education and training of tax payers, enforcement mechanisms and use of technology such as the electronic billing system. In addition to the reasons mentioned above, other external financing (total grants) are declining from 12.0% of GDP in 2010 to 7.8% of GDP in 2014 and revenue mobilization is becoming more important than before for the sustainability of public sector financing.

To our knowledge, there is no study conducted to estimate tax buoyancy and tax elasticity in Rwanda. The objective of this paper is to assess the impact of tax policy measures implemented during the last ten years by estimating long and short run tax buoyancy and elasticity in Rwanda.

The rest of this paper is organized as follow: section 2 presents a summary of literature review on the buoyancy and elasticity of tax revenue, in section 3 we discuss tax system development in Rwanda, before presenting the empirical methodology in the section 4 and Section 5 presents empirical analysis before concluding the paper.

2. Literature review

The elasticity and buoyancy of tax systems are concepts that have been widely studied in the public. By definition, elasticity is the change in tax revenue directly arising from a one unit change in income. It is defined as the built-in response of tax revenues to changes in income once the effect of discretionary changes made by authorities to maintain short-term revenue objectives are excluded (Indraratna, 2003).

The second concept widely used is the buoyancy which measures the responsiveness of revenue to a changed tax system whether the changes is due to discretionary measures, built-in responsiveness or both (Indraratna, 2003; Bilquees, 2004). If the buoyancy exceeds elasticity, discretionary tax measures are assumed to have contributed more to the growth in tax revenues than the built-in response to the base.

Empirical studies on the measurement of both the elasticity and buoyancy of tax revenues have used different methods. Generally, the estimation of elasticity involves adjusting the revenue time series to remove the discretionary tax measures. Methods used include the proportional Adjustment Method which adjusts a historical revenue series according to a particular year's tax structure assuming that the particular tax structure is maintained throughout the period under review; the Constant Rare Structure Method, Dummy Variable Approach and Divisia Index Approach (Indraratna, 2003)

The Constant Rate Structure method generates a simulated tax revenue time series for a reference year and estimate tax base for subsequent years. It is not used frequently in practice due to its reliance on the availability of disaggregated data on the effective tax rates on the changing composition of the bases (Choudhry, 1979;Bilquess, 2004; Rasheed, 2006). The Dummy Variable (DV) approach utilized by Rasheed (2006) and widely used by different researchers uses dummies to capture discretionary tax changes in tax rates and tax structures.

Using the Proportional Adjustment Method, Indraratna (2003) estimated the buoyancy and taxes to income growth with total revenue is in Sri Lanka over the period 1960 to 1994. He concluded that responsiveness of all tax to income growth with total revenue is low. He noted that the inelastic tax structure could be explained by factors such as exemptions, tax incentives, duty waivers and

low compliance as well as the sectors in the economy that were not subject to taxation. To assess if economic reforms did improve the elasticity of the system, he estimated tax elasticity in two separate periods: pre and post-reform periods. The results remained relatively unchanged, showing the different reforms introduced in the country have not improved the responsiveness of tax revenue to income growth.

Rasheed (2006) used the Dummy Variable (DV) approach to capture discretionary tax changes in tax rates and tax structures in Pakistan over the period 1980 to 2004. Using a Vector Error Correction Model (VECM), he found that only the buoyancy coefficients for GDP, Monetary aggregate (M) and volume of trade were significant. The coefficient on GDP was the largest at 0.174 while that one on M and Volume of trade was very low at 0.061 and 0.089 respectively. The weakness of this approach is that it becomes difficulty to provide an accurate estimate using the dummy variable approach when discretionary changes have been frequent in the past. The use of many dummy variables leads to reduction in the degrees of freedom which affects the efficiency of the estimators (Choudhry, 1979; Bilquees, 2004; Rasheed, 2006).

The Divisia Index (DI) approach was used by different authors including Choudhry (1979), Thompson (1999) and Bilquees (2004). Choudhry estimates the elasticity using the DI approach for United States of America (USA) between 1955 and 1975, United Kingdom (UK) between 1955 and 1974, Malaysia between 1961 and 1973 and Kenya between 1962 and 1974. His results indicated that both the buoyancy and elasticity estimates for the USA and UK were smaller than those for Malaysia and Kenya due to the differing tax structures for the developed and developing countries.

He also concluded that the proportional adjustment estimates were close to that of the DI approach but the constant rate structure approach gave the lowest estimates and failed to detect the effects of discretionary measures in the UK.

Thompson (1999) and Bilquees (2004) estimated the elasticity and buoyancy of tax revenues for Jamaica over the period 1991/92 to 1998/99 using the same methodology as Choudhry. They found that the tax system was more elastic than it was buoyant indicating that more revenues could be raised in the absence of discretionary measures. Using total GDP and non-agricultural GDP as the tax base and using a VECM to determine both the short-run and long-run elasticity, Bilquees (2004) estimated buoyancy and elasticity of the tax system in Pakistan over the period 1974/75 to 2003/03.

He found that tax changes did not significantly improve revenue, as the buoyancy coefficient was less than unity due to continued exemptions, allowances and evasions of tax. This finding was confirmed by Rasheed (2006) using the DI approach. Given that several tax measures were implemented in Jamaica, the dummy variable approach is not appropriate for the Jamaican tax system.

Different studies have also estimated short-run and long-run elasticity using standard VECM and ordinary least squares (OLS) methodologies. To improve the estimation of short-run and long-run elasticity, Sobel and Holcombe (1996) used the stock-Watson (1993) dynamic ordinary least squares (DOLS) model to correct for the coefficient bias and the Newey-West (1987) correction to eliminate the inconsistency in the standard errors. The DOLS and Newey-West correction are applied in addition to the OLS and VECM equations for robustness.

In Africa, existing literature mainly attributes poor tax performance to lack of development, low levels of economic growth, corruption as well as weak institutions. Institutional quality has been found to be one of the key factors behind the poor tax ratio performance and tax effort for both developing countries (Chand and Moene (1997); and developed countries (Tanzi and Davoodi (2000)). For example, Mauro (1995) finds that corruption is more prevalent in resource-abundant countries than in resource-poor ones. Leite and Weidmann (1999) also link corruption to natural resources.

For Tanzania, tax reforms failed to raise the revenue productivity of the tax system and that elasticities are less than unity for the major taxes and the total tax system Osoro (1993). In Ghana, tax reform process contributed greatly to the growth of revenue productivity as elasticities are greater than unity for the major taxes Kusi (1998). Muriithi and Moyi (2003), Kenyan tax reforms had positive impact on the overall tax structure and on the individual tax handles. According to Bilquess (2004), the use of discretionary measures has been relied upon significantly as a source of revenue augmentation in Paskistan.

3. Development of the structure of the tax system in Rwanda

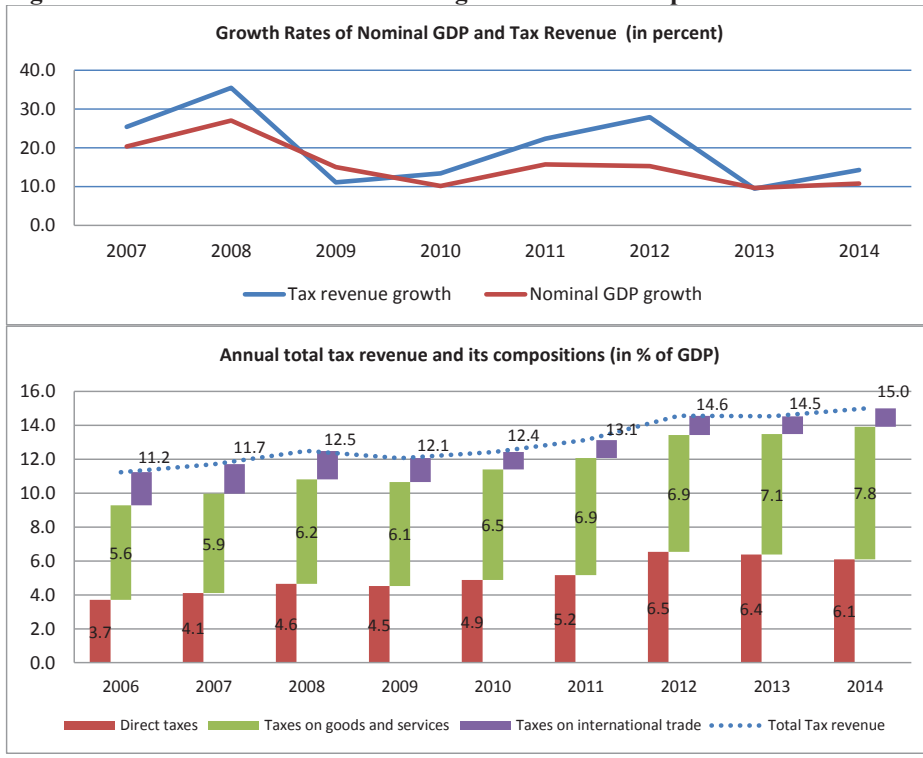
During the past ten years, the tax-to-GDP ratio has increased from 11.2 percent in 2006 to 15.0 percent in 2014. The declining trend in the taxes on international trade which came down from 1.5 percent of GDP in 2006 to close to 1 percent in 2014/2015 is due to a shift in origin of imports as more imports come from the COMESA free trade area and EAC countries. Imports from COMESA free trade area are not attracting import duties whilst those from EAC countries attract low rates.

This gradual decline in trade taxes has been offset by increasing revenue from direct taxes (PAYE and corporate income tax) and indirect taxes (VAT and excise duties). Tax revenue from companies and individuals increased from 4.2

percent of GDP in 2007 to 6.7 percent of GDP in 2014/2015 and from 5.9 percent of GDP in 2007 to 7.7 percent of GDP in 2014/2015 respectively.

Measures such as the introduction in 2010/11 of electronic tax filing and payment, and the merger of social security for income tax files (in July 2010), the introduction of electronic billing machines in 2013 and bringing local government taxes into central government budget in 2014 have contributed to the increase in the tax-to-GDP ratio.

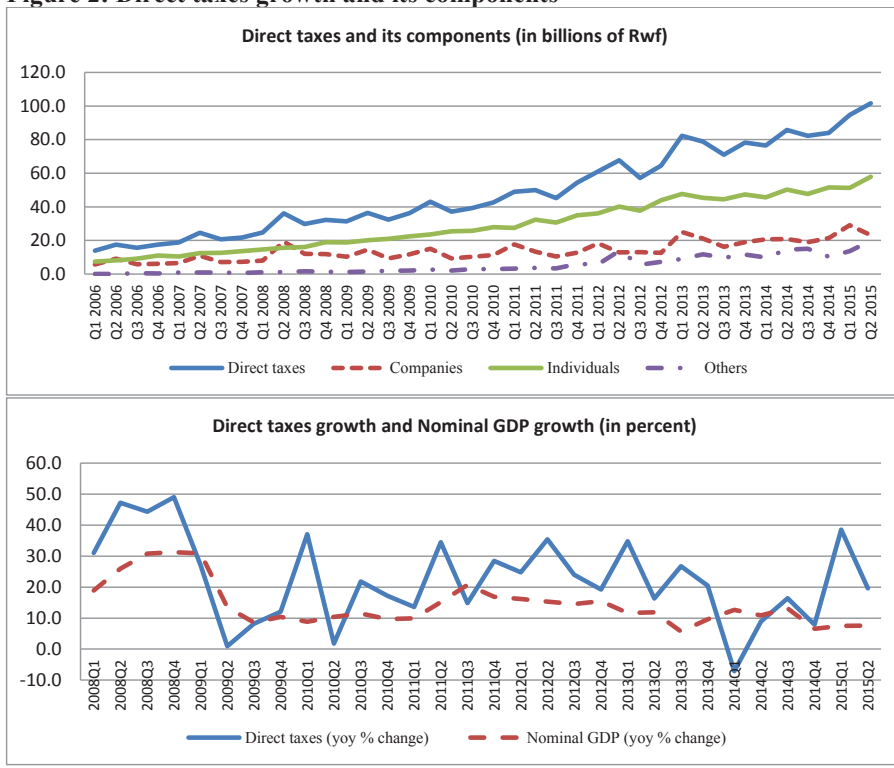
Figure 1: Evolution of total tax revenue growth and its components



Source: Authors' computation based on RRA and NISR data

Looking at different components of each tax type, the figure 2 below shows that the taxes on individuals or Pay- as-you earn (PAYE) is the biggest contributor to direct taxes with 57.5% of the total direct taxes followed by taxes on companies' profits with 25.5% and other taxes. During the past decade, direct taxes have growth much faster than Nominal GDP on average except for only three quarters (second quarter of 2009, second quarter of 2010 and first quarter of 2014). This shows how much direct taxes are buoyant with respect to nominal GDP.

Figure 2: Direct taxes growth and its components

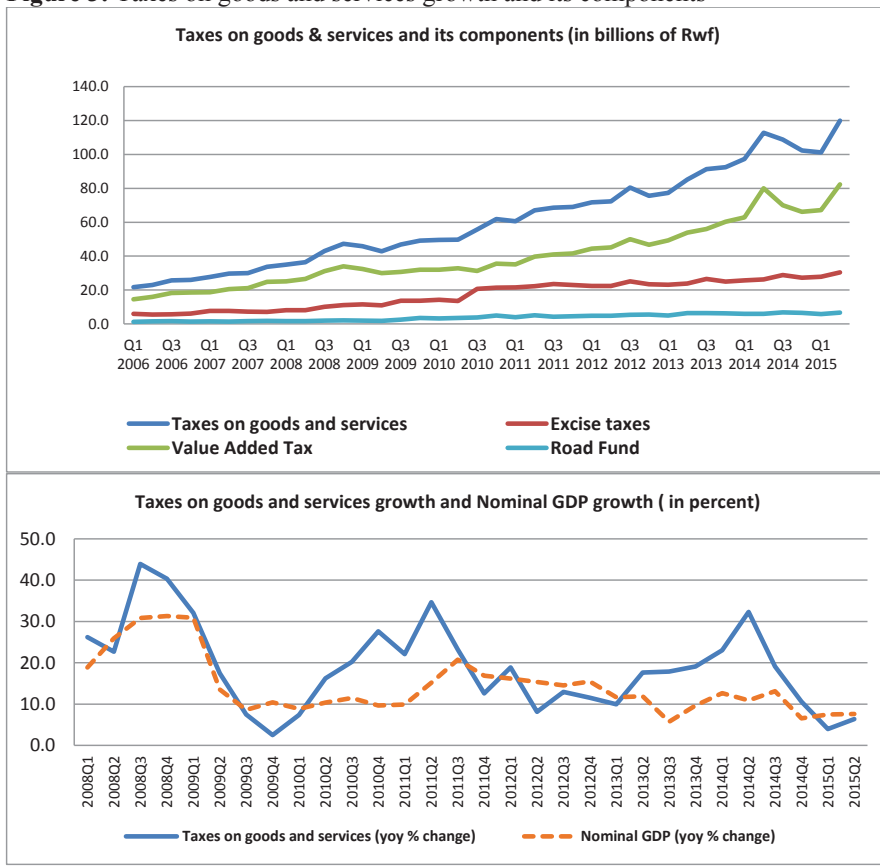


Source: Authors' computation based on RRA and NISR data

About the composition of taxes on goods and services, almost 70% comes from value added taxes (VAT) followed by excise duties (27%). The excise duties are mostly coming from excise on beer, wines & liquors, petrol, cigarettes, limonade,

vehicles, powdered milk, Air time etc. As it can be observed on the figure 3 below, in most of the periods, the growth rate of the taxes on goods and services was much higher than the nominal GDP growth rate.

Figure 3: Taxes on goods and services growth and its components

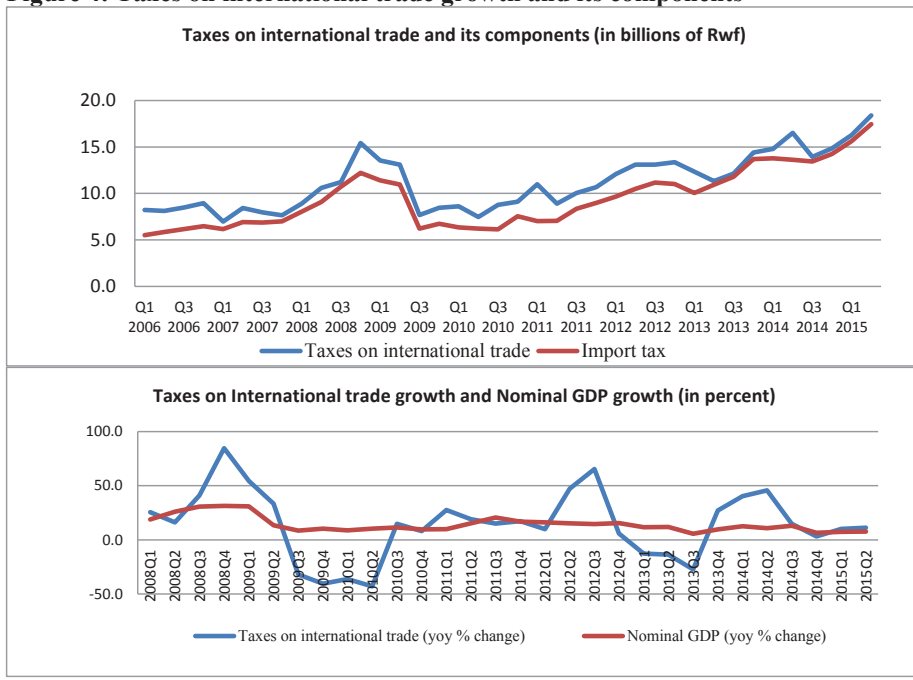


Source: Authors' computation based on RRA and NISR data

Most of the taxes on international trade are generated by import duties with almost 96% and the remaining is generated by other trade taxes including license fee for private warehouses. As it can be seen on the figure 4 below, the evolution of the taxes on international trade can be divided in two periods: before and after the accession of Rwanda to the East African Community in 2009.

Before Rwanda's accession to the EAC import duties and their growth rates were much higher than the nominal GDP growth rates. The loss of import duties due to Rwanda's accession to the EAC custom union in 2009 was expected and the benefits outweigh the costs as other domestic taxes such as VAT and direct taxes increased as a result of EAC.

Figure 4: Taxes on international trade growth and its components



Source: Authors' computation based on RRA and NISR data

The table 1 below shows the share of each tax category in the total tax revenue from the fiscal year of 2009/2010 to the fiscal year 2014/2015. On average, approximately half of Rwanda's tax revenue comes from indirect taxes (50.4%) followed by direct taxes (42.3 percent). The lion's share of the indirect tax revenue comes from the value added tax (VAT)—approximately one third of total revenue.

The rest is generated by excises, mostly on beer and petrol. Pay-as-you-earn (PAYE) on wages and salaries contribute for one quarter of total revenue.

Company income taxes (CIT) represent around 10 percent of the total, while property taxes generate less than 0.5 percent of total revenue, or 0.07 percent of GDP. Taxes on international trade accounted for 7.4 percent.

Table 1: Rwanda: Evolution of Tax Revenues by type of tax share in percent of total revenue

	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
1. Direct taxes	39.6	39.0	41.1	43.4	40.8	42.3
1.1.Tax on income and profit	39.0	38.6	40.6	43.0	40.7	41.9
- Companies	12.1	11.4	9.8	11.0	10.0	10.8
- Individuals (PAYE)	24.5	24.5	25.6	26.8	24.6	24.3
- Others	2.4	2.7	5.2	5.2	6.0	6.9
1.2. Property taxes	0.5	0.4	0.5	0.4	0.1	0.3
2. Taxes on goods and services	51.9	52.9	50.7	48.9	51.6	50.4
2.1. Excise taxes	14.6	18.5	16.4	14.6	13.6	13.3
2.2. Value Added Tax	33.9	30.5	30.9	30.7	33.9	33.3
of which: on imports	13.8	11.3	12.4	11.7	11.9	11.6
2.3. Road Fund	3.4	3.8	3.3	3.4	3.2	3.0
3. Taxes on international trade	8.6	8.1	8.3	7.7	7.6	7.4
3.2. Import tax	6.8	6.0	6.7	6.6	6.9	7.1
3.3. Other	0.6	0.4	0.2	0.2	0.7	0.3
Total tax revenue	100.0	100.0	100.0	100.0	100.0	100.0

Source: Rwanda Revenue Authority

4. Methodology

Authors such as Osoro (1993), Kusi (1998), Muriithi &Moyi (2003) and Bilquess (2004) used the following models to estimate buoyancy and elasticity:

$$T_t = \alpha Y_t^{\beta} e^{\varepsilon_t} \quad (1)$$

The logarithm transformation of the equation (1) gives

$$lnTt_t = ln\alpha + \beta lnY_t + \varepsilon_t \quad (2)$$

Or $tax_t = \mu_0 + \beta y_t + \varepsilon_t$ (3)

Where $tax_t = \log(T_t)$ and $y_t = \log(Y_t)$

ε: Stochastic disturbance term

The weakness of the model (1) is that it doesn't help appreciate what would have happened if changes to tax structure had not been as explained inter alia.

Some authors have used a set of cleaned data to estimate the elasticity of tax, Mansfield (1972), Osoro (1993) and Ariyo (1997) by eliminating the effects of discretionary tax measures using different methods such as the Historical time series tax data (HTSTD) adjusted to DTMs or dummy variables as proxies for DTMs, Dummy variables are used to represent important discretionary changes in tax rates and tax structures due to policy measures. In this case, equation (3) becomes:

$$tax_t = \mu_0 + \beta y_t + \sum_i \theta_i D_i + \varepsilon_t \quad (4)$$

Where : $Elasticity$, θ_i: Impact or coefficient of the discretionary policy change and D_i: Dummy variables.

In this paper we use the following models to estimate long run buoyancy and elasticity of taxes in Rwanda:

- $lnTt_t = ln\alpha + \beta lnY_t + \varepsilon_t$ (5)

- $lnTt_t = ln\alpha + \beta' lnY_t + \sum_i \theta_i D_i + \varepsilon_t$ (6)

Equation (5) is used to estimate long run buoyancy while equation (6) is used to estimate elasticity.

In order to capture short run dynamics, we estimate the following Error Correction Models (ECM):

- $\Delta lnTt_t = ln\alpha + \beta(\Delta lnY_t) + \Upsilon\ (\Delta\varepsilon_{t-1})$ (7)
- $\Delta lnTt_t = ln\alpha + \beta'(\Delta lnY_t) + \sum_i \theta_i D_i + \Upsilon\ (\Delta\varepsilon_{t-1})$ (8)

Equations (7) and (8) are used to estimate short run buoyancy and elasticity respectively.

5. Empirical analysis

5.1. Presentation of the data

In our models, we used the following variables which are expressed in real term and are transformed in Logarithm.

- Real GDP as a proxy for real income (LY);
- Logarithm of total taxes revenue (LTR);
- Logarithm of Direct taxes (LDT);
- Logarithm of Value Added Taxes (LVAT);
- Logarithm of Excise Duties (LET) and
- Logarithm of Import Duties (LIT).
- Dummy Variable for total taxes revenue (DM_TR);
- Dummy Variable for Direct taxes (DM_DT);
- Dummy Variable for Value Added Taxes (DM_VAT);
- Dummy Variable for Excise Duties (DM_ET) and
- Dummy Variable for Import Duties (DM_IT).

We have estimated each equation with two variables for buoyancy and three variables (including dummy) for elasticity separately both for the short and long run. Due to data unavailability, to estimate elasticities we used dummy variables instead of HTSTD adjusted.

The data used in this paper are Quarterly data spanning from the first quarter of 2006 up to the second quarter of 2015 and they are collected from Rwanda Revenue Authority and National Institute of Statistics of Rwanda. The data used are presented in appendix.

Before estimating equations (5), (6), (7) and (8), we analyzed stochastic properties of each variable used in these equations by testing their order of integration using the Augmented Dickey Fuller (ADF) test. As indicated in the table 3 below, all variables are I(1).

Table 2: ADF tests

	Levels		First differences		Conclusions
	ADF	Probability	ADF	Probability	
LDT	-1	0.74	-9.3	0.00**	I(1)
LET	1.54	0.94	-1.6	0.09*	I(1)
LVAT	2.39	0.99	-7.09	0.00**	I(1)
LIT	-2.59	0.1	-7.2	0.00**	I(1)
LTR	3.08	0.99	-7.95	0.00**	I(1)
LY	-1.29	0.62	-8.02	0.00**	I(1)

Source: Author's Estimates
**: Significant at 5%
*: Significant at 10%

As all variables are non-stationary, we tested for co-integration between GDP and tax revenues using quarterly data from January 2006 to the second quarter of 2015. Long and short run buoyancies have been computed first without isolating the impact of discretionary policy changes (estimation of the equation 5 and 7). Secondly, long and short run elasticity has been also estimated after controlling for

some discretionary policy changes during the period of the study (estimation of equation 6 and 8).

The results from the econometric estimation are presented in the following sub-sections.

5.2. Estimation and interpretation of the results

5.2.1. Buoyancy

Before estimating the models presented in the section 4 of methodology, we performed a co-integration test using two steps Engle Granger co-integration test. We tested also whether there is a short run relationship between variables using ECM.

The concept of co-integration of time series is an important tool to examine if there is a long run relationship between the variables. The test showed that there is a presence of co-integration relationship between LTR, LDT, LET and LVAT taken individually as endogenous variable and LY as exogenous variables. The only variable where there is no co-integration relationship was the LIT and LY.

Having established the existence of a long-run relationship between the variables, we run the regression using Ordinary Least Squares (OLS).

Table 3: Two steps Engle-Granger Co-integration Test for buoyancy

Equations	ADF t-statistic	Critical values			P-Value	conclusion
		1%	5%	10%		
LTR vs LY	-6.342337	-2.630762	-1.950394	-1.611202	0.0000	Co-integrated at 1%
LIT vs LY	-1.803683	-2.628961	-1.950117	-1.611339	0.082	Not co-integrated at 5%
LET vs LY	-2.835060	-2.628961	-1.950117	-1.611339	0.0058	Co-integrated at 1%
LDT vs LY	-6.484733	-2.632688	-1.950687	-1.611059		Co-integrated at 1%
LVAT vs LY	-2.835990	-2.628961	-1.950117	-1.611339	0.0058	Co-integrated at 1%

Source: Author's Estimates

Error correction models represent a powerful way of modeling economic series. After testing whether the time series data have long run relationship, it is important also to check whether there is short run relationship. The coefficient of the error correction term which measures the speed of adjustment must have negative sign and be significantly different from zero. If it is with positive sign ,it means that effects of chocks increases with time.

The result in the table 5 shows that the coefficients of the ECM have the appropriate (negative) sign. All error correction terms were negative and this is an indication that most of the short -run disequilibrium will be definitely eliminated in less than one year. Any perturbation which may affect one of the variables of the model shall be corrected early.

The significance of the ECM is an indication of the existence of a long run equilibrium relationship between the Tax revenues and gross domestic product in Rwanda.

Table 4: Summary of the long run and short run buoyancies for all tax types

Names of taxers	Long Run Buoyancies	Short Run Buoyancies	Speed of adjustment
LTR	1.449916**	0.205172	-0.499657
LDT	1.796086**	-0.229904	-0.726219
LET	1.755102**	0.548338	-0.260999
LIT	0.099937	0.284091	-0.355069
LVAT	1.312314**	0.784911	-0.386625

Source: Author's Estimates
** indicate that the buoyancy is significant at 1% significance level

All buoyancies are significant at 1% significance level except the buoyancy of the import duties which is not significant. Long run buoyancy for total tax revenue is 1.44 and it is significant at 1% significance level. This shows that total tax revenue is more buoyant with respect to GDP i.e. total tax revenue in real term is expected to increase by 1.44% when real GDP increase by 1%.

The long run buoyancy of direct tax (PAYE and corporate income) is 1.79 and it is significant at 1% of significance level, showing that a one percent increase in real GDP will lead to 1.75 percent increase in direct taxes (PAYE and companies' profit taxes), other factors remaining unchanged. There might be different reasons explaining this result. They include the structural transformation of the Rwandan economy where the share of agriculture which is attracting less taxes, has been reducing while the share of services and industry have increased over the period under review. For example, the share of agriculture in GDP declined from 39% in 2006 to 33 % in 2014 while the share of services increased from 43% in 2006 to 47% in 2014.

Other direct taxes revenue could have been generated by other discretionary policy changes implemented during the period of the study. These measures include the revision of personal income taxes (PIT) for micro enterprises by introducing a scheduler tax on turnover below 12 million in September 2012, the reduction of turnover tax for small enterprises from 4 to 3 percent and raising the ceiling for this regime from 20 to 50 million in September 2012 and the introduction of gaming law with a 15 percent tax on net winnings and a 13 percent tax on the net revenue of the company. Short run buoyancy is not significant as in the previous case because of the time lags between taxes collection and changes in GDP. For example, taxes on companies' profit are collected and paid quarterly based on the previous quarter income.

The long run buoyancy of excise duties is 1.75 and it is significant at 1% of significance level. This may be explained by increase of total consumption due to high increase in economic activities. Between 2006-2014, the real GDP in Rwanda increased by 7.6% on average. In addition to the increase in final consumption, there have been discretionary policy changes which may have contributed to high increase in excise duties. They include the change of excise on petroleum products

from ad valorem to specific in 2010, the reduction of specific excise on petrol from 283 Rwf/L to183 Rwf/L and on diesel from 250 Rwf/L to150 Rwf/L in 2011/2012 and an increase of excise duty on airtime of mobile phones from 5 to 8 and to 10 percent in 2011 and 2014 respectively plus other administrative measures undertaken by Rwanda Revenue Authority during the period of the study which played also an important role. About, import duties, the long and short run buoyancy are not significant.

The long run buoyancy of value added taxes is 1.31 and it is significant at 1% of significance level. This is the result of change in GDP combined with other discretionary policy changes. Some of those policy changes implemented during 2006-2014 include but they are limited to the impact of the recent measures such as the introduction of electronic billing machines and the ending of the VAT exemption on international projects implemented during the fiscal of in 2013/2014. About the short run buoyancy, VAT is the only tax type which has short run tax buoyancy which is significant at 10% of significance level. One of the reasons is that VAT is collected and paid on monthly basis with no effect of lag between changes in revenue and tax collection.

5.2.2. Elasticity

We tested the existence of long and short run relationship among variables with the same procedure as the one used for buoyancy and the results of the tests are summarized in the table 6 below.

Table 5: Two step Engle-Granger Co-integration Test for Elasticity

Equations	ADF t-statistic	Critical values			P-Value	conclusion
		1%	5%	10%		
LTR vs LY and DM_TR	-8.208064	-3.626784	-2.945842	-2.611531	0.0000	Co-integrated at 1%
LIT vs LY and DM_IT	-3.376781	-3.621023	-2.943427	-2.610263	0.0183	Co-integrated at 5%
LET vs LY and DM_ET	-4.289565	-3.621023	-2.943427	-2.610263	0.0017	Co-integrated at 1%
LDT vs LY and DM_DT	-8.090699	-3.626784	-2.945842	-2.611531	0.0000	Co-integrated at 1%
LVAT vs LY and DM_VAT	-4.636585	-3.621023	-2.943427	-2.610263	0.0006	Co-integrated at 1%

Source: Author's Estimates

The following table 7 shows estimated long and short run tax elasticities for all tax types from 2006 up to June 2015. All long run elasticities are significant at 1%.

Table 6: Estimated long run and short run elasticities for all tax types

Names of taxers	Long Run Elasticity	Short Run elasticity	Speed of adjustment
LTR	1.220556**	0.165620	-0.503831
LDT	1.637211**	-0.184740	-0.735388
LET	1.014766**	0.638913	-0.309421
LIT	0.674102**	0.136663	-0.388097
LVAT	1.114756**	0.763390	-0.520672

Source: Author's Estimates

*at 95% confidence level

One major policy changes is the accession of Rwanda to the EAC. Isolating the impact of this policy decision, the long run elasticity becomes 0.67. Though the accession to the EAC has reduced the import duties as expected, it has been offset by a large increase in domestic taxes such VAT and direct taxes due partly to high import emanating from EAC which are part of taxes bases for domestic taxes. This has also created other investment opportunities and consumers' welfare improvement due to lower prices due to cheap imports originating from EAC countries.

The long run elasticity of excise duties is 1.01 and it is significant at 1% of significance level. Those results show that excise duties grow in tandem with GDP after controlling all discretionary changes that occurred during 2006-2014 period such as the change of excise on petroleum products from ad valorem to specific in 2010, the reduction of specific excise on petrol from 283 Rwf/L to183 Rwf/L and on diesel from 250 Rwf/L to150 Rwf/L in 2011/2012 and the increase of excise duty on airtime of mobile phones from 5 to 8 and to 10 percent in 2011 and 2014 respectively.

The long run elasticity of direct taxes is 1.63 and it is significant at 1% of significance level. In addition to the structural transformation of the Rwandan economy, discretionary policy changes implemented during the period under review contributed to the increase in direct taxes collection. They include the revision of personal income taxes (PIT) for micro enterprises by introducing a scheduler tax on turnover below 12 million in September 2012, the reduction of turnover tax for small enterprises from 4 to 3 percent and raising the ceiling for this regime from 20 to 50million in September 2012 and the introduction of gaming law with a 15 percent tax on net winnings and a 13 percent tax on the net revenue of the company. With allowances and tax brackets fixed for a number during 2006-2014, there is likely to have been a 'fiscal drag' effect as taxpayers move into higher tax bands or pay more of their income at the higher tax band.

The long run elasticity of VAT is 1.11 and it is significant at 1% of significance level. The long run elasticity indicates that VAT increases by 1.1% for 1% increase in GDP after controlling all discretionary policy changes. Those policies include the introduction of electronic billing machines and the ending of the VAT exemption on international projects implemented during the fiscal of in 2013/2014. The long run elasticity of total tax revenue is 1.22 and it is significant at 1% of significance level. The long run elasticity shows that Rwandan tax system is elastic after netting out all discretionary policy changes stated above in each individual tax types.

5.3. Comparison between long run buoyancies and long run elasticity

Table 7: Comparison between long run buoyancies and long run elasticity

Names of taxers	Long Run Buoyancies	Long Run Elasticity	Difference
LTR	1.449916**	1.220556**	0.22936
LDT	1.796086**	1.637211**	0.158875
LET	1.755102**	1.014766**	0.740336
LIT	0.099937	0.674102**	-0.57417
LVAT	1.312314**	1.114756**	0.197558

Source: Author's Estimates

** Indicate that the buoyancy is significant at 1%

For all tax types, buoyancy is higher than elasticity except for import duties. The results show that discretionary policy changes implemented during the last ten years have yielded a positive impact on the tax collection in Rwanda.

6. Conclusion and recommendations

The objective of this paper was to estimate tax revenue buoyancy and elasticity to Gross Domestic Product (GDP) in Rwanda in attempt to provide some insight as to revenue responsiveness of Rwanda's tax structure to the change in GDP. We have estimated tax buoyancy and tax elasticity to assess the impact on tax collection of different policies implemented in Rwanda. Buoyancy is a measure of the responsiveness of tax receipts to economic growth without controlling for discretionary changes in the tax system or administration. All buoyancies are significant at 1% significance level except the buoyancy of the import duties.

Tax elasticity is a measure of the responsiveness of tax revenue to a change in national income or output after controlling for exogenous influences such as discretionary changes in tax policy. If a tax is elastic, a one percent increase in GNP or GDP results in a greater than one percent increase in revenue holding constant for discretionary tax changes.

Our result showed that long and short run tax elasticities for all tax types from 2006 up to June 2015 are significant at 1%. In addition, for all tax types, buoyancy is higher than elasticity except for import duties. This result indicates that discretionary policy changes implemented during the last ten years have yielded a positive impact on the tax collection in Rwanda.

As recommendations:

- Tax enforcement must be enhanced to increase the compliance and;
- The GoR should continue to implement fully the on-going tax reforms focusing mainly on Excise duties and VAT because it's where tax policy measures have worked well and it's where there is a potential room to improve compliance compared to other tax types.

One of the major limitations of this study was the lack of quantified impact of all tax policy changes implemented during the period of the study in order to eliminate the effects of discretionary tax measures using the method of the Historical time series tax data (HTSTD) adjusted to DTMs. There is a need for future research related to this topic such as the responsiveness of tax revenue to gross domestic product growth by economic sectors in Rwanda and the use of Historical time series tax data (HTSTD) adjusted to DTMs to compute tax elasticity.

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Appendix

Quarterly taxes and GDP from 2006 to 2015 in billions of Rwandan Francs

Period	*Direct taxes*	*Excise taxes*	*VAT*	Imports duties	*Total tax revenue*	GDP
Q1 2006	22.1	9.4	23.0	13.1	69.5	589.0
Q2 2006	26.6	8.4	24.1	12.3	73.7	633.0
Q3 2006	24.0	8.8	28.1	13.1	76.5	695.0
Q4 2006	25.8	8.9	27.3	13.2	77.2	696.0
Q1 2007	26.6	10.7	26.3	9.8	75.4	668.0
Q2 2007	33.2	10.4	27.8	11.4	84.8	682.0
Q3 2007	27.9	9.7	28.5	10.7	79.1	721.0
Q4 2007	28.9	9.4	33.0	10.2	84.0	742.0
Q1 2008	32.1	10.5	32.7	11.6	89.1	731.0
Q2 2008	44.1	9.9	32.4	12.9	101.5	773.0
Q3 2008	34.7	11.7	36.2	13.0	97.8	806.0
Q4 2008	36.3	12.5	38.2	17.3	106.7	816.0
Q1 2009	35.3	12.9	36.5	15.2	102.0	821.0
Q2 2009	40.9	12.3	33.7	14.7	103.7	812.0
Q3 2009	35.6	15.0	33.8	8.4	95.5	835.0
Q4 2009	38.7	14.6	34.0	9.0	100.0	855.0
Q1 2010	46.8	15.5	34.8	9.4	110.1	863.0
Q2 2010	40.4	14.6	35.7	8.1	102.6	864.0
Q3 2010	41.9	22.0	33.3	9.3	110.4	902.0
Q4 2010	45.3	22.8	37.8	9.7	120.8	938.0
Q1 2011	51.0	22.4	36.6	11.5	125.5	917.0
Q2 2011	49.0	21.9	38.9	8.7	123.4	899.0
Q3 2011	44.7	23.3	40.5	9.9	122.6	1,011.0
Q4 2011	53.9	22.7	41.1	10.6	132.8	1,019.0
Q1 2012	59.9	22.0	43.6	11.8	142.0	998.0
Q2 2012	63.9	21.1	42.5	12.4	144.5	999.0
Q3 2012	53.4	23.5	46.7	12.2	140.9	1,085.0
Q4 2012	59.8	21.7	43.2	12.4	142.1	1,102.0
Q1 2013	75.5	21.1	45.2	11.3	157.7	1,046.0
Q2 2013	71.0	21.5	48.5	10.2	158.0	1,071.0
Q3 2013	64.0	24.0	50.4	10.9	157.2	1,116.0
Q4 2013	68.6	21.8	52.9	12.6	162.4	1,148.0
Q1 2014	67.1	22.5	55.1	13.0	165.5	1,124.0
Q2 2014	74.0	22.7	68.9	14.2	185.4	1,136.0
Q3 2014	71.0	24.8	60.4	12.0	176.7	1,205.0
Q4 2014	73.7	23.9	58.1	13.0	176.5	1,221.0
Q1 2015	83.0	24.4	58.9	14.3	186.1	1,209.0
Q2 2015	87.6	26.3	71.0	15.8	206.9	1,216.0

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