NATIONAL BANK OF RWANDA
BANKI NKURU Y' U RWANDA

ECONOMIC REVIEW

Nº: 006

December 2014

ECONOMIC REVIEW

N^{0} 006

December 2014

Foreword

In this sixth edition of the National Bank of Rwanda's Economic Review are published five research papers. This is in line with the ongoing efforts to disseminate knowledge and other information on the Rwandan economy to the general public. Effective communication with all stakeholders is and will remain a high priority on the BNR agenda.

The first paper analyzes the linkage between financial inclusion, stability, integrity, and consumer protection in Rwanda. Somewhat linked, the next two papers focus on the estimation of the output gap for the Rwandan economy which serves as an estimate of aggregate spending in the whole economy. This is used as an input in the third paper to estimate the monetary policy reaction function for Rwanda. The fourth paper estimates the real effective exchange rate misalignment in Rwanda whereas the last paper investigates the determinants of interest rate spread in Rwanda.

The National Bank of Rwanda assumes no responsibility for the views expressed by the authors of the aforementioned five papers. Reprinting of any figures or statements contained herein is permitted on condition that proper citation and/or referencing is given to the National Bank of Rwanda's Economic Review.

Economic Review N° 006

Please send your comments and questions to the Office of the Chief Economist (thkigabo@yahoo.fr, tkigabo@bnr.rw) and/or the Monetary Policy and Research Department, KN 6 Avenue 4, P.O Box 531 Kigali-Rwanda or on Monetary_Policy_Res_Group@bnr.rw.

Table of contents

Economic Review N⁰ 006

Financial Inclusion, Stability, Integrity and Consumer protection:

Harnessing Synergies, Managing Trade-offs

Monique Nsanzabaganwa[1]

Introduction

Financial inclusion has been high on the agenda of public policy makers, including financial sector regulators, for its developmental benefits, while private sector players continue to discover its commercial value proposal and innovate to unleash the same. But a valid question often asked by regulators is to know whether pursuing financial inclusion is not bound to jeopardize the stability and integrity of the financial sector, exposing customers to a range or risks in the process. Thus, the linkage between financial inclusion, stability, integrity, and consumer protection commonly referred to as I-SIP is the subject matter in this paper. Using the Rwandan case, the paper argues that well managed financial inclusion can bring positive externalities in the financial sector and reinforce the afore-mentioned, seemingly conflicting objectives, namely, stability, integrity, and consumer protection.

According to FinScope Surveys (FinMark Trust definition), financial inclusion refers to a situation where members of the population deal with

[1] This paper is an elaboration of the statement made by Dr Monique Nsanzabaganwa, Vice Governor of the National Bank of Rwanda, when presenting the Rwandan case at the Kigali International Conference on Financial Inclusion, Inclusive Growth and Sustainable Development. The conference was organized to mark the 50 years of existence of the National Bank of Rwanda, on 18th July 2014.

financial service providers to transact, save, borrow or manage their risks. Exclusion means no dealing at all.

Financial inclusion can be measured by access to, uptake of, or usage of, financial services by adult population. Financial access itself is a resultant of three factors, namely proximity (percentage of population having access to a financial institution within a 5-km radius, for instance), eligibility (like how friendly and easy to meet are the KYC "Know Your Customer" criteria) and affordability (cost such as interest rates, etc.) of the service.

Financial inclusion can be formal or informal. It is formal when it refers to dealing with a regulated institution, either a bank or a non-bank financial institution such as a microfinance institution, a credit and saving cooperative, an insurance company or a mobile financial service provider. Financial inclusion is informal when people deal with unregulated providers such as associations or cooperatives, saving groups or money lenders.

In Rwanda, financial inclusion has made tremendous strides in the last five years or so. Leadership of the country played a crucial role for this transformation. First of all, financial inclusion was envisioned as a must-do for wealth creation and poverty reduction. Looking at it from a formal inclusion perspective, for example, Government implemented a country-wide grass-root savings and credit cooperatives system dubbed Umurenge SACCOs and ensured all its cash transfers (salaries, vouchers for agricultural inputs, Vision 2020 Umurenge safety net program- VUP, etc.) are channeled through a recipient account.

Even on informal level, with or without partnering with a non-government organization, different forms of village saving groups targeting the most vulnerable poor members of the community have been encouraged, especially in rural areas, with a view to graduating their members into SACCO clients as they grow.

The Central Bank also fulfilled a developmental role through its enabling regulation and efficient supervision, in addition to an active role played alongside Government and the industry to deploy consumer education and enforce consumer protection.

All in all, the ecosystem in place has been largely successful in harnessing the synergies between financial inclusion and the three objectives of ensuring the stability and integrity of the financial system and protecting consumer rights, while mitigating the risks involved. However, few challenges remain, which relevant players are working together to address.

The rest of the paper is organized as follows: Section one provides a conceptual framework to understanding the constructive and destructive linkages between financial inclusion and other policy objectives, mainly stability, integrity and consumer protection. Section 2 depicts a picture of financial inclusion in Rwanda, on which Section 3 and Section 4 will build to illustrate how the constructive linkages and the destructive ones respectively deployed on the ground, and what has been the policy response in that regard.

The paper concludes by pointing at remaining and emerging challenges which policy makers are called to keep under control to fully harness the positive linkages of financial inclusion.

1. The benefits and trade-offs of financial inclusion

> *"A growing body of research suggests that whether broad-based access to formal financial services promotes financial stability depends on how that access is managed within the regulatory and supervisory framework, especially in terms of financial integrity and consumer protection. Four factors come into play: financial inclusion, financial consumer protection, financial integrity, and financial stability. These factors are inter-related and, under the right conditions, positively related. Yet failings on one dimension are likely to lead to problems on others" (CGAP 2012)*

Financial inclusion, mainly formal, contributes to the work of monetary policy makers and financial sector regulators alike. As more and more people are brought into the mainstream of financial sector, there is a decline in the amount of money and operations happening off the system. As such, regulation of bank liquidity can be done with increased precision. Similarly, with financial inclusion, savings are better pulled together, which positively impacts investments through financial intermediation (Prasad 2010: 18-20). Moreover, when people get financially included, there are less and less risky financial dealings because the business becomes regulated and more transparent (FATF/OECD 2013: 15-16). Financial inclusion also increases diversification and competition in the system, making it more innovative, resilient (Han and Melecky 2013: 2-4) and affordable.

Financial inclusion ultimately improves the transmission mechanism of monetary policies, thus making them more effective in ensuring macroeconomic stability (for instance, see Mbutor and Uba 2013 on Nigerian Experience).

But financial inclusion often comes with a cost. The immediate one to think of is that increasing physical and/or virtual access demands more resources if proper supervision and know-your-customer standards are to be upheld at all times. The situation might be more complex if there are multiple layers and multiple regulators in the system as effective coordination becomes an imperative. Yet another considerable difficulty stems from the fact that the new comers to the system as a result of financial inclusion tend to be the less educated financially. The related limited negotiation power therefore prevents competition from playing its full potential to ensure value for money to the consumer. But on the other side, hastily included consumers may introduce free-rider problems in the credit market with increased unpaid loans thus posing a risk to the system.

The good news is that all these trade-offs can be anticipated and managed (GPFI 2012: 1-5). Policy makers, regulators and private sector players therefore do not have to make a choice between financial inclusion and something else, as this would undermine their growth prospects and compromise the sustainability of their development objectives. Financial inclusion is to be pursued not for the sake of it, but for its impact on the bottom line which is prosperity. In fact, the South African case evidence suggests that synergies between financial inclusion, stability, integrity and consumer protection are better optimized if these four policy objectives (the I-SIP) are tackled collectively rather than independently (GPFI 2012: 2).

2. Benchmarking financial inclusion in Rwanda[2]

Access to formal inclusion in Rwanda doubled to 42% in 2012 compared to 2008, while total exclusion declined to 28% from 52% over the same period (FinScope studies 2008 and 20123). Leadership was demonstrated in several fronts, which drove this rapid transformation. The departing point was a consensus that financial inclusion is one of the key strategies to reach high growth with a poverty-reducing face, yet formal financial inclusion was still lagging behind at 21% in 2008. Government then took a decision to increase that rate to 80% by 2017[4], and got the same endorsed by the National Dialogue[5] meeting for nation-wide ownership. The strategy that was adopted was the creation of a program named Umurenge Savings and Credit Cooperatives (Umurenge SACCO or U-SACCO) to fast-track access at grass root.

In 2009, populations were mobilized to form up their U-SACCOs in line with the 416 administrative sectors that are found in the 30 Districts of the country. During the first two years of the program, the institutions concentrated on mobilizing the savings while working on fulfilling conditions for licensing.

[2] For more details, see National Bank of Rwanda 2014, mainly Chapter Four and Five.
[3] FinScope Rwanda 2008 and FinScope Rwanda 2012 available on http://www.statistics.gov.rw/publications/finscope-survey-report-2008 and http://www.statistics.gov.rw/publications/finscope-survey-report-2013 respectively.
[4] It is the same commitment that the country reiterated in the Maya Declaration.
[5] National Dialogue meeting is an annual forum of leaders at the grassroots and national levels, from the public, private and civil society sectors, convened every year and chaired by the President of the Republic. At the convention, participants deliberate on a number of issues of national interest, exchange ideas for consensus building, hold each other accountable as they monitor implementation of decisions taken previously, and commit to move together to implement new decisions taken.

The first three U-SACCOs were fully licensed in 2010, and a critical mass of them completed it in 2012, with the last U-SACCO obtaining its license in 2013. The 416 institutions were able to run on member contributions and government subsidies that came in in terms of salaries for three critical staff (manager, loan officer and accountant) and minimum equipment (lap-top, printer and a modem for internet connection) covered gradually as a U-SACCO grew to break-even point. In June 2014, 73% had managed to graduate from the subsidy.

Other strategies that helped to push formal inclusion included:

- expansion of commercial branch network as a result of increased competition: in June 2014, there were more than 500 bank branches, 70% of which were in rural areas;
- Agent banking was enabled in 2012, raising the number of agents to 2,179 end June 2014;
- Mobile financial services, both mobile network operator-based and bank-based grew at high speed since 2012, increasing agents four-fold to 12,828 between 2012 and June 2014, while mobile payment subscribers tripled to 3,187,197 and mobile banking subscribers almost doubled to half a million over the same period.

With these strategies, and U-SACCO system that continued to mature and grow its clients by 27% between 2012 and June 2014, there was no doubt that formal financial inclusion stood at a rate much higher than its 42% level in 2012. In 2012, proximity had improved to 90% of Rwandan population living within 5km radius, thanks to SACCOs.

With more than 2000 agents by June 2014, 5 times outnumbering the U-SACCOs, the proximity would have drawn closer to 100% in June 2014.

As a result, U-SACCO system has been instrumental in the delivery of Government community initiatives such as Vision 2020 Umurenge Program started in 2008 targeting the poorest of the community, whose annual transfers were 98% channeled through Umurenge SACCOs thereby representing roughly 20% of the system deposits at the end of each financial year.

Table 1 Estimated amount paid to VUP beneficiaries for three years

VUP components	2011/2012	2012/2013	2013/2014	TOTAL
Direct support	**4,035,705,922**	**6,309,946,939**	**9,368,470,468**	**19,714,123,329**
Public works	**4,233,477,765**	**4,764,131,967**	**5,171,351,898**	**14,168,961,630**
Financial services	**3,851,633,465**	**3,592,317,386**	**3,480,295,672**	**10,924,246,523**
Total	**12,120,817,152**	**14,666,396,292**	**18,020,118,038**	**44,807,331,482**

Source: Ministry of Local Government (MINALOC)

It can be therefore concluded that financial inclusion through U-SACCOs has had a significant contribution to the reduction of poverty by 12 percentage points in five years from 56.7% in 2008 to 44.9% in 2012, which Paul Collier perceives as "very rare in [the African] continent"[6].

[6] Key note presented at the "Reaching Vision 2020: Facts and Plans" event, Kigali Serena Hotel, 7 February 2012.

3. Financial inclusion born synergies at play in the Rwandan market

A lot of benefits have accrued from increased financial inclusion in Rwanda. Firstly, the effectiveness of the monetary policy implemented by the National Bank of Rwanda was positively impacted by developments in the financial sector, mainly the banking, microfinance and payment systems, as the average share of currency in circulation to broad money between 2000-2008 declined from 19.3% to 13.2% over the period between 2009 to 2013, suggesting that the central bank action could reach liquidity increasingly brought on to the system. As a matter of fact, the number of accounts in banks and microfinance (including U-SACCO) had exceeded 5 million (one account for every 2 Rwandans on average), with an average growth rate of 20% and 29% for commercial banks and microfinance institutions respectively, between 2008 and 2013. As a result, core inflation, which had hit an annual average of 22% in 2008, declined to an average of 3.66% between 2009 and 2013.

Secondly, the level of intermediation has increased, with credit to the private sector as share of GDP moving from 12.1% on average between 2000 and 2008 to 13.7% between 2009 and June 2014. The number of loans from banks and microfinance reached 350,000, with an average growth rate of 76% and 17% for banks and microfinance respectively, between 2008 and 2013. This empowered the rapid growth of the economy, which grew by 6.4% on average between 2008 and 2013.

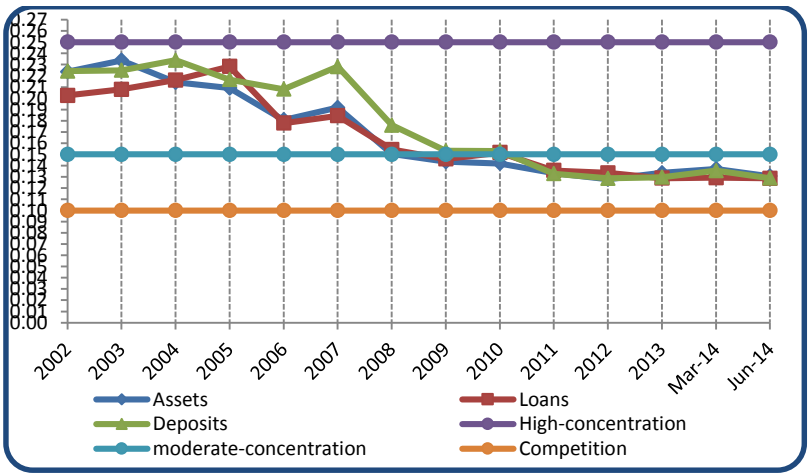
Table 2 Financial inclusion and trend in broad money (M3), credit to private sector (CPS) and currency in circulation (CIC)

Average in %, unless otherwise indicated	M3/GDP	CIC/GDP	CPS/GDP	CIC/M3
Average 2000-2008	17.5	3.3	12.1	19.3
Average 2009-2013	19.7	2.6	13.7	13.2
Average GDP in FRW billion (2000-2008)	1354.7			
Average GDP in FRW billion (2009-2013)	3876.0			

Source: National Bank of Rwanda

Thirdly, there has been increased competition in the financial sector, as indicated by the falling trend in the Herfindah Index that crossed the moderate-concentration benchmark of 0.15 in 2009 and is now continuing to decline further below that line towards full competition benchmark of 0.10.

Chart 1: Evolution of HHI for loans, deposits and assets in Rwanda



Source: Financial Stability Directorate, National Bank of Rwanda

The fourth area was the system liquidity that has sustained high levels, partly thanks to RTGS and electronic transfers including e-tax payment, partly thanks to U-SACCOs that managed to mobilise savings beyond 44 billion, representing about 15% of the most liquid assets of commercial banks worth 297 billion in June 2014. A big part of the U-SACCO savings ends up in commercial banks as par the guidelines on security of the funds.

4. How financial inclusion trade-offs were managed in Rwanda

Stability

The introduction of strategies that promote financial inclusion understandably created some disruption in the market. The quality of assets got affected as institutions were fighting to gain/retain clients. This was the case mainly with microfinance institutions, but also commercial banks panicked a bit. The central bank response was to mobilize for financial education and a functional credit information system coupled with tight supervision. The result was induced good behavior and more transparency in the market, which however had an initial cost of increasing the level of NPL, after book clean-up imposed by the supervisor. In fact, proper application of rules on loan classification and provisioning induced an initial deterioration in the level of NPLs especially for other microfinance institutions, which were also negatively affected by their laxity in loan applications scrutiny out of fear of competition from the newly introduced U-SACCOs. The good news was that the situation started to normalize, with the level of non-performing loans in commercial banks reaching 6.6% in June 2014 from 12.4% in December 2008.

In June 2014, non-performing loans in the microfinance industry stood at 7.6% U-SACCO system included, and 7.9% U-SACCO excluded (U-SACCO system stood at 7% if taken alone).

Table 3 Trends in Non-performing loans

	Dec-08	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Jun-14
Commercial banks	12.6	11.9	10.8	8	6.1	6.9	6.6
MFI Excluding U-SACCO	5.4	9.2	11.2	12.9	9.5	6.6	7.9
U-SACCO				5.6	5.3	7.3	7
Microfinance total	5.4	9.2	11.2	12	8.5	6.8	7.6

Source: National Bank of Rwanda

It took the central bank a lot of resources (time, money, human resources) to contain the rise in NPLs. The central bank that is also regulator of financial services including Umurenge SACCOs, had to deploy resident supervisors, two in each of the 30 Districts, to respond to the need of closer supervision of U-SACCOs and other local microfinance institutions. As the situation stabilized, in June 2014, the number of U-SACCO inspectors was reduced to 32, and their work centers have been moved from District to the BNR's Head Quarters and 5 branches on proximity basis.

Future plans to further mitigate the risk inherent to U-SACCOs include the following:

- Continue build the capacity of their board and committee members, management and staff: RICEM- Rwanda Institute of Cooperatives, Entrepreneurship and Microfinance has been put in place and the central bank is one of the steering agencies. The formal trainings will supplement the ongoing coaching on internal control tools, and the regular prudential reviews performed by the regulator.
- Consolidation of U-SACCO system with the creation of an apex body that will ensure synergies are promoted, financial picture is unified and self-regulation is enhanced before the Bank inspectors come in.
- Equip the system with an integrated information management and reporting system to support the above.

BNR has been empowered by law to oversee payment systems. This function was made part of the broader Financial Stability Directorate in June 2014, for better synergy and early alert of any systemic issues that may originate from payment systems and affect financial stability.

Integrity

The issue of KYC- "know your customer" is mitigated to a large extent thanks to the Smart Identity Card implemented by the Government of Rwanda. Furthermore, the smart ID permits searches on the credit information about a loan applicant and helps with detecting fraudulent transactions, while the on-line mortgage registration system enables loan security protection.

The central bank has facilitated financial institutions access the ID database managed at the National ID Agency (NIDA) by using the bank's gateway. These systems work for banks and microfinance alike, including U-SACCOs who are compulsory participants.

In the presence of increasing uptake of mobile financial services, the registration of SIM cards in force in Rwanda has been of invaluable support.

For residual fraud cases, the central bank has issued guidelines on KYC and AML-CFT and has been facilitating an industry-wide forum where industry players meet to exchange information and take preventive measures together. A Financial Investigation Unit, arm of the Rwanda National Police, housed in the premises of the central bank, was created to enforce the AML-CFT law. The central bank Governor chairs FIU Advisory board.

Consumer protection

In addition to financial education (national financial literacy strategy in place, endorsed by Cabinet), the central bank has been supporting Access to Finance Forums created in every District, whereby local stakeholders in the financial and economic development arena meet to discuss issues pertaining to financial inclusion and to harmonize actions in that regard.

The central bank has enacted regulations on consumer protection in matters of disclosure of information, handling and settling claims, etc. The same is enforced through reporting, off-site and on-site analysis done by the Bank.

The central bank has advocated for the creation of Ombudsman of Financial Services function within the Office of Ombudsman, since handling financial institutions clients' claims is not part of the core business of a central bank.

On the other side, the Bank has drafted a deposit insurance guarantee scheme and the draft law was submitted for Cabinet consideration and subsequent presentation to Parliament.

Rwanda is an active member of AFI and AMPI[7], and has gained a lot from the working groups, including the one on consumer protection.

Conclusion and way forward

It can be concluded that so far, managing the trade-offs and harnessing the synergies between financial inclusion, financial stability, financial integrity and financial consumer protection in Rwanda has been a difficult but feasible work, and considerable success has been registered in many areas. However, challenges remain, which are manageable.

Like in any market, meaningful financial inclusion is measured by constant usage, and this lags behind access in most of the cases. Raising awareness and understanding on the part of clients and providers remain a constant challenge: there is need to convert eligibility (which is not an issue because of smart ID), proximity (which is not an issue because of SACCOs, bank

[7] AFI: Alliance for Financial Inclusion; AMPI: African Mobile Financial Services Policy Initiative

agents, mobile financial services) and uptake (which is on course to reach 80% by 2017) into transformative usage for significant impact on people's livelihoods, hence continue reduce poverty and enable inclusive growth.

Raising saving and borrowing for investment is another challenge. The 2012 FinScope study revealed that only 5% of savers and 6% of borrowers did it for investment purposes.

Building regulatory and supervisory capacity in the face of fast-changing innovations for increased financial inclusion remains a daunting task for the National Bank of Rwanda, like it is for any regulator/supervisor world-wide[8], if stability and integrity of the financial sector are to be preserved. The Bank staff needs to be ahead of the game as much as possible, and engage players so as to come up with accommodative but robust rules for that game.

Managing the systemic risk created by interoperability is also high on the list of challenges. Rwanda is steadily moving towards full interoperability among accounts, cards and e-wallets for both domestic and regional market players, which is a good thing. But systemic risk is also growing by the same token.

[8] For instance, the 14th Annual International Conference on Policy Challenges for the Financial Sector jointly organized by the Federal Reserve System, the World Bank and the International Monetary Fund, whose theme was "Global Financial Sector Reform: Five Years On – Are We Treating the Symptoms or Curing the Disease?" emphasized the need to strengthen supervisory capacity in order to enforce the rules, which rules should also be kept simple for everyone to understand. The capacity gaps identified included; lack of clarity in the sources of systemic risk, limited capacity of supervisors to regulate by function/product in lieu of form of an institution, limited capacity to understand business models and KPIs setting (what boards of the supervised institutions give management as targets to achieve, and why), etc.

Collaboration among the regulator of telecommunications and other regulators internally, and cooperation with regional regulators and supervisors, are imperative to keep the risk checked.

Last but not least is the issue of maintaining the stability of U-SACCO system. As was depicted in Table 3 above, the quality of portfolio in these institutions deserves constant monitoring. As the capacity building, consolidation and automation mentioned above go their course, there is need to continue working on soft issues such as governance of the institutions (to ensure adherence to internal control rules) and address behavioral issues (to uproot clients' tendencies not to pay back loans or U-SACCO leaders/management's leniency to enforce borrowers pay their dues).

References

AFR, 2013. *FinScope Rwanda 2012*. Technical Report. Kigali: Access to Finance Rwanda, January.

CGAP, 2012. *Financial Inclusion and Stability: What Does Research Show?* Washington: CGAP Brief, May.

FATF/OECD, 2013. *Anti-Money Laundering and Terrorist Financing Measures and Financial Inclusion*. Paris:
Financial Action Task Force, February.

GPFI, 2012. *Financial Inclusion – A Pathway to Financial Stability? Understanding the Linkages*. Issues Paper.
Basel: Global Partnership for Financial Inclusion, October.

Han, R. and M. Melecky, 2013. *Financial Inclusion for Financial Stability. Access to Bank Deposits and the Growth of Deposits in the Global Financial Crisis*. Policy Research Working Paper 6577. Washington: The World Bank, August.

Mbutor, M. O. and I. Uba, 2013. "The Impact of Financial Inclusion on Monetary Policy in Nigeria". *Journal of*
Economics and International Finance, Vol. 5(8). November: 318-326.

National Bank of Rwanda, 2014. *National Bank of Rwanda @ 50 and the Recovery of a Nation*. Kigali: Fountain Publishers.

National Institute of Statistics of Rwanda, 2008. *FinScope Rwanda 2008*. Kigali: NISR, June.

Prasad, E., 2010. *Financial Sector Regulation and Reforms in Emerging Markets: An Overview*. NBER Working Paper Number 16428. Cambridge: National Bureau of Economic Research, October.

Estimating output gap model for Rwandan economy[9]

Authors:

Dr. Thomas Kigabo R **Mrs. Joy Irankunda**

Abstract

The potential output and the corresponding output gap are key variables in identifying the scope for sustainable non-inflationary growth and assessment of the stance of macroeconomic policies. In this paper, we estimate the potential output and output gap for Rwanda using four statistical methodologies: the linear time trend method, the Hodrick-Prescott (HP) filter, the Beveridge-Nelson decomposition technique and a linear state space model. These estimates provide useful information for policymakers to judge inflationary or deflationary pressures in the Rwandan economy. We also examine the relationship between output gap and inflation to gauge the extent of slack in the economy. The results of the estimation indicate that HP filter and linear time trend methods give almost identical estimates while there were variations in the estimates obtained from the other methods. The key finding is that monetary and fiscal policy makers should respond to the shifts in the level of output gap to avoid inflationary pressures while continuing support to the economic growth.

Key words: Potential output, output gap, Hodrick-Prescott filter, the Unobservable Components Method

[9] The views expressed are those of the authors and not necessarily those of the National Bank of Rwanda. We thank Dr. Ibrahim Stevens, German Development Cooperation (GIZ) Macroeconomic Advisor, for the very useful comments and discussions, which contributed to improve the quality of this paper. Any remaining errors are of course the responsibility of the authors.

1. INTRODUCTION

One of the fundamental objectives of monetary policy authorities in both developed and developing countries is to maintain price stability. The crucial role of this goal cannot be underestimated since it has significant macroeconomic benefits with economy-wide ramifications. In pursuit of this goal, monetary policy authorities are expected to continuously monitor the inflationary pressures that emerge as the economy grows overtime. Understanding the relationship between real economic activity and inflation is of paramount importance for monetary policy authorities. A key component of this relationship is the output gap which plays a vital role in assessing inflationary pressures and the cyclical position of the economy (Osman, Rosmy and Balli, 2008).

Potential output is the level of output consistent with a stable rate of inflation. At this level the demand and supply in the aggregate economy are balanced. Thus, the deviation of actual output from potential, or the output gap, provides a measure of inflationary pressure in the economy. If the output gap is positive through time then inflation will begin to move upwards in response to demand pressures in key markets. Within this framework, an accurate measure of the economy's level of potential output is required to explain the historical path of inflation and assess the extent of current inflationary pressures (Conway and Hunt, 1997). Potential output can be thought of as the maximum output an economy can sustain without a rise in inflation. If actual output is below potential, resources are not being fully utilized and this puts downward pressure on inflation.

If actual output is above potential output, this can be seen as a source for inflationary pressures and as a signal for the central bank to tighten monetary policy.

The National Bank of Rwanda (BNR) like other central banks has the mandate to ensure and maintain price stability; enhance and maintain a stable and competitive financial system; and support Government economic policies without prejudice to price stability and financial system stability. BNR therefore needs to regularly evaluate whether its monetary policy orientation will lead to price stability and continue supporting the economic growth objective of the Government. Thus, BNR needs to have a more reliable gauge of the inflationary pressure and the potential output that is likely to prevail in the future to support decision of Monetary Policy Committee about monetary policy stance.

There is a large literature focusing on the estimation of potential output and the corresponding output gap especially for industrialized countries, see, for example, Mishkin (2007). This demonstrates not only the theoretical significance of these variables but also their policy implications. Theoretically, these variables are important inputs to many macroeconomic models that are designed to improve understanding of how economies work. For example, the output gap is extensively used in price and wage inflation models that are based on Philips curve and monetary policy reaction functions (Clarida et al, 1998 and Roberts, 1995).

Estimates of the output gap and potential output are therefore very important for the formulation of monetary policy, especially for central banks operating under a floating exchange rate regime with an inflation target or a price based monetary policy framework. Furthermore, estimation of the size of the output

gap is an important indicator for the thrust of fiscal policy since it is used in calculating the structural fiscal balance among others, while the estimated potential output is used to give an ex-post assessment of the impact of past structural reforms, which most Sub-Saharan African Countries have undertaken.

In the academic literature, methods used to estimate potential output and output gap are similar to business cycle decomposition methods. These methods allow separating the permanent component or trend of a series from its cyclical or transitory component. Therefore, potential output is the trend or permanent component while the output gap is the transitory or cyclical component. Various techniques have been developed to measure potential output and the output gap. According to Mishkin (2007) these methods can be grouped into three categories: aggregate approaches; growth-accounting approaches and the dynamic stochastic general equilibrium (DSGE) approaches. Others, for example, Gerlach and Yiu (2004) have divided the methods into an atheoretical approach, a structural approach or a mixed approach. The atheoretical approach is purely statistical approach; the structural approach relies on economic theory; and the mixed approach allows the statistical model to have some economic structure.

This paper examines a variety of methods that are used to estimate potential output and provide empirical estimates for Rwanda. The estimation is limited to a number of well-known statistical techniques because we consider this a first estimate; but also due to the availability of data. Further work would be done to estimate the output gap in Rwanda using other methods including those based on economic theory.

The rest of the paper is organized as follows: Section 2 briefly describes alternative methods for estimating potential output and the output gap. Section 3 presents the empirical findings using each of the four different methods. Section 4 summarizes the main findings and carries the concluding remarks.

2. METHODOLOGY OF OUTPUT GAP ESTIMATION

Following the categorization used by various authors, for example, Mishkin 2007, there are broadly two approaches for estimating potential output and the output gap: statistical detrending (or filters) and estimation of structural relationships. Detrending methods separates a time series for output into a permanent and a cyclical component. Methods based on structural relationships rely on economic theory in order to isolate the effects of structural and cyclical influences on output. Other approaches include the use of cyclical indicators, such as surveys or summary measures from large datasets, and estimates from dynamic stochastic general equilibrium (DSGE) models.[10]

Some of the detrending methods include the Hodrick-Prescott (HP) filter, the Baxter-King band pass (BK) filter and the Kalman filter (KF) while structural relationships approaches include: structural vector autoregression (SVAR) models, Production Function method, demand–side models and multivariate system models. In this paper we use the linear time trend, the HP filter, Beveridge-Nelson decomposition method and an unobserved components or linear state space model to estimate the potential output gap in Rwanda.

[10] See, for example, Kiley (2010) for an example of a DSGE estimate of the output gap.

2.1. The Linear Time Trend Method

The first and the oldest statistical technique that is empirically utilized to estimate both the potential output and the output gap is the linear trend method. It assumes that output is approximated as a simple deterministic function of time and that output can be decomposed into a trend component and a cyclical component.

$$Y_t = \alpha + \beta t + \varepsilon_t \qquad (1)$$

The potential output is given by

$$\hat{Y}_t = \hat{\alpha} + \hat{\beta} t \qquad (2)$$

The output gap is then obtained as the residual from the estimation of the equation (1):

$$YGap_t = Y_t - Y^*_t \qquad (3)$$

One of the main drawbacks of this technique is that it assumes that the potential output grows at a constant rate and this implies that all the movements in output about the time trend are interpreted as demand shocks since it does not allow any supply shocks to the system (Claus, 2000).

This assumption is very problematic and difficult to justify theoretically since the growth of output depends on the growth of the factors of production and improvements in technology and there is no reason for these factors to be constant over time especially when the economies have undergone considerable structural change.

The fact that output gap estimates are sensitive to the sample period also undermines the credibility of the estimates obtained from the linear trend method.

2. 2. The Hodrick-Prescott (HP) Filter

Alternative detrending methods were developed to take into consideration the limit of the linear trend method. Arguably, the most popular filter used is the HP filter. Like the linear trend, this method is not based on economic theory or a structural relationship, but instead gives a useful approximation of the growth rate of the potential output. A desirable feature of the H-P filter is that it renders the output gap stationary over a wide range of smoothing values (Hodrick and Prescott, 1997) and also it allows the trend to change overtime. The HP filter method is a simple smoothing procedure assuming that growth component varying "smoothly" over time.

In particular, a given time series say Y_t (or output), may be expressed as the sum of a growth component or trend Y^*_t (or potential output) and a cyclical component or output gap $YGap_t$:

$$Y_t = Ygap_t + Y^*_t \qquad t=1,2,\ldots \qquad (4)$$

The measure of the smoothness of Y_t is the sum of the squares of its second difference. The average of deviations of $YGAP_t$ from Y_t^* is assumed to be near zero over a long period of time.

These assumptions lead to a programming problem of finding the growth components by minimizing the following:

$$Min\sum_{t=1}^{T}(Y_t - Y^*_t)^2 + \lambda\sum_{t=2}^{T-1}\left[(Y^*_{t+1} - Y^*_t) - (Y^*_t - Y^*_{t-1})\right]^2 \quad (5)$$

Where λ determines the degree of smoothness of the trend.

The parameter λ is a positive number, which penalizes variability in the growth component series and the larger the value of λ, the smoother is the solution series. Moreover, as λ approaches infinity, the limit of the solutions for equation (3) is the least squares of a linear time trend model. On the other hand, as the smoothing factor approaches zero, the function is minimized by eliminating the difference between actual and potential output that is making potential output equal to actual output. A major drawback comes from the difficulty in identifying the appropriate detrending parameterλ.

Since the choice of λ remains a key judgment, there are three possible decision criteria. The first would be to follow Hodrick and Prescott's approach and choose a constant ratio of the variances of trend output and actual output. Applied to many countries, this approach would generate a different λ value for each country and would mean that countries whose actual output fluctuates more would also show greater fluctuation in trend.
A second approach would be to impose a uniform degree of smoothness and the same variance in trend output for each country. A difficulty with both these criteria is that they ignore the possibility that some countries respond with greater flexibility to economic shocks than others which would affect how closely output trend would follow actual output.

A third approach is to choose a value of λ that generates a pattern of cycles which is broadly consistent with prior views about past cycles in each country.

The HP method has been used in a number of empirical studies. The popularity of this method is due to its flexibility in tracking the characteristics of the fluctuations in trend output. The advantage of the HP filter is that it renders the output gap stationary over a wide range of smoothing values and it allows the trend to change overtime.

The HP method has its weaknesses as well. The smoothing weight (λ) depends on how λ affects responsive potential output to movements in actual output. For high smoothing factor, the estimate indicates output above potential, but for moderate or low smoothing, the estimate suggests output below potential. Thus, an appropriate smoothing parameter (λ) is difficult to identify.

In addition, the HP method is the high end-sample biases, which reflect the symmetric trending objective of the method across the whole sample and the different constraints that apply within the sample and its edges.

To counter this problem, researchers use output projections to augment the observations. The reliability of estimates of potential output and the output gap would depend on the accuracy of the forecasts used to avoid the end-sample bias. Finally, for integrated or nearly integrated series, it is shown that an arbitrary value of smoothing parameter could lead to spurious cyclicality and an excessive smoothing of structural breaks.

2.3. Unobservable Components Methods

The approach consists at estimating unobserved variables such as potential output using information from observed variable such as output.

Beveridge and Nelson (1981) proposed a detrending method assuming that output contains unobserved permanent and temporary components.

The two elements are a random walk with a drift and a stationary autoregressive process:

$$\phi(L)\Delta Y_t = C + \theta(L)\varepsilon_t, \qquad \varepsilon_t \rightarrow iid(0,\sigma^2) \tag{6}$$

(6) is an ARMA(p,q) model capturing changes in output y.

$$\phi(L) = 1 - \phi_1 L - \phi_2 L^2 - \ldots - \phi_p L^p \tag{7}$$

$$\theta(L) = 1 + \theta_1 L + \theta_2 L^2 + \ldots + \phi_q L^q \tag{8}$$

$$|\phi| \prec 1; |\theta| \prec 1 \tag{9}$$

Following Wold representation, (6) can be written as:

$$\Delta y_t = \mu + \psi(L)\varepsilon_t \tag{10}$$

Where $\psi(L) = \phi(L)^{-1}\theta(L) = \sum_{j=0}^{\infty} \psi_j L^j$ (11)

In this decomposition, potential output corresponds to the permanent component of output and the part of output due to transitory shocks is defined as the output gap as defined by (10).

Watson (1986) suggested an unobservable components model that decomposes output into a permanent and a transitory component, which corresponds to potential output and output gap respectively:

$$Y_t = Y_t^p + Z_t \quad (12)$$

The permanent or potential output is assumed to follow a random walk with drift:

$$Y_t^p = \mu^p + Y_{t-1}^p + \varepsilon_t^y \quad (13)$$

Where μ^y is a drift term that can be used as a measure of the rate of growth of potential output, and $\varepsilon_t^y \sim N(0, \sigma_y^2)$. This equation implies that the rate of growth of potential output not only depends on temporary shocks captured by $\varepsilon_t^y \sim N(0, \sigma_y^2)$ but also on the more persistent growth factor μ^p . The error terms in the two components are uncorrelated.

Following Clark (1989), we assume that the drift parameter follows a random walk and can be written as:

$$\mu^p = \mu_{t-1}^p + \varepsilon_t^\mu \quad (14)$$

Where $\varepsilon_t^\mu \sim N(0, \sigma_\mu^2)$ and represents a permanent shock to the rate of growth of potential output.

Finally, we assume that the output gap follows an AR(2) process:

$$Z_t = \emptyset_1 Z_{t-1} + \emptyset_2 Z_{t-2} + \varepsilon_t^z \quad (15)$$

Where $\varepsilon_t^z \sim (0, \sigma_z^2)$ and the roots of $(1\text{-}\emptyset_1 L - \emptyset_2 L^2) = 0$ lie outside the unit circle.

In order to estimate the model, we must write it in a state space form. The state space formulation consists of two equations, the measurement equation (or the observation equation) which describe the observed variables as a function of the unobserved variables and the transition equation (or the state equation) which describes the evolutionary processes of the unobserved state variables (Kuttner 1994; Gerlach and Smets 1997).

Let $\zeta_t = \begin{bmatrix} Y_t^p & z_t & z_{t-1} & \mu_t \end{bmatrix}$ (16),

Denote the vector of state variables and $\beta = [1\ 1\ 0\ 0]$ be a matrix of coefficients.

The measurement equation in a vector notation can be written as:

$$y_t = \beta \zeta_t \quad (17)$$

To complete the model, the transition equation which describes the evolutionary processes of the state variables can be written as:

$$S_t = \Gamma\zeta_{t-1} + e_t \quad (18)$$

Estimates of the parameters of the model and of the state variables can be obtained by maximizing the following likelihood function using the Kalman Filter. The likelihood function is defined as

$$Log\Pi = -\frac{T}{2}\ log(2\pi) - \frac{1}{2}\sum_1^T log|F_t| - \frac{1}{2}\sum_1^T v_t^T\ F_t^{-1} v_t \quad (19)$$

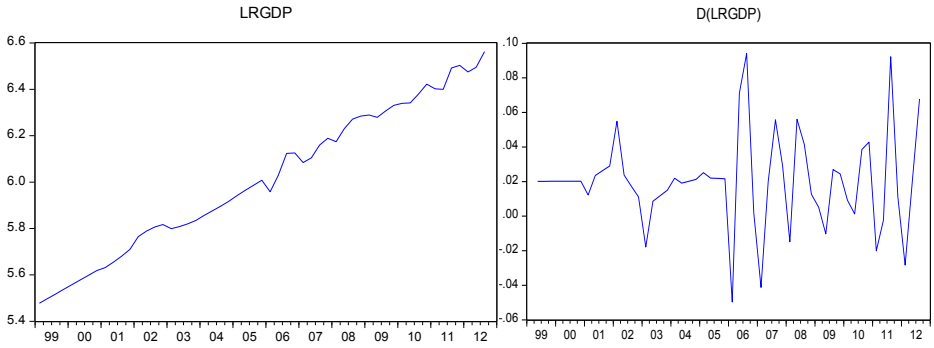
Where T is the sample size, v is the prediction error matrix and F is the mean square error matrix of the prediction errors.

3. EMPIRICAL ESTIMATES OF POTENTIAL OUTPUT AND OUTPUT GAP

The data used in this study are quarterly data on real GDP from 1999Q1 to 2012Q3. Real GDP is not stationary and its first difference is stationary (figure 1), indicating that the real GDP is I(1). This result is confirmed by a number of known tests for non-stationarity.[11]

[11] For example, the ADF statistic for non-stationarity is 7.8 considering the variable at level while its value is -10.8 considering the variable at fist difference.

Figure 1: Level and first difference of real GDP (in log)

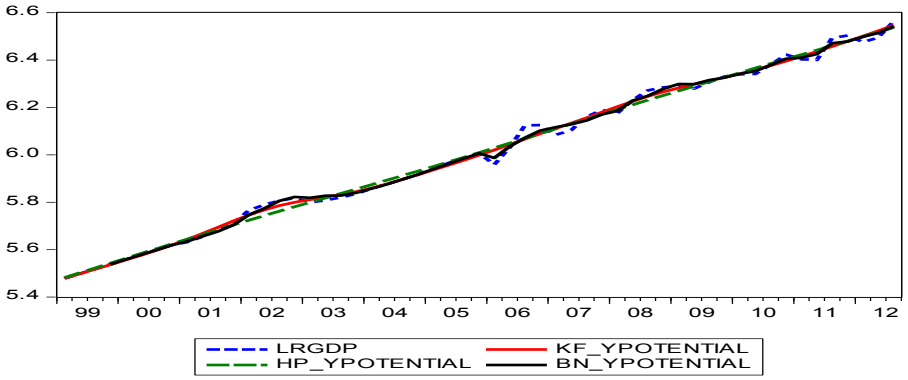


Source: *Authors' calculations*

We estimate the potential output and the output gap using the linear time trend method, the HP filter, the BN decomposition and an unobservable components or linear state space method. Estimates from the linear time trend and HP filter method produce similar results. Therefore, we only report results from HP, KF and BN techniques.

Figure 2 shows estimated (filtered) potential outputs and actual output. The results indicate that KF and HP potential outputs co-move together while BN potential output, which is non-linear, co-moves with the actual output.

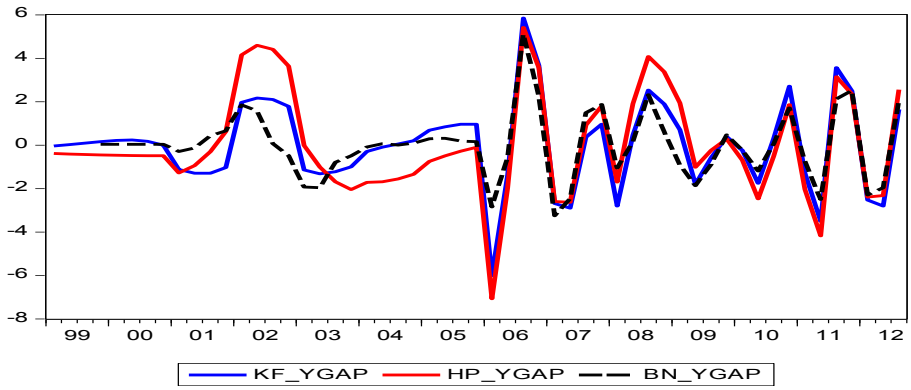
Figure 2: HP Potential output, BN Potential output, KF Potential output and current output



Source: *Authors' estimation*

The output gap estimates from the three estimation techniques clearly indicate some cyclical behavior. As can be seen below, the various filtration techniques yield roughly the same output gap. The output gap started to be volatile as early as mid-2005 and became high unstable in 2006 and, to some extent, in both 2008 and 2011.

Figure 3: HP output gap, BN output gap and KF output gap



Source: *Authors' estimation*

Table I: Filtration results

	Trough			Peak		
	Min.	**Average**	**Max.**	**Min.**	**Average**	**Max.**
KF	-6.01	-1.67	-0.04	0.03	1.30	5.85
HP	-7.07	-1.37	-0.02	0.28	2.81	5.42
BN	-3.25	-1.32	-0.09	0.00	0.95	5.12
Average	**-5.44**	**-1.45**	**-0.05**	**0.10**	**1.69**	**5.46**

Source: *Authors' estimation*

4. DISCUSSIONS OF RESULTS

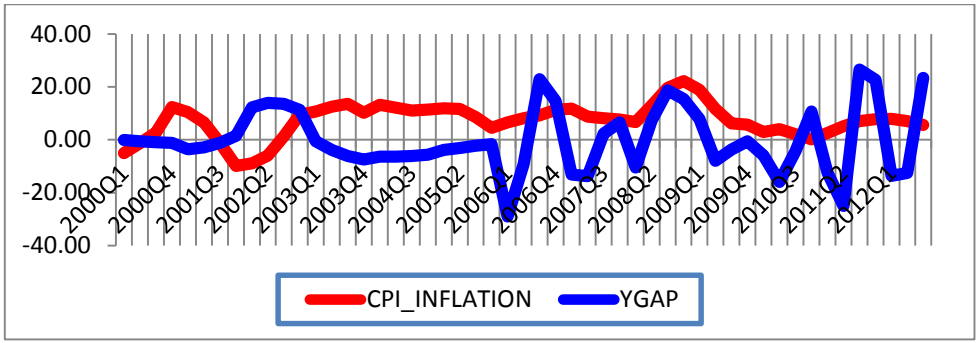
Inflation and output gap

The correlation between inflation and output gap as well as the direction of causality between the two variables would show, for example, whether the output gap contain useful information to gauge inflationary pressure in Rwanda. Using quarterly data from 1999Q1 to 2012Q3, the results for correlation confirm a weak (0.08) correlation between output gap and inflation. Granger causality tests indicate that the output gap does not Granger-cause inflation in Rwanda or vice versa.

This weak causality does not mean that there is no link between output gap and inflation in Rwanda. It suggests that is useful to forecast inflation from a simple Phillips curve relationship.

The graph below showing the historical path of inflation compared to the level of the output gap indicates that for some period, there is a co-movement between the two variables and sometimes with lag.

Figure 4: HP output gap and CPI inflation



Source: *Authors' estimation*

To crosscheck the results it is also useful to look at the effects of money growth and the output gap on inflation because the monetary policy framework in Rwanda is a combination of monetary, inflation and other targets. One of the important assumptions in monetary targeting framework is that there is a long run relationship between the money stock and the price, by assuming a stable money demand function.

To test this assumption, different approaches of modeling inflation are used, among them is the estimation of the relationship between money stock, real output and price level based on monetarist view which postulates that inflation is always a monetary phenomenon in long run .This is achieved by estimating the P-star model of inflation, which is based on the principle that the deviation of money from its long run path helps to explain the future path of inflation.

Kigabo (2007) estimated the P-star model for Rwanda. This model assigns a crucial role to the real money gap as a predictor of future inflation, as done in the role of the output gap in traditional Phillips curves.

The P-star model may be considered as modern monetarist approach to modeling inflation and has been intensively used in different central banks to discuss the monetary targeting.

Repeating the exercise done by Kigabo (2007) with an extension of the sample size and using the HP output gap as one of explanatory variables of inflation, based on quantitative theory of money, the commonly p-star model is written as follows:

$$\pi_{t+1} = \pi^{e}_{t+1,t} + \alpha_m(m_t^r - m_t^{r*}) + \alpha_y(y_t - y_t^*) + \alpha_z z_{t+1} + \varepsilon_{t+1}$$

Where $(m_t^r - m_t^{r*})$ is the money gap, $(y_t - y_t^*)$ is the output gap and z is the exchange rate.

Applying the Engle-Granger tests, the below results show that the used variables are cointegrated.

Table II: Engle Granger results

	Value	Prob.*
Engle-Granger tau-statistic	-5.080052	0.0087
Engle-Granger z-statistic	-53.87787	0.0000

*MacKinnon (1996) p-values.

Source: Authors' estimation

We estimated the p-star model for the period from 1999Q1 – 2012Q3. The results below indicate clearly that, except the output gap, coefficients for other variables are statistically significant with expected signs.

Table III: P-star model results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPINF	0.756473	0.106696	7.089997	0.0000
M3_GAP	-0.181699	0.087573	-2.074835	0.0439
OUTPUT_GAP	0.150399	0.187914	0.800359	0.4278
NEXRATE	0.004566	0.001635	2.792101	0.0077

R-squared	0.504853	Mean dependent var	7.467292
Adjusted R-squared	0.471093	S.D. dependent var	4.907352
S.E. of regression	3.568922	Sum squared resid	560.4369
Durbin-Watson stat	0.649557	Long-run variance	9.194469

Source: *Authors' estimation*

The above result shows that, in long-run, the output gap has no significant impact on inflation. However, by considering data from 2008, When BNR introduced important changes in its monetary policy management by introducing the use of Key Repo Rate, findings show that output gap impacts significantly inflation with a high coefficient followed by inflation expectation and money gap while the macroeconomic impact of exchange rate is not significant. This is a clear indication that policy makers in Rwanda should respond to shifts in the level of the output gap to avoid inflationary pressures.

Table IV: P-star model results (sample from 2008)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPINF	0.822411	0.124413	6.610348	0.0000
M3_GAP	-0.400389	0.110797	-3.613710	0.0036
OUTPUT_GAP	0.900515	0.307366	2.929781	0.0126
NEXRATE	0.002801	0.002017	1.388642	0.1902

R-squared	0.723677	Mean dependent var	8.538750
Adjusted R-squared	0.654597	S.D. dependent var	6.567568
S.E. of regression	3.859827	Sum squared resid	178.7792
Durbin-Watson stat	1.165973	Long-run variance	6.651981

Source: *Authors' estimation*

Conclusion

The objective of this paper is to estimate the potential output and the corresponding output gap using different univariate methods. A good estimated output gap constitutes a powerful tool for a central bank as it contributes to decide about the monetary policy stance. The results from this study tend to favor the use of HP method as it reflects better the reality of the Rwandan economy, compared to the trend in inflation during the period under review. In addition, the potential output obtained using HP and linear methods are less volatile compared to the one from BN method.

The important finding is that there is a link between the level of output gap and inflation in Rwanda since 2008. As policy implication, monetary and fiscal policy makers should respond to the shifts in the level of output gap to avoid inflationary pressures while continuing support to the economic growth.

As mentioned, one of the main limitations of the statistical detrending techniques is that they are not based on economic theory. Further work would therefore be required to produce estimates of the output gap that include economic theory. Most used methodologies include; the production function approach and a structural VAR model.

REFERENCES

Adnan,H.,Bukhari,S.and Safdar,K.,2008. Estimating output gap for Pakistan economy:Structural and statistical approaches. SBP research bulletin 4.

Baxter, M and R. King, 1999. Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series. *Review of Economics and Statistics*, 81.

Burns, A.F. and W.A.Mitchell, 1946. Measuring Business Cycles (NBER:New York,NY).

Cerra, V. and S.C. Saxena, 2000. Alternative Methods of Estimating Potential Output and the Output Gap: An Application to Sweden. IMF Working Paper No. 00/59.

Clarida, R., Gali, J., Gertler, M. 1998.Monetary Policy Rules in Practice: Some International Evidence. *European Economic Review,* 42, 1033-1067

Conway,P. and B. Hunt, 1997. Estimating Potential Output: a semi-structural approach.

De Brouwer, G., 1998. Estimating Output Gaps in Australia. Reserve Bank of Australia, Research Discussion Paper No. 9809.

Dupasquier, C., A. Guay and P. St-Amant, 1997.A Comparison of Alternative Methodologies for Estimating Potential Output and the Output Gap, Bank of Canada, Working Paper no 97-5.

Dupasquier,C., Guay,A. and St-Amant,P., 1997. A Comparison of Alternative Methodologies for Estimating Potential Output and the Output Gap. Bank of Canada Working Paper 97-5.

Gerlach, S. and F. Smets 1997. Output Gaps and Inflation. Bank for International Settlements mimeo.

Gerlach, S and Yiu, M. S., 2004, 'Estimating Output Gaps in Asia: A cross country study,' Journal of Japanese International Economies 18, 2004, 115–136 .

Giorno C., P. Richardson, D. Roseveare and P. van den Noord, 1995.Estimating Potential Output, Output Gaps and Structural Budget Balances. OECD Economic Department, Working Paper No.152

Hodrick, R.J. and E.C. Prescott, 1997.Post-War U.S. Business Cycles: An Empirical Investigation.*Journal of Money, Credit, and Banking,* 29, 1-16.

Kavi G. and Steven M. Measures of potential output in Fiji", Working Paper 2000/06, 2000.

Kiley, T, 2010, 'Output Gaps,' Finance and Economic Discussion Series, Federal Reserve Board, 2010-27.

Kuttner K.N., 1994.Estimating Potential Output as a Latent Variable. Journal of Business& Economic Statistics, Vol.12, No.3, pp. 361-68.

Mishkin, F.S., 2007. 'Estimating Potential Output.' Address at the Conference of Price Measurement for Monetary Policy, Federal Reserve Bank of Dallas (May).

Mohamed,O., 2008. Estimating potential output and output gap for East African countries: An eclectic approach. Euro journals.

Osman, M., Jean Louis, R. and Balli, F., 2008. Output gap and inflation nexus: the case of United Arab Emirates. MPRA.

Watson, M.W. 1986. Univariate Detrending Methods with Stochastic Trends. *Journal of Monetary Economics,* 18(1), pp. 49-75.

Estimating the Taylor Rule for Rwanda

Authors:

Mr. Gichondo Mukiza Ananias Mr. Karangwa Mathias

Abstract

The Taylor rule is a monetary-policy rule that predicts by how much the central bank should change the nominal interest rate in response to changes in inflation, output, or other economic conditions. It is a useful tool that guides monetary policy makers to decide on the appropriate monetary policy stance that is line with macroeconomic fundamentals.

Owing to the challenges related with the monetary targeting framework and in spirit of transiting towards a currency union under the EAC protocols, EAC central banks agreed to adopt a price-based monetary policy framework by 2017. As a forward-looking monetary policy, the inflation-targeting framework relies on modeling and forecasting. In line with this, EAC central banks have not only embarked on the upgrading of modeling and forecasting capacities of their staff but also resolved to adopt the Forecasting and Policy Analysis Systems (FPAS) which involves the use of a respective small macro-model tailored to each of the economies of the EAC member states. One of the core equations of the FPAS small macro-model is the Taylor rule, which defines how monetary authorities react to attain their primary objective of price stability. In this paper, we estimate simple versions of the Taylor rule with twofold objectives. Firstly, the results will be useful inputs to the small macro-model for Rwanda, especially as a guide to model specification and calibration

exercises. Secondly, results will henceforth be used to guide monetary policy decision making in Rwanda even when medium-term forecasts are not yet available.

Results show that the standard static Taylor rule does not hold for Rwanda since all coefficients are not significant and also their magnitudes differ from those proposed by Taylor. The best model is found to be the smoothed dynamic Taylor type rule that uses the repo rate as a smoothing factor if estimations are carried out on data from 2008 which is an indication of the positive effect of financial sector reforms as well as innovation in monetary policy management on the monetary policy transmission mechanism.

The inclusion of the first lag of inflation, the second lag of output gap and first lag of the repo rate imply respectively that policy makers are more concerned with inflation than output gap while setting the policy rate and that the monetary policy stance is quite persistent given the inflation inertia and persistence of business cycles. Results also show that monetary policy reaction to demand pressures (output gap) is quite stronger than reaction to deviation of inflation from target. Monetary policy reaction in Rwanda has been more discretionary given the complexity of the sources of inflation

1. INTRODUCTION

The Taylor rule spells out that the interest rate adjusts in response to the deviation of inflation from its target and real output from its potential level. In its initial version, the Taylor rule assumes that the federal funds rate is raised by 1.5 percentage points for each 1 percentage point increase in inflation (Taylor 1993). Further, an increase in the interest rate of that magnitude would raise real interest rates and help cool off the economy, thus reducing inflationary pressures. According to Taylor (1993), interest rates are reduced by 0.5 percentage point for each percentage point decline in real GDP below its potential level. Such a reduction in the interest rate helps to mitigate a (growth cycle) recession and maintain price stability.

The Taylor rule prescribes that when inflation exceed the target, the central bank should increase the short-term nominal interest rate whereas when there is a recession the nominal interest rate should be lowered. The rule is useful following the gradual breakdown of the link between money growth and inflation and following the transition of monetary policy regimes to inflation targeting or to more price-based monetary policy framework.

Once there are no inflation and output deviations, the nominal interest rate is set according to the fisher equation (i.e. the equation that links real and nominal interest rates through expected inflation) and this is the benchmark recommendation of the Taylor rule.

The rule contains two adjustment factors: the inflation gap which defines the long run or medium-term objective of maintaining price stability and the output gap which represents the short-run objective of promoting maximum sustainable growth. The latter suggests that in the short run monetary policy leans against cyclical winds.

Many studies have tested the applicability of Taylor rules especially in developing economies whereas the same studies on developing countries remain scanty (Mthuli Ncube & Mtholokozisi M. Tshuma, 2010). Hitherto, no study has been carried out about the application of the Taylor rule for Rwanda and this paper seeks to address this gap. The paper compares the results of the original static Taylor rule with the smoothed dynamic Taylor rule to select the model that best fits Rwandan data. In this paper, we estimate simple versions of the Taylor rule with twofold objectives. Firstly, the results will be useful inputs to the small macro-model for Rwanda, especially as a guide to model specification and calibration exercises. Secondly, results will be henceforth used to guide monetary policy decision making in Rwanda even when medium-term forecasts are not yet available.

The rest of the paper is organized as follows: section II reviews the literature, section III is about the specification and estimation of the Taylor rule for Rwanda, section IV gives the results and section V gives the conclusion.

2. LITERATURE REVIEW

2.1. Definition of a rule

A rule can be defined as "nothing more than a systematic decision process that uses information in a consistent and predictable way." The concept of a monetary policy rule or fiscal policy rule is the application of this principle in the implementation of monetary policy by a central bank or fiscal policy by fiscal authorities. Policy rules can be discretionary (i.e. generally based on expert judgment and therefore more flexible) or non-discretionary if they follow rigid prescriptions derived algebraically from pre-set equations. However, evidence from literature shows that non-discretionary policy rules are more useful than discretionary ones especially in developed economies with efficient financial markets (William Poole, 1999).

2.2. Difference between rule and discretion

It has been well documented that discretionary monetary policy suffers from the problem of time-inconsistency given that the low inflationary objective becomes dynamically inconsistent in the presence of discretionary monetary authorities with the economic agents having rational expectations (Barro and Gordon, 1983; Walsh, 1995). The same authors suggest that the problem of time inconsistency can be overcome if there are mechanisms to enable private agents punish the policymaker in case the latter acts against the announced rule and also when the policy maker cares about maintaining his/her reputation.

To deal with the same problem, Rogoff (1985) suggested delegation of powers to a conservative central banker who is inflation-averse.

Discretionary monetary policy involves the making of period-by-period re-optimization on the part of the monetary authority whereby expert judgment takes precedence over mechanical adherence to a particular algebraic formula in the conduct of monetary policy decisions. Conversely, a monetary policy rule entails the period-by-period implementation of a contingency formula that has been selected to be generally applicable for an indefinite number of decision periods. The above definitions portray the divergence in views of early scholars who often distinguished between rule and discretion as two polar extremes. Recent literature shows that, though an algebraic formula, the monetary policy rule must be flexible enough to respond to the dynamic nature of the economy by for example responding to changes in inflation and output. To this effect, an activist monetary policy rule is one that is conditional on the state of the economy, that is, one that is adjusted when economic conditions dictate so (Bennet T., McCallum, 1994; John B. Taylor, 1993).

There has been a lot of debate on the fundamental nature of the policy rule as well as the capacity and independence of the central bank required to enable it abide by the policy rule (i.e. the commitment problem). Several challenges involved in the design of a good policy rule such as the lack of agreement concerning appropriate models of monetary policy, the associated social costs of inflation and unemployment and the on-going changes in the economic structure relevant to monetary policymaking

(e.g. improvements in payment systems) have always been cited in the literature (Bennet T., McCallum, 1994).

In the language of monetary policy, it is always necessary to draw a clear distinction between goals, targets and instruments. The target refers to an operational variable that takes precedence in the actual conduct of monetary policy. Possible candidates as central bank's target variables are: some comprehensive price index (CPI or GDP deflator), Nominal GDP or any other measure of nominal spending, a monetary aggregate, or foreign exchange. It is worth noting that most central banks measure targets as growth rates rather than (growing) levels. The goal refers to the ultimate but typically non-operational objective of monetary policy. For example, if the target variable is inflation (i.e. CPI in growth rates), the goal can be price stability (low and stable inflation). Instruments refer to the variables that central banks actually manipulate more or less directly on a daily or weekly basis in their attempts to achieve specified targets. For most central banks the short-term interest rate would be regarded as the instrument variable, but some analysts continue to promote the monetary base (or some other controllable narrow aggregate) in that capacity. Clearly, the choice of the instrument variable depends on the monetary policy regime with an inflation targeting regime adopting the short-term interest rate whereas the monetary targeting regime using the monetary base or reserve money (Bennet T., McCallum, 1994).

2.3. The (original) Taylor rule

The original Taylor rule is specified as follows:

$$i_t = r^* + \pi_t + \alpha_1(y_t - \bar{y}_t) + \alpha_2(\pi_t - \bar{\pi}_t) \quad \text{.....(1)}$$

$$i_t = r^* + \pi_t + \alpha_1\hat{y}_t + \alpha_2(\pi_t - \bar{\pi}_t) \quad \text{.....(2)}$$

$$i_t = r^* + \pi_t + \alpha_1(y_t - \bar{y}_t) + \alpha_2(\pi_t - \bar{\pi}_t)$$
$$= (r^* - \alpha_2\bar{\pi}_t) + \pi_t + \alpha_2\pi_t + \alpha_1\hat{y}_t = \alpha_0 + (1+\alpha_2)\pi_t + \alpha_1\hat{y}_t \quad \text{.....(3)}$$

where $\alpha_0 = r^* - \alpha_2\bar{\pi}_t$ and $\hat{y}_t = y_t - \bar{y}_t$

i_t is the short-term policy rate, r^* is the long run equilibrium real interest rate, π_t is the current inflation rate (which Taylor assumes to be an average for the last 4 quarters including the current one), $\bar{\pi}_t$ is inflation target, $\hat{y}_t$ is the output gap measured as the deviation of current output (y_t) from its long run trend/potential output($\bar{y}_t$).

In the absence of deviation of inflation from its target and of output from its potential level, the short-term nominal interest rate is set according to the Fisher equation, stated as follows:

$$i_t = r_t + \pi^e \quad \text{.....(4)}$$

where i_t is the short-term nominal interest rate; r_t is real interest rate; π^e is expected inflation.

In his original work, Taylor assumes that current inflation and the long run equilibrium interest rate to be equal to 2% each and he also assigned equal weight to output gap and inflation deviation from target($\alpha_1 = \alpha_2 = 0.5$).

In order to ensure macroeconomic stability, the parameters in the Taylor rule have to satisfy certain restrictions notably $\alpha_1, \alpha_2 \geq 0$. If the coefficient on inflation deviation is less than zero then a rise in inflation would lead to interest rate cut, which will induce increased spending. This would tend to increase aggregate demand, thereby further increasing inflation. Likewise, if this coefficient is greater than zero then this instability does not arise because then Taylor ensures that inflation is equal to its targeted value (John Taylor B. 1999).

According to the Taylor principle, for each one-percent increase in inflation, the central bank should raise the nominal interest rate by more than one percentage point. The Taylor rule is intended to foster price stability and full employment by systematically reducing uncertainty and increasing the credibility of future actions by the central bank. It may also avoid the inefficiencies of time inconsistency from the exercise of discretionary policy (John Taylor B. 1993; John Taylor B. 1999).

The Taylor rule prescribes that when inflation exceed the target, the central bank should increase the short-term nominal interest rate whereas when there is a recession the nominal interest rate should be lowered.

The rule is useful following the gradual breakdown of the link between money growth and inflation and following the transition of monetary policy regimes to inflation targeting in many countries.

Once there are no inflation and output deviations, the nominal interest rate is set according to the fisher equation and this is the benchmark recommendation of the Taylor rule. The rule contains two adjustment factors: the inflation gap which defined the long run objective of maintaining price stability and the output gap which represents the short-run objective of promoting maximum sustainable growth. The latter suggests that in the short run monetary policy leans against cyclical winds.

2.4. Target versus instrument rules

Instrument rules are simple and explicit reaction functions and hence easy to follow. They require little amount of human capital that take timely decisions depending on the state of the economy. What is required is just to make a rule that has good theoretical properties and is expected perform well, no matter what the transmission mechanism or the state of the economy is. In this regard, the policy maker is supposed to follow it mechanically. Taylor (1993) warns on the mechanical use of the rule and suggests that it should be used as a guideline to central bankers while taking monetary policy decisions. The key issue here is that the instrument rule is a mechanical algebraic formula that cannot be adjusted even if expert judgments recommends doing so (Svenson, 2003; McCallum, 2000).

A target rule is sometimes called inflation targeting or inflation forecasting targeting. Under this framework, the central bank announces a numerical inflation target (point target or range) and monetary policy has legislated mandate for achieving that inflation target with clear instrument independence (Bernankee and Mishkin, 1997). There are two types of target rules: the first is the general targeting rule which specifies an operational loss function, which the monetary policy is committed to minimize. The second is the specific targeting rule in which a condition for setting the instrument is specified e.g. marginal rate of transformation and substitution between the target variables is equalized.

2.5 Transition to new policies

Recently, the key question has been to determine how economies move from one policy to another. John B. Taylor (1993) illustrates this phenomenon by giving an example of a situation where the inflation target is revised down from 5% to 2% by monetary authorities; the transition problem becomes a problem of disinflation and only affects the intercept term in the Taylor rule equation. Since targets reflect the long run equilibrium, the example highlighted by Taylor (1993) implies that the long run equilibrium has a dynamic path as it can change from time to time when macroeconomic fundamentals change. Thus, there is need to always revise targets to align them to the realities of the economy and to stimulate long run macroeconomic performance.

2.6. Choosing optimal rules (the loss function)

One of the most important aspects when choosing an optimal rule is the channel of the monetary transmission mechanism specified in a model. Factors such as the persistence of prices and output, the interest rate elasticity of demand, the degree of openness of the economy, and the form of expectations influence the optimal parameters in an instrument rule. Therefore, identifying the channels of the monetary policy transmission process is an important step in designing an efficient instrument rule. Taylor rules generally follow the financial market price view of the monetary transmission mechanism. In this view monetary policy takes effect through prices and rates of return on financial assets. Some of these models are small three equation systems consisting of an aggregate demand equation, a price adjustment equation, and the instrument rule. Other models are larger ones that provide a more detailed description of aggregate demand and the price adjustment process.

The role of aggregate demand in the transmission mechanism differs between these models in three fundamental ways. First, the response of aggregate demand to changes in interest rates differs across different models. Some models assume that aggregate demand responds to short-term interest rates while others assume that long-term interest rates drive aggregate demand. Second, the persistence of output (i.e. by how long output responds to changes in the real interest rates) varies between models and this partially affects the magnitude of interest rate movements that are required to achieve output stability.

Third, the inclusion of open-economy components of aggregate demand introduces an additional channel that can alter significantly the timeliness of monetary policy. Macroeconomic models treat the effects of the external shocks differently depending on the realities of the economy being modeled, thus there is always need to specify the models in a way that suits a particular economy.

Different models can have very different price specifications, and this determines how monetary policy affects real variables in the model. Some models assume completely backward-looking price setting behavior; others employ more descriptive price adjustment mechanisms. Among these models staggered price or wage setting behavior is a common assumption, in which case inflation can be entirely forward looking or be a mixture of expected future and past inflation.

Models that explicitly assume rational expectations introduce additional channels through which monetary policy can operate. Inflation expectations, and subsequent price movements they induce, enter the monetary transmission mechanism via their resulting impact on short-term real interest rates. This, combined with an expectations theory of the term structure, will in turn affect current long-term interest rate movements and subsequently aggregate demand. However, the extent to which these expectations are able to affect real interest rates also depends on the wage and price setting behavior assumed in the model (Taylor, 1995; Svensson, 2000). When the central bank has a credible inflation target, expected inflation will be quite low, reducing the need for a large weight on inflation in the instrument rule (Smets, 1998).

A simple backward-looking structural model based on Ball (1997) can be used to establish the linkages between the monetary transmission mechanism and the choice of an optimal instrument rule. The model describes the economy with two equations, the dynamic Investment-Saving (IS) equation, which approximates aggregate demand, and the Phillips curve, which approximates aggregate supply, stated as follows:

$$IS: \tilde{y}_t = -\omega \tilde{r}_{t-1} + \phi \tilde{y}_{t-1} + \varepsilon_t \quad \text{.....(5)}$$

$$Phillips: \tilde{\pi}_t = \psi \tilde{\pi}_{t-1} + \varphi \tilde{y}_{t-1} + \eta_t \quad \text{.....(6)}$$

$$\omega > 0, 0 \leq \phi \leq 1$$
$$\psi, \varphi > 0$$

Where $\tilde{y}_t, \tilde{r}_t, \tilde{\pi}_t$ refer to output gap, inflation deviation from target and real interest rate deviation from its long run equilibrium value. Policy makers set real interest rates after observing current shocks ε_t and η_t. In this simple economic system, interest rate changes affect expected output only in the following period. Assuming one cannot forecast ε_t then expected output is given by:

$$E(\tilde{y}_{t+1}) = -\omega \tilde{r}_t + \phi \tilde{y}_t \quad \text{.....(7)}$$
$$\omega \tilde{r}_t = \phi \tilde{y}_t - E(\tilde{y}_{t+1})$$

But $E(\tilde{y}_{t+1}) = -qE(\tilde{\pi}_{t+1}) = -qE(\psi \tilde{\pi}_t + \varphi \tilde{y}_t + \eta_{t+1}) = -q\psi \tilde{\pi}_t - q\varphi \tilde{y}_t$ since the policy maker can set expected output at any level by choosing the appropriate level of real interest rate. However, when doing so, the policy maker has to take expected inflation as given because the real interest rate affects inflation with a two-period lag.

Thus:

$$\omega\tilde{r}_t = \phi\tilde{y}_t - E(\tilde{y}_{t+1}) = \phi\tilde{y}_t - [-q\psi\tilde{\pi}_t - q\varphi\tilde{y}_t] = \phi\tilde{y}_t + q\varphi\tilde{y}_t + q\psi\tilde{\pi}_t = (\phi + \varphi q)\tilde{y}_t + q\psi\tilde{\pi}_t \ldots (8)$$

$$\tilde{r}_t = \left(\frac{\phi + \varphi q}{\omega}\right)\tilde{y}_t + \left(\frac{q\psi}{\omega}\right)\tilde{\pi}_t \equiv \alpha\tilde{\pi}_t + \beta\tilde{y}_t \ldots\ldots\ldots\ldots real\_version\_policy\_rule \ldots\ldots (9)$$

Whereby α and β are functions of the dynamics of the model defined in terms of relative weights as:

$$\beta = \frac{\phi + \varphi q}{\omega}; \frac{q\psi}{\omega} = \alpha \ldots\ldots\ldots\ldots (10)$$

The parameter q is determined by minimizing the policy makers' loss function of the form: $L = \delta_y^2 + \mu\delta_\pi^2$ With μ defining the weight assigned by policy makers. The solution to this minimization problem is:

$$q = \frac{-(1 - \psi^2 + \mu\varphi^2) + \sqrt{(1 - \psi^2 + \mu\varphi^2)^2 + 4\varphi^2\psi^2\mu}}{2\psi\varphi} \ldots\ldots\ldots\ldots (11)$$

Thus q is a function of the model's parameters and the weight that policy makers assign to inflation and output variance in their loss function.

2.7. The Taylor type rules

Since the work of John B. Taylor (1993 and 1999), other scholars came up with variants of the Taylor rule by modifying or considering some of Taylor's assumptions: such as estimation and calibration of model parameters rather than assuming that inflation and output deviation have equal weights, inclusion of relevant instruments such as the exchange rate and using of base money or reserve money as the target variable.

The Taylor-type rules came up to respond to some of the challenges associated with the Taylor rule. These include:

Timing: this involves whether to include contemporaneous, lagged or future (i.e. leads) values of instruments or targets. This point addressed the weakness of the original Taylor rule which did not capture the effect of expectations of economic agents.

Weights: While Taylor assumed equal weights for both inflation deviation and output gap, literature shows that these coefficients differ depending on the weight attached to them by monetary authorities. Several studies have tried to estimate realistic weights while others have resorted to the use of historical and stochastic simulations (calibrations) of these coefficients.

Measurement: the measurement of target variables has to be clear, that is whether to measure them as growth rates or (growing) levels. Practically, it is for example easier and economically more appealing to measure prices as percentage changes rather than using CPI in levels as a target variable. Another issue is about how trends are measured for example how potential GDP is measured. There are several techniques used to derive an economy's potential output and these include the use of statistical methods like filters (Kalman, HP & High band pass filters) as well as the use of production functions and simple linear-trend models, among others.

The inflation target can be normatively set by the policy makers or be estimated from the data by computing average inflation for a given time horizon.

Choice of instruments and targets: in order to replicate the economic realities of a country, appropriate instruments and targets must be chosen. Generally, inflation targeting economies use the short-term nominal interest rate as the monetary policy instrument while those with the monetary targeting regime use base money or reserve money.

With regard to the choice of the target variables, come countries whose monetary authorities have greater influence on the exchange rate market (generally those fixing exchange rates) tend to include the exchange rate gap as a target variable. As an example, Jose R. Sanchez Fung (2002) estimated a smoothed Taylor rule for the Dominican Republic using base money as an instrument and inflation gap, output gap and nominal exchange rate gap as the adjustment factors as well as the lagged term of the base money as the smoothing factor.

Non-linearity: non-linearities in the Taylor rule may arise from an irregularity in the central bank's preferences or a non-linear macroeconomic structure of the economy such as movement from a very low inflation period to exceptionally high inflation period.

A backward looking Taylor rule, which illustrates how the nominal interest relates to the lagged values of the interest rates, inflation rate, output gap and the real effective exchange rate (a proxy for exchange rate is specified as follows (Nicolas Moumni & Salma Dasser, 2009):

$$i_t = \alpha + \theta\pi_{t-1} + \beta y_{t-1} + \gamma q_{t-1} + \varepsilon_t \quad (12)$$

Where $\alpha = r - \phi\pi^*$ and $\theta = 1 + \phi$, π_{t-1} is the lagged value of inflation deviation from its target value, y_{t-1} is the lag of the output gap and q_{t-1} is the lagged value of the real effective exchange rate (which is often excluded in many studies) and the last term is the random error. The major drawback of the backward looking Taylor rule is its inability to predict the future of the economy with current inflation and output gap.

Another Taylor type rule is one that is forward looking as specified by Qin and Enders (2008) as follows:

$$i_t = \alpha + \theta E\pi_{t+1} + \beta E y_{t+1} + \gamma E q_{t+1} + \varepsilon_t \quad (13)$$

Where $E\pi_{t+1}$, Ey_{t+1} and Eq_{t+1} are forecasts for inflation deviation, output gap and real effective exchange rate respectively between period t and t+1. This rule suggests that monetary policy reacts in response to expected path of the variables of interest.

Other special variants of the Taylor rule include both backward and forward looking models that take into account interest rate smoothing (Castelnuovo, 2003).

The backward looking model with an interest rate smoothing term is stated as:

$$i_t = \rho i_{t-1} + (1-\rho)\left[\alpha + \theta\pi_{t-1} + \beta y_{t-1} + \gamma q_{t-1}\right] + \varepsilon_t \quad (14)$$

Where $\pi_{t-1}, y_{t-1}, q_{t-1}, \varepsilon_t$ is as defined in the backward looking model stated earlier and ρ is a measure of the degree of smoothing of interest rate changes. The coefficient ρ is assumed to lie between zero and one, with larger values denoting slow speed of adjustment of the interest rate to the target level.

A forward looking Taylor type rule is stated as:

$$i_t = \rho i_{t-1} + (1-\rho)\left[\alpha + \theta\pi_{t+1} + \beta y_{t+1} + \gamma q_{t+1}\right] + \varepsilon_t \quad \text{.....(15)}$$

Where $\pi_{t+1}, y_{t+1}, q_{t+1}, \varepsilon_t$ is as defined in the forward looking model above and the coefficient ρ still measures the degree of smoothing of interest rate changes.

The hybrid Taylor rule is another variant of the Taylor rule which relates the policy rate, inflation, output gap and the real effective exchange rate as follows:

$$i_t = \alpha_1 E\pi_{t+1} + \alpha_2 y_{t-1} + \alpha_3 q_{t-1} \quad \text{.....(16)}$$

Where α_1 is a coefficient of the central bank's reaction to expected inflation; α_2 is a measure of the sensitivity of the policy rate to the lagged output gap and α_3 measures the response of the policy rate to the lagged real effective exchange rate. The hybrid Taylor rule is thus set according to forward looking inflation and the lagged output gap and lagged real effective exchange rate. Proponents of this rule argue that it is able to capture the central bank's existing policy (Barnett and Duzhak, 2008) whereas critics argue that the rule

is flawed since it contradicts the original idea of simple rules as a heuristic for monetary policy (Bofinger and Mayer, 2006).

The final variant of the Taylor rule is one that addresses the problem of non-linearity. Nonlinearities in the Taylor rule can arise in various ways. For instance, Taylor and Davradakis (2006) point out that they may result from an irregularity in the central bank's preferences or a nonlinear macroeconomic structure of the economy. Consequently, it is inappropriate to use the simple linear Taylor rule when the central banks preferences are asymmetric. Furthermore, Castro (2008) argues that a nonlinear Taylor rule is appropriate to enlighten the behaviour of monetary policy when the central bank is assigning different weights to negative and positive inflation and output gaps in its loss function. Kesriyeli et al (2004), suggest that the failure to incorporate interest rate dynamics in the development of literature of nonlinear monetary policy rules may lead to model misspecification.

A number of studies show that different nonlinear time series models such as Markov switching, artificial neural networks and smooth transition regression (STR) have been used to determine the behaviour of the central banks.
Swanson (1995) has utilized the artificial neural networks (ANN) nonlinear model to assess the information in the term structure due to its flexibility and simplicity. In addition, this model has performed well in various empirical applications where linear models have been unsuccessful. However, Petersen (2007) indicates that although ANN models can fit the data, they fail to give an economic explanation for the observed nonlinear behaviour. Furthermore, some researchers such as Petersen (2007) have criticized the Markov-

switching model on the basis that it assumes that the regime switches are exogenous and it fails to provide economic intuition behind the nonlinear policy behaviour.

As an example of the non-linear Taylor rule, Terasvirta (2002) specified a standard smooth transition regression model of the following form:

$$i_t = \phi' z_t + \theta' z_t G(y, c, s_t) + u_t, t = 1, ..., T \quad (17)$$

and the logistic function of the form:

$$G(y, c, s_t) = \left(1 + \exp\{-\gamma(s_t - c)\}\right)^{-1}, \gamma > 0 \quad (18)$$

Where $z_t = \left(w_t', x_t'\right)$ is the vector of explanatory variables; $w_t' = \left(1, y_t, y_{t-1}, ..., y_{t-p}\right)'$ and $x_t' = \left(1, x_{1t}, ..., x_{kt}\right)'$ is a vector of strongly exogenous variables. The parameters $\phi' = \left(\phi_0', \phi_1', ..., \phi_m'\right)$ and $\theta' = \left(\theta_0', \theta_1', ..., \theta_m'\right)$ represent $\left((m+1)*1\right)$ parameter vectors in the linear and non-linear parts of the model, respectively. Further, the error term is $u_t \sim iid\left(0, \delta^2\right)$.

The transition function $G(y, c, s_t)$ is continuous and bounded between zero and one and is a function of the transition variables s_t. As a transition variable moves towards negative infinity, the transition function gets closer to zero. Conversely, when the transition variable approaches positive infinity, the transition function gets closer to one. The transition function increases monotonically as a function of s_t and the slope parameter γ indicates the

smoothness of the transition from one to another and c is the location parameter that determines where the transition occurs. A logistic STR (LSTR) model results when the smooth transition equation is combined with the logistic function for the transition function. When for example inflation is used as a threshold variable, the LTSR can be specified as follows:

$$i_t = \phi_0 + \phi_1 i_{t-1} + \phi_2 \pi_t + \phi_3 y_t + \phi_4 e_t + \left[\phi_0 + \phi_1 i_{t-1} + \phi_2 \pi_t + \phi_3 y_t + \phi_4 e_t\right] * G\left(y, c, \pi_t\right) + v_t \quad \text{....(19)}$$

Where i_{t-1}, π_t, y_t, e_t refer to the lagged policy rate (the smoothing term), the contemporaneous inflation rate, the contemporaneous output gap and the current exchange rate. Some empirical studies also include the foreign policy rate to isolate the effect of the external sector on the domestic economy (Mthuli Ncube & Mtholokozisi M. Tshuma, 2010).

Following McCallum (1994), some studies specify what is known in the literature as the McCallum rule by using the monetary aggregate or reserve money as an instrument variable. These include studies for the Dominican Republic (Jose R. Sanchez Fung, 2002) who assumed that monetary aggregate or base money target (h_t) is set basing on the output gap $\left(y_t - y_t^*\right)$, inflation deviation from target $\left(\pi_t - \pi_t^*\right)$ and the spread between the market exchange rate (e_t^m) and the official exchange rate (e_t^o).

The equation is specified as follows:

$$h_t = \beta_0 + \beta_1\left(y_t - y_t^*\right) + \beta_2\left(e_t^m - e_t^o\right) + \beta_3\left(\pi_t - \pi_t^*\right) + \varepsilon_t \quad \text{.....(20)}$$

In line with the above approach and take note of Stationarity the following model was estimated for Kenya by Henry Rotich, Musa Kathanje and Isaya Maana (2007) allowing for inclusion of lags and leads as well as expectations (backward and forward looking):

$$\Delta h_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma\left(y_{t+m} - y^*_{t+m}\right) + \rho\Delta h_{t-1} + \varepsilon_t \quad \text{.....(21)}$$

In summary, the design of monetary policy rules is always influenced by several considerations which include: deciding whether to use static or dynamic models, whether to use smoothing factors and which ones are appropriate, which instrument variables are appropriate, the relevant targets to use and incorporation of expectations (forward looking, backward looking or rational) if necessary. Sometimes, different sets of models are estimated and compared to identify the best one, for example as done in Morocco by Nicolas Moumni & Salma Dasser (2009). However, the original idea of using simple rules as a heuristic for monetary policy should not be compromised (Bofinger and Mayer, 2006).

3. SPECIFICATION AND ESTIMATION OF THE TAYLOR RULE FOR THE RWANDAN ECONOMY

3.1. Monetary policy in Rwanda

The National Bank of Rwanda (BNR) has gradually moved away from direct controls towards more market oriented policy tools since 1995 and has increasingly utilized open market operations for the conduct of monetary policy. The floating of the exchange rate since 1995 has added to the operational independence of monetary policy.

Similar to many central banks, BNR has increasingly focused on the stabilization objectives rather than the development objective, and with the new BNR Law in 1997 as amended in 2007 under which the BNR is established, these objectives were revised in accordance with the international trends in central banking and are now stated as maintaining price stability. Further, the National Bank of Rwanda focuses on economic and financial system stability.

The BNR conducts monetary policy based on a monetary targeting framework with the monetary base as the operating target and interest rate (the Key Repo Rate) as the policy instrument, with the view of achieving price stability. A monetary program is prepared considering the economic outlook of the country and projections based on the desired rate of monetary expansion to achieve a target rate of inflation, consistent with the projected rate of economic growth, balance of payments forecast and expected fiscal operations of the government. Accordingly, a reserve money target is established, which is the operating target for monetary policy.

To meet the reserve money targets, open market operations are conducted with Repo and reverse Repo rates as the key policy instruments forming the lower and upper bounds of the interest rate corridor in which the interbank call money market operates. However, in practice, the fact that the BNR is also concerned with economic growth, the link between monetary and fiscal policies cannot be ruled out.

3.2. The empirical model for the Rwandan economy

Rwanda still follows a monetary targeting framework using reserve money as the operational target though the policy rate (KRR) is also used as a tool of signaling the monetary policy stance. Given this fact, the relevant Taylor rule for Rwanda is one that considers either the KRR or reserve money as the instrument variables and output gap and inflation as the key target variables.

The objective of this study is to estimate a monetary policy reaction function for Rwanda and to conduct historical simulation to enable comparison of actual policy rate with the Taylor rule. The study explores different Taylor rules, starting with the original static Taylor rule (Taylor, 1993) and its modifications taking into account the dynamic properties of the economy. To this effect, two smoothed dynamic Taylor rules are considered: one that uses the repo rate as a smoothing factor and the other one that uses the reserve money as the smoothing factor. These two models provide a basis to judge whether recent developments in the financial sector and modernization of the monetary policy framework by introducing more flexibility have improved the efficiency of using the repo rate as a monetary policy instrument and can

thus be based on to anticipate a successful transition from the monetary targeting framework to inflation targeting.

The standard Taylor rule can be written as:

$$i_t = r^* + \pi_t + \alpha_1 y_t + \alpha_2(\pi_t - \pi^*) \quad (22)$$

Where r^* is the long run equilibrium real interest rate, it is the short interest rate taken as monetary policy instrument, π_t is the CPI inflation, y_t is the output gap calculated as percentage deviation of actual output from the nominal level and π^* is the long run inflation target of the central bank.

Equation (22)

$$\Leftrightarrow i_t = r^* + \pi_t + \alpha_1 y_t + \alpha_2 \pi_t - \alpha_2 \pi^* = r^* - \alpha_2 \pi^* + \alpha_1 y_t + (1 + \alpha_2)\pi_t$$

$$\Leftrightarrow i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \varepsilon_t \quad (23)$$

The parameters to be estimated are β_0, β_1 and β_2 and instead of using inflation deviation from the long rum inflation target, equation 23 uses actual inflation as it seems to be more convenient for a country like Rwanda that does not target inflation. Note also that the intercept term lumps together the long run equilibrium real interest rate and inflation target since they are both constants.

4. RESULTS

In this paper, we consider two sub-samples: the first sample is from 1999Q1 to 2008Q2 while the second sample is from 2008Q3 to 2012Q4. We use quarterly data for the repo rate, reserve money, Key repo rate (KRR), repo rate, output gap and inflation. The repo rate (Mop rate) is used in the first sample given that the KRR was introduced in august 2008 while the KRR is used thereafter. The ADF Stationarity test shows that the output gap, (key) repo rate and inflation are stationary (I (0)) at 5% and 10% respectively for the entire data set combining the two sub-samples.

Table 1: Augmented Dickey Fuller unit root tests

Variables		ADF test statistic	Critical value for the test	Order of integration
1	INFLATION	-4.24	-2.95 (at 5%)	I(0)
2	OUTPUT_GAP	-2.93	-1.95 (at 5%)	I(0)
3	(KEY) REPO RATE	-2.87	-2.60 (at 10%)	I(0)

Source: BNR, Monetary Policy and Research Department

Using equations 23-25 stated hereunder, we first estimated the various Taylor rule equations for Rwanda for the period 1999Q1-2008Q2 but none of the variables turned out to be significant (results omitted) in all the estimated models.

Using the second sample (2008Q3 to 2012Q4), we estimate three versions of the Taylor rule and compare results. After testing for cointegration (results omitted), we estimate the standard static Taylor rule stated in equation 23 above.

The estimation results are not in line with the empirical findings in the original Taylor rule paper because all coefficients are not statistically different from zero and have magnitude different to what was prescribed by Taylor (1993). The goodness of fit is also not good as indicated by the very low R^2 and there is positive serial correlation as indicated by the DW statistic.

Table 2: Results of the original static Taylor rule

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUTPUT_GAP	-0.080583	0.065293	-1.234175	0.2350
INFLATION	0.100039	0.026008	3.846479	0.0014
C	6.131317	0.250859	24.44124	0.0000

R-squared	0.113136	Mean dependent var	6.988421
Adjusted R-squared	0.002278	S.D. dependent var	1.070259
S.E. of regression	1.069039	Sum squared resid	18.28551
Durbin-Watson stat	0.672114	Long-run variance	0.355179

Source: *BNR, Monetary Policy and Research Department*

Due to the fact that the transmission mechanism is weak in developing countries, we estimate a smoothed dynamic version of equation 23 using lagged output gap and lagged inflation as well as including the lagged policy rate (Repo rate) as a smoothing factor.

The Taylor type rule is stated as follows:

$$\text{Re}\, po_t = \beta_0 + \beta_1 y_{t-2} + \beta_2 \pi_{t-1} + \beta_3 \text{Re}\, po_{t-1} + \varepsilon_t \quad \text{.....(24)}$$

The below Engle-Granger test on residuals series from equation 24 indicate that the null hypothesis of presence of the unit root is rejected at a conventional level of significance of 5%.

Thus, we conclude that variables used are cointegrated.

Table 3: Cointegration test for the smoothed Taylor rule

	Value	Prob.*
Engle-Granger tau-statistic	-7.182778	0.0008
Engle-Granger z-statistic	-26.82515	0.0019

*MacKinnon (1996) p-values.

Source: *BNR, Monetary Policy and Research Department*

Using the smoothed dynamic Taylor rule specified in equation 24, the results improve significantly. The signs of parameters are as expected implying that the output gap and inflation are positively correlated with interest rate as indicated in table 4 below:

Table 4: Results of the smoothed dynamic Taylor rule

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUTPUT_GAP(-2)	0.124867	0.041249	3.027197	0.0080
INFLATION(-1)	0.047941	0.016343	2.933394	0.0097
REPO(-1)	0.631990	0.074163	8.521672	0.0000
C	2.235853	0.489425	4.568329	0.0003

R-squared	0.771415	Mean dependent var	7.012000
Adjusted R-squared	0.728556	S.D. dependent var	1.047037
S.E. of regression	0.545509	Sum squared resid	4.761290
Durbin-Watson stat	2.630578	Long-run variance	0.113337

Source: *BNR, Monetary Policy and Research Department*

Since the reserve money is the operational target in Rwanda, we substitute in equation 24 the repo rate by reserve money as the monetary policy instrument and also include contemporaneous inflation to yield the following Taylor type rule:

$$\mathrm{Re}po_t = \beta_0 + \beta_1 y_{t-2} + \beta_2 \pi_t + \beta_3 \mathrm{R}M_{t-1} + \varepsilon_t \quad \text{.....(25)}$$

Note that the McCallum rule such as

$$h_t = \beta_0 + \beta_1 \left(y_t - y_t^* \right) + \beta_2 \left(\pi_t - \pi_t^* \right) + \varepsilon_t \quad \text{.....(26)}$$

Where "h" is the monetary aggregate (M3 or Reserve money), in McCallum (1994) can be estimated instead. We do not estimate this given the intention to move towards price based monetary policy in which the interest rate will be the operational target and also the current use of the KRR by BNR to signal the monetary policy stance.

As indicated by the Engle-Granger test on residuals series derived from equation 25, the null hypothesis of the presence of the unit root is rejected at the 5% level of significance. Thus, the variables are cointegrated.

Table 5: Cointegration test for the second smoothed Taylor rule

	Value	Prob.*
Engle-Granger tau-statistic	-6.196766	0.0051
Engle-Granger z-statistic	-24.98840	0.0038

*MacKinnon (1996) p-values.

Source: BNR, Monetary Policy and Research Department

Contrary to expectations, the results are counter-intuitive in a sense that though the included variables are statistically significant, the signs on output gap and inflation are unexpected.

Table 6: Results of the second smoothed dynamic Taylor rule

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUTPUT_GAP(-2)	-0.857113	0.347794	-2.464429	0.0263
INFLATION	-0.268240	0.149043	-1.799754	0.0920
RM(-1)	0.800374	0.084086	9.518531	0.0000
C	4.697043	1.397014	3.362201	0.0043
R-squared	0.606868	Mean dependent var		14.27895
Adjusted R-squared	0.528242	S.D. dependent var		9.137443
S.E. of regression	6.276021	Sum squared resid		590.8267
Durbin-Watson stat	2.723714	Long-run variance		9.034293

Source: BNR, Monetary Policy and Research Department

Using data for the most recent period (2008Q3 to 2012Q4), the standard static Taylor rule equation does not give good results.

The two smoothed dynamic equations also give different results, with the one using the repo rate as a smoothing factor giving better results and being theoretically more appealing given the signs of the coefficients, the overall

goodness of fit of the model (R^2 of 77%) while all the coefficients are significant at 5%.

Focusing on the smoothed dynamic Taylor type rule that uses the repo rate as a smoothing factor, there are a number of issues to be discussed regarding the results. First, if we consider the whole sample, no variable in the model is significant but by considering a sub-sample starting in 2008 all coefficients are statistically significant. Monetary policy background in Rwanda shows that since 2008, the National Bank of Rwanda has been introducing important reforms namely the use of the REPO operations to smoothly manage liquidity, increased communication to the public of the monetary policy stance, modernization of the payments systems and introduction of a more flexible monetary policy framework. The results just confirm the fact that monetary policy became more efficient in the post-2008 period.

In line with the current monetary policy framework implemented by BNR, it is clear that the latter has not been following the rule originally proposed by Taylor in 1993 as well as its variants proposed later by other authors. This paper seeks to produce results to be used as a starting point towards the use of more forward looking price-based monetary policy.

Second, the order of lags in the smoothed dynamic Taylor type rule model that uses the repo rate as a smoothing factor implicitly shows that monetary policy in Rwanda first reacts to inflation before considering short-term stabilization of output growth. This is an indication that price stability is a

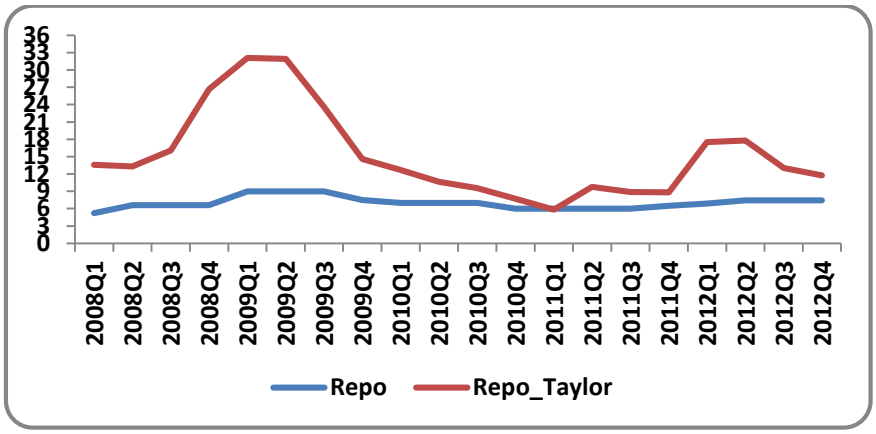
priority of the National Bank of Rwanda but also an evidence of the correlation, in the short-term, between output and inflation.

Third, findings show that lagged repo rate (one quarter), lagged inflation (one quarter) and lagged output (two quarters) explain about 63%, 12.5% and 4.8% respectively of the variability in the repo rate.

The high significance of the lagged repo rate in terms of explaining the variability of the repo rate shows that the monetary policy in Rwanda is more persistent given the inflation inertia and persistence of business cycles.

Lastly, the results of the Taylor rule indicated that monetary policy was not as active as required especially during the two episodes: 2008-2009 and 2011-12. According to the Taylor rule, monetary policy should have been tighter.

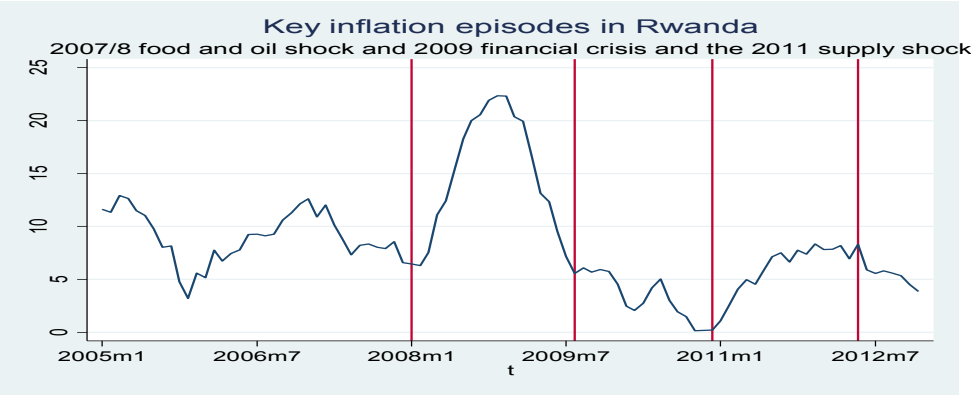
Figure 1: Comparing actual repo and Taylor rule



Source: *BNR, Monetary Policy and Research Department*

The peak episodes shown in figure 1 above suggest that inflation was high and monetary policy was quite accommodative. This indeed is confirmed by the figure flow:

Figure 2: Headline inflation in Rwanda



Source: *BNR, Monetary Policy and Research Department*

However, these findings should not be taken at face value. The major causes of inflation during the two episodes mentioned above were international food and oil price shocks, the adverse effects of the financial crisis as well as regional food shocks. This therefore justifies why monetary policy was not so much tight as this would have contracted the economy without necessarily solving the inflation problem.

5. CONCLUSION

This study has compared the results of the standard static Taylor rule, the smoothed dynamic Taylor type rule using the repo rate as a smoothing factor and the smoothed dynamic Taylor type rule using reserve money as a smoothing factor.

Results show that the standard static Taylor rule does not hold for Rwanda whereas the best model is found to be the smoothed dynamic Taylor type rule that uses the repo rate as a smoothing factor if estimations are carried out on data from 2008 which is an indication of the positive effect of financial sector reforms and innovation in monetary policy management on the monetary policy transmission mechanism. The latter implies that successful transition to a more forward looking price-based monetary policy framework requires continued redress of the structural problems that impede the effectiveness of the monetary policy transmission mechanism.

The order of lags in the smoothed dynamic Taylor type rule model that uses the repo rate as a smoothing factor implies that monetary policy in Rwanda is more concerned with price stability. The fact that the original static Taylor rule does not hold and that monetary policy was accommodative in the peak periods indicated in figure 2 above confirms two facts. First, the specification of the Taylor rule should be tailored towards the realities of the Rwandan economy. Second, the application of the Taylor rule in monetary policy formulation has been and should continue to be discretionary. The role of

expert judgment, as demonstrated by BNR's reaction during periods of supply shocks, is crucial for effective monetary policy making.

Finally, this paper serves as a useful input to the Forecasting and Policy Analysis Systems (FPAS), a prerequisite for a smooth transition towards a price-based monetary policy framework. The results of the paper will continuously be updated to inform monetary policy making. This is in line with the current practice of communicating the Key Repo Rate to the public both as a signal of the BNR monetary policy stance and also as a way of anchoring expectations of economic agents during the transition to the price-based monetary policy framework.

REFERENCES

Ball, Laurence. 1997. Efficient Rules for Monetary Policy. NBER Working Paper No. 5952 (March).

Barnett, W.A. & Duzhak, E.A., 2008. Non-robust dynamic inferences from macroeconometric models: Bifurcation stratification of confidence regions. Physica A: Statistical Mechanics and its Applications, 387(15), 3817-3825.

Barro, Robert J., and David B. Gordon (1983b) Rules, Discretion and Reputation in A Model Of Monetary Policy. Journal of Monetary Economics 12:1, 101–121.

Barro, Robert, and David Gordon (1983a) A Positive Theory of Monetary Policy in a Natural Rate Model. Journal of Political Economy 91, 589–610.

Bernanke, Ben S., and Frederic S. Mishkin (1997) Inflation Targeting: A New Framework for Monetary Policy? Journal of Economic Perspectives 11:2, 97–116.

Bofinger, P & Mayer, E, 2006. The Svesson vs McCallum and Nelson controversy revisited in the BWM framework. DIW Berlin, German Institute for Economic Research.

Castelnuovo, E., 2003. Taylor Rules and Interest Rate Smoothing in the US and EMU, EconWPA.

Castro, V., 2008. Are Central Banks following a linear or nonlinear (augmented) Taylor rule?, University of Warwick, Department of Economics.

Henry Rotich, Musa Kathanje and Isaya Maana (2007). A monetary policy reaction function for Kenya, Paper Presented During the 13th Annual African Econometric Society Conference in Pretoria, South Africa from 9th to 11th July 2008

José R. Sánchez-Fung (2002). Estimating a monetary policy reaction function for the Dominican Republic, Discussion Paper 02/01, ISSN: 1466-0814

Kesriyeli, M., Osborn, D.R. & Sensier, M., 2004. Nonlinearity and Structural Change in Interest Rate Reaction Functions for the US, UK and Germany, Economics, The University of Manchester.

McCallum, B. (2000), Alternative monetary policy rules: A comparison with historical settings for the United States, the United Kingdom, and Japan , Federal Reserve Bank of Richmond Economic Quarterly, 86(1), 49-77.

McCallum, B. T. (1994a). Monetary Policy and the Term Structure of Interest Rates," NBER Working Paper No. 4938.

McCallum, B. T. (1994b). A Reconsideration of the Uncovered Interest Rate Parity Relationship," Journal of Monetary Economics, 33, 105-132

McCallum, Bennett T. (1994). Specification of Policy Rules and Performance Measures in Multi-country Simulation Studies, Journal of International Money and Finance, 13(3), 259-275, June.

Mthuli Ncube & Mtholokozisi M. Tshuma (2010). Monetary Policy Conduct Based on Nonlinear Taylor Rule: Evidence from South Africa, African Development Bank working paper

Nicolas Moumni & Salma Dasser (2009). Relevance of a Taylor-type rule in the active monetary policy of Bank Al-Maghrib

Petersen, K., 2007. *Does the Federal Reserve Follow a Nonlinear Taylor Rule?* University of Connecticut, Department of Economics.

Qin, T. & Enders, W., 2008. In-sample and out-of-sample properties of linear and nonlinear Taylor rules. Journal of Macroeconomics, 30(1), 428-443.

Rogoff, Kenneth (1985). The Optimal Degree of Commitment to an Intermediate Monetary Target. Quarterly Journal of Economics 100, 1169–1189.

Smets, Frank. 1998. Output Gap Uncertainty: Does it Matter for the Taylor Rule? BIS Working Papers, No. 60 (November).

Svensson L., (2003), What is wrong with Taylor rules? Using judgment in monetary policy through targeting rules, NBER Working Paper N° 9421.

Svensson, Lars E.O. 2000. Open-Economy Inflation Targeting. Journal of International Economics 50(1): 155-183.

Taylor J.B., (1993), Discretion versus Policy Rules in Practice, Carnegie Rochester Conference series on public policy, vol. 39, December.

Taylor J.B., (1999), An Historical Analysis of Monetary Policy Rules. In Taylor, J.B., ed.

Taylor J.B., (1999), Monetary *Policy Rules*. Chicago: University of Chicago Press.

Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. Carnegie-Rochester Conference Series on Public Policy, 39, 195-214. http://dx.doi.org/10.1016/0167-2231 (93)90009-L

Taylor, M.P. & Davradakis, E., 2006. Interest rate setting and inflation targeting: evidence of a nonlinear Taylor rule for the United Kingdom

Teles, V. K., & Zaidan, M. (2010). Taylor Principle and Inflation Stability in Emerging Market Countries. Journal of Development Economics, 91, 180-83.

Van Dijk, D., Terasvirta, T & Franses, P.H 2002. Smooth transition autoregressive models-a survey of recent economic developments, Econometric Reviews 21:1-47

W.S. Malik and A.M. Ahmed (2007). The Taylor Rule and the Macroeconomic Performance in Pakistan, Pakistan institute of development economics, Islamabad

Walsh, Carl (1995) Optimal Contracts for Independent Central Bankers. American Economic Review 85, 150-167.

William Poole, 1999. Monetary Policy Rules? The Jeffrey and Kathryn Cole Honors College Lecture Michigan State University East Lansing, Michigan

Real effective exchange rate misalignment in Rwanda

Mr. Wilberforce Nuwagira **Dr. Thomas Kigabo**

Abstract

This paper estimates the real exchange rate misalignment in Rwanda. The empirical analysis builds on quarterly data from 2000Q1 to 2012Q1 and derives a long-run Behavioral Equilibrium Exchange Rate (BEER). The econometric analysis starts by analyzing the stochastic properties of the data and found the variables are stationary at first level of differencing. Accordingly, the paper proceeds by estimating the cointegration and error correction models. Regression results Show that most of the long-run behavior of the real exchange rate could be explained by net foreign assets, terms of trade, productivity, degree of trade openness and government expenditure. On the basis of these fundamentals, alternating episodes of overvaluation and undervaluation were identified and the antecedents characterizing the episodes were equally traced within the review period. Among others for instance, government expenditure on traded goods especially imports and deteriorating terms of trade were discovered to account for undervaluation while surges in capital flows and improved productivity in non-traded goods accounted for overvaluation. The paper recommends effective monitoring of exchange rate developments to avoid higher levels of volatility.

1. INTRODUCTION

The real effective exchange rate misalignment is a key variable in policy circles and its calculation is one of the most controversial issues in the mainstream macroeconomics. Misalignments are used as a tool to predict future exchange rate shifts among floaters and to evaluate the need to adjust the exchange rate among countries with less flexible regimes.

Exchange rate assessment is a crucial element in evaluating country's international competitiveness and thus its macroeconomic performance and sustainability of its policies.

(Krugman, 1979, Frankel and Rose, 1996) argue that sustained real effective exchange rate (REER) overvaluations constitute an early warning indicator of possible currency crashes and they also have led to a drastic adjustment of relative prices and to a decline in the aggregate growth rate of the economy. On the other hand, REER movements determine production and consumption choices between domestic and international goods, policymakers sometimes perceive the REER as an additional tool to influence the economy.

Some countries have tried to maintain their currencies undervalued in order to boost the performance of the export sector and, hence, the aggregate economic activity. For instance, academics have suggested that capital controls and undervalued exchange rates have been key elements of an export-oriented development strategy for Japan and Germany after World

War II and, more recently, China and other East Asian Economies (Dooley et al.2003).

It is argued in the literature that real exchange rate misalignments may affect growth and welfare (Edwards, 1989): Keeping the REER at the wrong levels may create distortions in the relative price of traded to non-traded goods, generate incorrect signals to economic agents thus, leading to sub-optimal allocation of resources across sectors and result into greater economic instability. The deviation of the exchange rate from its equilibrium value signifies the misalignment (Edwards, 1994, Elbadawi, 1994, Montiel, 1999 and Williamson, 1994)

Empirical studies indicate that persistent misalignment of real exchange rate can impose severe losses of welfare and efficiency. Misalignments usually are accompanied by the imposition of restriction of exchange and trade controls to slow down the drainage of foreign exchange reserves that occurs when the REER is overvalued.

Exchange and trade controls introduce large inefficiency costs and encourage the creation of strong lobbies that compete for the rents generated by protective measures. Furthermore, exchange rate overvaluation can greatly hurt exports and, if prolonged, can wipe out agricultural infrastructure of developing countries (World Bank, 1984, Pfefferman, 1985).

These types of costs can even be significant in a situation of short-term structural misalignment if there are imperfections in local capital markets. Exchange rate misalignment also promotes speculation and usually generates massive capital flight out of the country.

Although capital flight may be optimal from a purely private perspective, it can substantially reduce the social welfare of the country (Cuddington, 1986).

The existing literature suggests that maintaining the REER close to equilibrium level is necessary for sustained growth and countries that avoided overvaluation have been associated with sustained export-led growth and substantial export diversification. Others have argued that undervaluation which could be attributed to competitive devaluations may drive the exchange rate to a level that encourages exports and promote growth. On the other hand, overvaluations may reflect macroeconomic policy inconsistencies that are likely to discourage growth (Razin and Collins, 1999).It has also stressed the importance of REER stability and the correction of misaligned REERs as determinants of economic performance in less developed countries.

(Edwards 1988) and (Sachs 1985) claims that the different development experiences in East Asia, Latin America and Africa may be attributed to their different trade regimes and exchange practices. On the one hand, unstable and overvalued REERs provided weak incentives to exports and are supported by protectionist policies and persistent misaligned REERs in Africa has caused a severe drop in agricultural output (The World Bank, 1984). On the other hand, it has been argued that outward-orientation policies and exchange rate levels that encouraged export growth in East Asian countries generated a boost in their growth rates (Dollar, 1992).

More recently, the appropriate level of the RER and its effects on economic activity has been present in crucial debates like the performance showed by the Chinese economy and the exchange rate policy of future accession of countries to the Euro Area.

Government of Rwanda has embarked on economic reforms since 1995. The foundation of the transformation of the economy is based on a process of economic liberalization and turning away from control regulation and state command to market policies. The implementation of these reform programs has benefited from the support of IMF and the World Bank and the key areas of reform were the introduction of a more flexible exchange rate regime and fully liberalized current account.

As in other Sub-Saharan African countries, generating a sustained growth is the most pressing challenge in Rwanda as a condition to achieve its vision 2020 and meet the MDGs. Rwanda is one of the African countries that demonstrate ownership of its development programs and progress in good governance and institutional capacity. Consequently, the country continues to receive more international aid and other capital flows for financing the economy. However, resource booms, such as those associated with rapid aid surges could also pose a serious challenge for macroeconomic stability, especially with regard to the tendency of high flows aid to be associated with disequilibrium Real Exchange Rate (REER) appreciation because of increased and possibly unsustainable domestic absorption, the so called "Dutch Disease".

The objective of this paper is to estimate an equilibrium relationship between REER and the economic fundamentals based on the theoretical model in line with Edwards (1989) and identifying the impact of RER misalignment on growth and export competitiveness in Rwanda. The study is also a contribution to the East Africa community's (EAC) effort of harmonizing the exchange rate regimes in the process of implementing of the East Africa Monetary Union (EAMU) protocol.

The rest of the paper is organized as follows. Section 2 is an overview of exchange rate policies in Rwanda. Section 3 is literature review and theoretical issues with emphasis on studies that have applied the BEER approach. Section 4 is methodology, 5 is the empirical results and discussion and Section 6 entails conclusion and lessons for policy recommendations.

2. OVERVIEW OF EXCHANGE RATE POLICIES IN RWANDA

The exchange rate policy in Rwanda is analyzed in two distinct periods; the first period reflecting a system of fixed exchange rate and the second period, as more flexible exchange rate system.

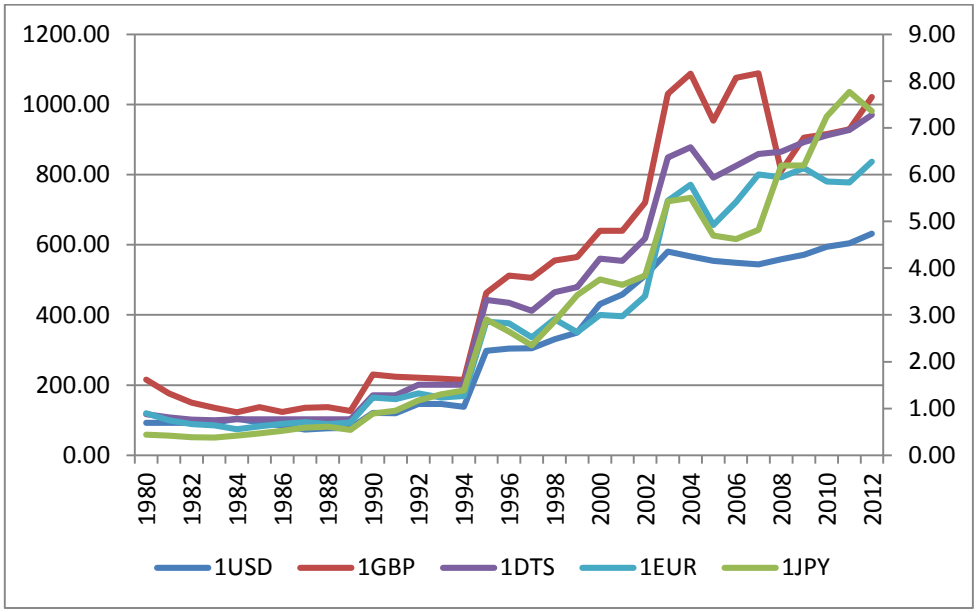
During the fixed exchange rate system, foreign currencies of the banking system were held by the central bank, the later was the sole institution authorized to carry out exchange transactions. The exchange rate was initially pegged to the Belgian franc, then to the American dollar and finally to the Special drawing rights (SDR). Its value did not reflect economic reality due to lack of exchange rate flexibility (Himili, 2000).

During this period, the exchange rate seemed to be overestimated; causing a rising of effective prices of Rwandan exports and a loss of competitiveness on the international market. However, many reforms of exchange rate system were undertaken since 1990 to correct the overvaluation of RWF and to improve external competitiveness.

The statutory order n° SP 1 of 3rd March 1995 by National Bank of Rwanda(BNR)organizing the foreign exchange market instituted a flexible system of exchange of RFW. To avoid the risks related to the flexible exchange system, the central bank has chosen a more flexible exchange rate policy of RWF with nominal anchor, which links the level of exchange rate to the fundamentals of the economy.

The objective of this flexible system aims at approaching as much as possible the exchange rate equilibrium level; to stabilize prices and support growth. Under this system, the National Bank of Rwanda intervenes on foreign market to smoothen the volatility of exchange rate using its reference rate as the average of interbank exchange rate and the BNR intervention rate.

Fig 1: Bilateral nominal exchange rate of RWF (1980-2010)



***Source**: BNR, Monetary and Research Department*

Figure 1, clearly shows that Rwanda's bilateral nominal exchange rate generally appreciated due to rigidity in exchange rate during the period 1980-1990s and it started depreciating from 1995 with the advent of financial liberalization that led to exchange rate flexibility which reflects changes in economic fundamentals. Up to now minor fluctuations prevail but the trend shows that from 2010 onwards, exchange rate has remained relatively stable.

3. THEORETICAL AND EMPIRICAL LITERATURE REVIEW

Real exchange rate is simply described as the domestic relative price of traded to non-traded goods, (Dornbusch 1987).

While traded goods price was observed to be exogenously determined, the domestic price of non-traded goods is endogenously determined. According to Baffes, Elbadawi and O'Connell (1999) long run equilibrium exchange rate prevails when the economy is in internal and external balance for sustainable values of policy and exogenous variables.

The real exchange rate is misaligned when it is out of line with its economic fundamentals for a sustained period of time. The misalignment is the difference between the observed RER and non-observed equilibrium REER. An overvalued real exchange rate indicates that the value of current RER is above its equilibrium value, with undervalued RER indicating the opposite.
A number of studies, for instance have found that the level of the REER relative to an equilibrium REER, and its stability, has strong influence on exports and private investment (Caballero and Corbo, 1989, Ghura and Grennes, 1993) More seriously, Yotopoulos and Sawada (2005) discover that systematic deviations of nominal exchange rate from their Purchasing power parity (PPP) levels may endanger serious instabilities of the international macroeconomic system.

Empirical studies on the determination of real exchange rate misalignment have been challenging mainly due to the fact that the equilibrium real exchange rate is unobservable and has to be estimated.

There are many approaches to determining the equilibrium exchange rate but three of them are considered for the purpose of this study.

The first is based on purchasing power parity (PPP), which relates the nominal exchange rate to price differentials between countries. Cassel (1918) asserts that under the condition of free trade, the nominal exchange rate between two countries is equal to the ratio of two countries' price level. This suggests that the equilibrium real exchange rate remains constant with nominal exchange rate movement offsetting relative price change between the countries.

For example, Johansen and Juselius (1992) estimate PPP for the United Kingdom by incorporating the uncovered interest rate parity (UIP) relation into their model and found out that exchange rate experienced minor fluctuations from the equilibrium.

Similarly, for the Japanese yen–U.S. dollar exchange rate, MacDonald and Nagayasu (1998) find some minor deviation of the observed data from the calculated medium to long-run equilibrium exchange rate based on the PPP and UIP.

Dollar (1992) uses Heston and summers' PPP estimations to calculate relative international price levels RPLi for 95 developing countries from 1976 to 1985. The author compares local prices measured in dollars using current nominal exchange rates with prices in dollars in the United States. If prices are the same, the exchange rate is said to be in a neutral position. If prices are higher there might be some overvaluation and if prices are lower, then there might be some undervaluation. As Dollar (1992) argues, those estimates have to take into account the fact that prices of non-tradable in poorer countries tend to be lower because of lower wages.

Thus, overvaluation or undervaluation has to be analyzed in terms of relative per capita income levels.

However, relying on a misalignment measure based on purchasing power parity consists of the choice of a base period in which the economy is thought to have been in equilibrium and then the RER for this period is assumed to be in equilibrium for the rest of the sample period. This approach is questionable because the equilibrium RER is not a static indicator and moves overtime as the economy's fundamentals move. As a consequence and as rightly pointed out by Elbadawi (1994), the PPP approach runs the risk of identifying as a misalignment what may in fact be an equilibrium movement in RER. Given the limitations of the PPP approach, the 1980s witnessed the emergence of a new literature that tried to estimate the equilibrium exchange rate.

Using the cointegration technique, Elbadawi & Soto (1997) estimate Equilibrium real effective exchange rate for seven developing countries based on annual data from 1966 to 1999. They reject the PPP approach and adopt the approach based on economic fundamentals. As a consequence, most studies using the equilibrium exchange rate in the 1980s and 1990s focused on individual countries and time series data (Williamson, 1994).

The second approach concentrates on the exchange rate that supports sustainable internal and external macroeconomic balances over the medium to long term. This is often referred to as the fundamental equilibrium exchange rate (FEER) approach.

Here the equilibrium exchange rate is essentially determined by the current account balance target, which depends on underlying sustainable equilibrium for international assets, as well as national income base on full employment. The current account targets should also be associated with desired levels of saving and investment.

Williamson (1994), for instance, estimates the fundamental equilibrium exchange rate of the G-7 countries given desirable current account balances based on the potential output estimates for those countries calculated by the IMF and the OECD. He found that in the last quarter of 1989, the actual U.S. dollar was 14 percent overvalued, while the Japanese yen was 27 percent undervalued.

Elbadawi and Soto (1997) used single equation cointegration methodology and discovered that the RER for Mali was virtually in equilibrium on the average between 1987 and 1994. Devarajan (1997) used computable general equilibrium estimates and found that the RER for Burkina Faso was overvalued by about 9% in 1993.

The Fundamental equilibrium exchange rate approach is based on macroeconomic identities; because it does not involve a theory of exchange rate determination (Clark and MacDonald, 1998), the equilibrium exchange rate calculated should not be viewed as normative. The equilibrium concept is largely meant to imply the desirability of the underlying internal and external balances rather than exchange rates per se (Bayoumi et al., 1994). However, it is observed that this approach is less applicable as it is based on

value judgments therefore, inappropriate for meaningful and dependable applications.

Finally, the behavioral equilibrium exchange rate (BEER) approach focuses on the dynamic behavior of the exchange rate, including short-run movements and deviations and taking broader macroeconomic conditions into account. The choice of fundamentals may vary depending on the theoretical model used. Starting with a model of risk-adjusted interest parity to construct an equilibrium real exchange rate equation, Clark and MacDonald (1998) include in their model as fundamentals terms of trade, the ratio of the domestic consumer price index to the producer price index and the stock of net foreign assets, as well as the relative supply of domestic to foreign government debt as a risk premium factor.

Using a similar approach, Elbadawi (1994), relying on an identity for nominal domestic absorption, estimated the long-term equilibrium exchange rates for Chile, Ghana, and India for the period 1967-1988 using economic fundamentals such as terms of trade, resource balances, degree of openness of the economy, share of government expenditure in GDP, and a measure of excess money supply.

Baffes, Elbadawi, and O'Connell (1999) examine misalignment for Côte d'Ivoire and Burkina Faso using single-equation time series. They found that for Côte d'Ivoire the actual real exchange rate was overvalued by 34 percent on average during the period 1987–93, though Burkina Faso does not seem to have experienced any major overvaluation.

In the panel context, on the other hand, Dufrenot and Yehoue (2005), analyzing the relationship between real exchange rates and economic fundamentals in 64 developing countries, found that exchange rate dynamics are less likely to be explained by fundamentals such as productivity, terms of trade, and trade openness for middle-income countries than for low income countries.

Maesofernandez, Osbat and Schnatz (2001) using quarterly data from 1975 to 1998 and up to four different specifications of BEER/PEER methodology indicate that the euro effective exchange rate was unambiguously undervalued in 2000, although the extent largely depends on a particular specification chosen. The driving fundamental variables in their models were long term real interest rates differentials, productivity, net foreign assets, relative fiscal stance, real price of oil, and relative total consumption differentials. Iimi(2006) used the BEER methodology and found that the Botswana's pula seems to have been undervalued in the late 1980s and overvalued by 5 to 10 percent in recent years, though the misalignment in the 1990s seems to have been very marginal. Although the limitation of this study is that the model included a few fundamental variables for fear of loss of degree of freedom, it should still be recognized that these pieces of evidence were arrived at from a sample comprising of only 19 observations (1985 – 2004).

Iossifov and Loukoianova (2007) estimated BEER model for Ghana and results show that most of the REER's long-run behavior can be explained by real GDP growth, real interest rate differentials (both relative to trading-partner countries), and the real world prices of Ghana's main export commodities.

The REER in late 2006 was found to be very close to its estimated equilibrium level and deviations from the equilibrium path are eliminated within two to three years.

The review of the empirical literature on the exchange rate misalignment reveals that while much has been done on developing countries, the studies on Rwanda are still very few.

This paper employs the third approach because it seems to be a more general method for calculating the real exchange rate and exchange rate misalignment consistent with the concept of economic equilibrium. More important, the analytical focus of the paper is equilibrium exchange rate behavior, including cyclical and transitory deviations, in connection with macroeconomic fundamentals. For Rwanda, the main factors that affect the equilibrium exchange rate may be the terms of trade, government consumption, capital flows, productivity and the degree of openness based on findings from studies done in countries that have similar features like Rwanda.

4. METHODOLOGY

This study is a kin to the work of Edwards (1989) and this choice draws from the fact that unlike other theoretical models that focus only on the determinants of the EREER, it distinguishes factors that determine the EREER from those that determine short-run dynamics of the REER. Moreover, the model was developed to capture the structure of a typical developing country.

To determine the extent of misalignment, we first need to establish the long-run relationship between the real effective exchange rate and its determinants. Econometrically, this paper applies a single equation approach and uses cointegration analysis to identify the long run relationships among variables. Meanwhile, the stochastic properties of data are assessed on the basis of unit root tests and long run relationship is estimated as well as error correction mechanism (ECM) to account for short run deviations from the long run equilibrium. The cointegration parameters are used to perform a permanent-transitory decomposition using the Hodrick and Prescott filter (1997). Similar methodology was applied by Clark and MacDonald (1998), Baffes, Elbadawi and O'connell (1999), recently Lim (2006) as well as Lossifov and Loukoianova (2007).

For the purpose of this paper, the movements in the exchange of Rwandan currency are explained by macroeconomic variables such as terms of trade (TOT), relative productivity of home tradables proxied by GDP percapita, government expenditure as a ratio of GDP (GOV), capital flows proxied by net foreign assets (NFA) and the degree of economic openness (OPEN). The main question that arises is whether the actual real exchange rate is overvalued or undervalued in comparison with sustainable equilibrium levels. To address this question, this paper applies the behavioral equilibrium exchange rate (BEER) approach to determine the extent of misalignment to Rwanda exchange rate movements over the period 2000Q1-2012Q1.

The study utilizes the IMF weighted REER index because the REER computed by BNR is only available from 2005 while the rest of the data is

constructed and collected from various secondary data sources such as the National Institute of Statistics of Rwanda; the Ministry of Finances and Economic Planning and the National Bank of Rwanda.

Thus the model is specified as below;

$$\log(RER)_t = \beta_0 + \beta_1 \log(TOT)_t + \beta_2 \log(prod)_t + \beta_3 \log(open)_t + \beta_4 \log(NFA)_t + \beta_5 \log(Gov)_t + \varepsilon_t \quad \ldots\ldots (1)$$

Where;

The dependent variable is the real effective exchange rate. It is the CPI-based multilateral real effective exchange rate. The *REER* is defined as the ratio of the domestic consumer price index to the foreign consumer price index and constructed as the trade-weighted average of the real exchange rate where the weights are generated by the IMF based on both bilateral trade shares and export similarities.

$REER_t = \sum (NEER)\ (P_{it}^*/p_t)$….. (2) Where $NEER_{it}$ is the nominal effective exchange rate for Rwanda with respect to the partner i, p^*_{it} is the price in partner trading country, i representing the price of tradable and p_t is the CPI of home country as a proxy for price of non-tradable. The methodology of computing REER is presented in appendix 3.

TOT is terms of trade which is defined as the ratio of export price index to import price index.

OPEN is the degree of openness of the economy and is computed as the ratio of the sum of export and import to the gross domestic product *(GDP)*.
PROD relative productivity proxied by percapita gross domestic product.

NFA is net foreign assets used as a proxy measure for capital flows; it is computed by adding net foreign assets by monetary authority (central bank) and net foreign assets by commercial banks.

GOV is government expenditure as a ratio of GDP less capital expenditure.
E_i is disturbance term that contains all other influences

Expected signs for the coefficients according to the economic theory are as follows:

The terms of trade's influence on the *REER* cannot be signed a priori, as this depends on whether income or substitution effects dominate. The former leads to real currency appreciation (increase in REER) while the latter to real currency depreciation (decrease in REER).
An increase in the openness variable is assumed to be arising from a decline in tariff rates, leading to a fall in the domestic prices of importables. This will lead to high demand of foreign currency to take advantage of cheap imports, and less demand for domestic currency. Hence an increase in the degree of openness is expected to lead to the depreciation of the equilibrium real effective exchange rate. As a result, the openness variable is expected to carry a negative sign. Empirical researches show that there is a negative link between trade integration and real exchange rate volatility (Calderon and Kubota, 2009, Hau, 2002).

High government spending is likely to translate into high demand of non tradables, which would lead to a rise in the price of non tradables. According to the definition of *REER* as the ratio of the domestic consumer price index (CPI) to the foreign consumer price index, this will lead to a real appreciation. The effect partially depends on the extent of how RER is fully determined by the supply side of the economy. The increase of public expenditures causes an appreciation of RER and a permanent increase in government spending leads to an appreciation of the equilibrium RER in the long run (Edward, 1989; Frenkel and Mussa, 1985). We expect this variable to be positively signed.

Similarly high productivity will make the economy stronger leading to an appreciated equilibrium *RER* hence we expect it to carry a positive sign. Productivity in the traded goods sector relative to the non-traded sector. A rapid economic growth is accompanied by real exchange rate appreciation because of the differential productivity growth between tradable and non-tradable sectors (Imed and Christopher, 2001, Antonia and Bara, 2006, Samara, 2009)

Higher net foreign asset payments from abroad would lead to higher capital inflows with a pressure on the exchange rate. We expect this variable to be positively signed

5. EMPIRICAL RESULTS

The BEER approach benefits from cointegration technique to establish a long run relationship between REER and its fundamental determinants.

The variables used as proxies for fundamentals include: log of relative productivity of tradables (LPROD); log of openness (LOPEN); log of net foreign assets (LNFA) as a proxy of capital inflows, log of terms of trade (LTOT) and log of government expenditure (LGOV).

5.1. Long- run relationship

Before performing the cointegration technique, we analyse the stochastic properties of variables used in the model particularly the stationary of variables using the Dickey-Fuller (ADF) test. As indicated in the table below, all variables are I (1).

Table 1: Results of tests for stationarity using Augmented Dickey-Fuller (ADF)

Variables	ADF(level)	Critical value (5%)	Prob	ADF(First diff)	Critical value (5%)	Prob
Lnreer	-2.97	-3.51	0.14	-5.35	-3.51	0.0004
Lntot	-2.25	-3.51	0.45	-2.81	-2.15	0.064
Lnprod	-1.91	-3.51	0.97	-4.98	-3.51	0.0001
Lngov	0.45	-2.93	0.98	-8.16	-3.58	0.004
Lnopen	1.30	-1.95	0.95	-2.04	-1.95	0.0000
Lnnfa	-1.68	-3.51	0.74	-8.16	-3.51	0.0000

Source: *Authors' estimation*

Note: *lags are selected on the basis of modified Schwarz information criterion*

To test for the existence of long run relationship between real exchange rate and explanatory variables used in the model, we apply Johansen's cointegration technique.

The tables below depict that trace indicates two cointegrating equations while max-Eigen value identify one cointegrating relationship.

Table 2: unrestricted cointegration Rank test

Series: LNREER LNTOT LNPROD LNOPEN LNNFA LNGOV_GDP
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.588342	104.1787	83.93712	0.0008
At most 1 *	0.452441	63.35079	60.06141	0.0257
At most 2	0.392700	35.64565	40.17493	0.1328
At most 3	0.194619	12.70393	24.27596	0.6467
At most 4	0.056216	2.747684	12.32090	0.8780
At most 5	0.001873	0.086237	4.129906	0.8094

***Source**: Authors 'estimation*
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level.

Table 3: Unrestricted cointegration Rank test (Maximum eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.588342	40.82787	36.63019	0.0153
At most 1	0.452441	27.70514	30.43961	0.1057
At most 2	0.392700	22.94172	24.15921	0.0724
At most 3	0.194619	9.956248	17.79730	0.4898
At most 4	0.056216	2.661447	11.22480	0.8383
At most 5	0.001873	0.086237	4.129906	0.8094

***Source**: Authors' estimation*
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.

It was observed that the existence of multiple cointegrating vectors complicates the interpretation of equilibrium condition (Johansen and Juselius, 1992). The most desired outcome is a case of a single cointegration vector because it is clear on both structural and reduced form relationship. Therefore, the cointegrating relationship identified by max-eigenvalue is used to describe the relationship between REER and its fundamentals. In this study, the first cointegrating vector, therefore, is utilized as the long-run relationship, which exists between real exchange rate and its fundamentals.

5.2. The Equilibrium Real Effective Exchange Rate Model

The equilibrium real exchange rate model is estimated based on Elbadawi (1994).The central idea here is that the equilibrium (long run) real exchange rate involves normalizing the cointegration vector on LOGREER as per Johansen Maximum Likelihood method in order to get the determinants of

the long run real exchange rate. Table 4 shows the normalized cointegrating coefficients for the equilibrium real exchange rate equation.

Table 4: Normalized Cointegrating Coefficients of Equilibrium REER Model

Normalized coefficients(p-values in parentheses)						
LOGREER	**LOGTOT**	**LOGPROD**	**LOGOPEN**	**LOGNFA**	**LOGGOV**	**C**
1.000000	**-0.51**	**-1.7**	**0.68**	**-0.53**	**-0.12**	**0.03**
	(4.28)	**(8.92)**	**(4.25)**	**(2.26)**	**(10.6)**	**(1.7)**

Source: *Authors' estimation*

Note: *The numbers in parenthesis are T-statistics and they imply that all the estimates are significantly different from zero at 5% significance level.*

In equation form the normalized vector can be expressed as follows:

$$l\,\mathrm{Re}\,r_t = 0.03 + 0.5ltot_t + 1.7lprod_t - 0.68lopen_t + 0.53\ln fa_t + 0.12\lg ov_t$$

(1.7) (4.28) (8.92) (4.25) (2.26) (10.6)….. (3)

In this long run relationship, LOGPROD, LOGNFA, LOGTOT and LOGGOV have positive (appreciating) effects whereas LOGOPEN have negative (depreciating) effect on real effective exchange rate. The positive sign of LPROD is according to the so called Balassa- Samuelson theory which states that productivity rise in tradables leads to increase in demand of non-tradables, thus real exchange rate appreciates. This is due to the fact that if productivity of traded goods relative to non-traded goods productivity is growing faster at home than abroad, the home currency should appreciate in real terms. As far as the impact of NFA on REER is concerned, the results

show that increase in long-run capital inflows appreciate real exchange rate. NFA can affect equilibrium real exchange rate through both supply and demand channels. In the supply channel, Capital inflows increase the existing capital stock and bring spillover effects of technology transfer and indeed Rwanda has received enormous amounts of capital flows which in first round leads to an increase in output and fall in prices of non-traded goods thus depreciating the real exchange rate and in the second round, the increase in output of non-traded goods expands disposable income and thus leads to the appreciation of Rwandan currency.

The Positive sign of terms of trade indicate that income effect dominates insinuating that improvement in terms of trade raises demand for locally produced goods (non-traded) hence non-traded goods prices increase relative to traded goods, thus appreciating Rwanda's currency. As regards to government expenditure, the sign is positive implying that an increase in government expenditure translates into high demand for non-traded which leads to the rise in prices of non-traded goods thereby appreciating real effective exchange rate.

Finally, the sign of openness is negative, implying that an increase in openness depreciates REER because as Rwanda seeks to fully integrate within East African community there has been a decline in tariff rates together with the removal of non–tariff barriers, this has led to the fall in prices of importable goods from EAC leading to expenditure switching thereby depreciating our equilibrium real effective exchange rate.

5.3. Short-run dynamics of Exchange Rate

The appropriate mechanism for modeling the short-run real effective exchange rate for Rwanda is an error correction mechanism (ECM). The results from an error correction mechanism show that in the short term, only NFA carries the burden of adjustment of real effective exchange rate. The error correction term (-0.47) is negative which indicates that if the REER is misaligned, it will adjust downward to re-establish the long-run equilibrium and vice-versa. The partial adjustment of short-run disequilibrium is corrected for in period close to two quarters

Table 5. Results of Error Correction Model

Variable	Coefficient	Std.error	-statistic	Prob.
D(Log Tot)	-0.16	0.13	-1.24	0.21
D(LogProd)	-0.07	0.44	-0.16	0.86
D(LogOpen	0.03	0.04	0.89	0.37
D(LogNfa)	-0.08	0.03	-2.46	0.01
D(LogGov)	-0.01	0.03	-0.54	0.58
ECM	-0.474	0.095	-4.98	0.0000

Source: *Authors' estimations*

5.4. Exchange Rate Misalignment

The Equilibrium real exchange rate was obtained by first decomposing the fundamentals of the equilibrium real exchange rate into their permanent and cyclical components. This is because the equilibrium real exchange rate requires the fundamentals to be at their sustainable values.

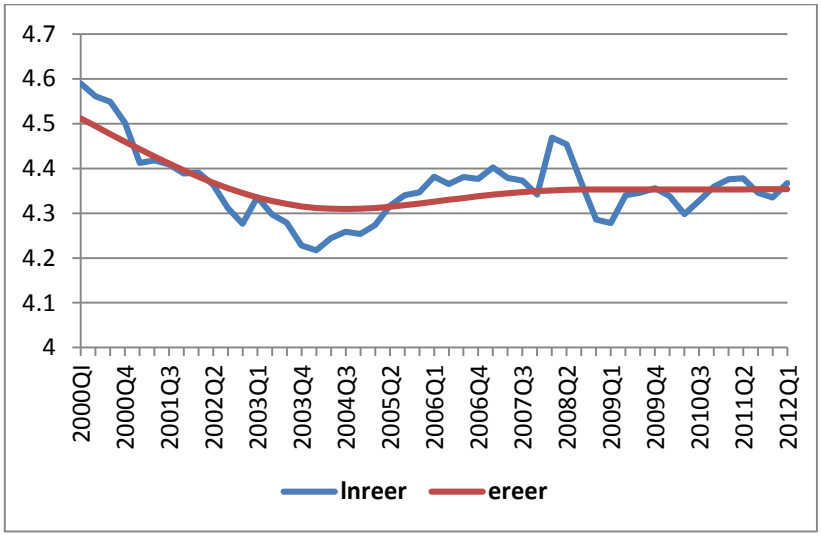
To do this we used the Hodrick-Prescott Filter and the permanent components were then substituted into the equilibrium real exchange rate model to obtain the equilibrium real effective exchange rate.

Figure 2, Shows the level of exchange rate misalignment. When actual real effective exchange rate (LREER) is above the equilibrium real effective exchange rate (LEREER), it shows over-valuation and vice versa.

Real exchange rate misalignment (RERM is then calculated as the difference between actual and equilibrium real effective exchange rate

RERM=LREER-LEREER…. (4)

Figure 2: Actual and Equilibrium Real Exchange rate



***Source**: Authors' estimation*

The results of misalignment as depicted by the above graph reject the purchasing power parity (PPP) school of thought and support Edwards and Elbadawi's view of behavioral approach that equilibrium real effective exchange rate is not constant over time, as PPP approach contends.

Equilibrium real effective exchange rate can change over time, as a result of fundamentals like productivity and capital flows. We further identified the episodes of overvaluation and undervaluation and the antecedents characterizing the episodes were equally traced within the review period. More importantly the table below shows that the level of misalignment in Rwanda is not high, varying between 0.04% and 2.33%

Table 6: Episodes of Real Effective Exchange rate Misalignment in Rwanda

Range	Outcome	Misalignment (%)
2000Q1-2001Q1	Overvaluation	1.39%
2002Q1-2005Q1	Undervaluation	-2.33%
2005Q1-2007Q3	Overvaluation	1.67%
2007Q4-2011Q3	Undervaluation	-0.04%

Source: *Authors' estimation*

5.5. REER and export performance in Rwanda

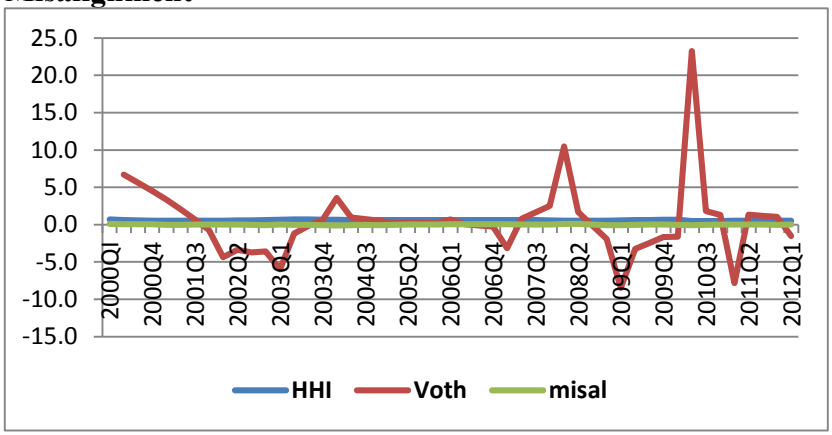
In this subsection we assess the link between RER misalignment and export sector development because sustained policies have been associated with significant export diversification.

The export sector performance is identified as one of the key factors which will contribute to achieving the Rwandan Government economic goals as defined in its Vision 2020 and Economic Development and Poverty Reduction strategy (EDPRS) Expanding and diversifying Rwanda's exports are central to improving the current account balance in the long term, easing the dependence on foreign aid and debt, and leading to stable and sustainable

economic growth in the long run. However, currently Rwanda still faces a problem of high export concentration which is one of the most highly concentrated in terms of exports in the East African Region as per the graph below. Rwanda's exports are dominated by traditional exports (coffee, tea and minerals) even if their shares in total exports have been declining over time. In the period between 1990 -1999, their share was 84.9% on average and it declined to 78.2% period 2000-2010 and 74.79% by the of end 2011. It is also important to note that the share of other exports and re-exports has been increasing, from 15.1% to 27.3% and 22.08% respectively in the period under review. There is no significant negative relationship between RER over valuation and increase of level of external sector concentration.

Regressing Herfendehl-Hirshman index (HHI) of export concentration on the level of FRW overvaluation, we find a negative but insignificant relationship between the two variables. In addition, there is no indication that nontraditional exports improve with a reduction in overvaluation. As mentioned, the level of exchange rate misalignment in Rwanda is moderate and as such it doesn't have a significant negative impact on export development.

Figure 3: HHI, Variation of other Exports (Voth) and RER Misalignment



Source: *Monetary Policy and Research*

5.6. Exports sensitivity to exchange rate Movement in Rwanda

The effect of exchange rate movements on exports growth is further analyzed by estimating export- exchange rate elasticities for Rwanda. Following imperfect substitutes approach a kin to Bayoumi et al (2011), Chen et al (2012), Aziz and Chinoy (2012), we estimate the export- exchange rate elasticities for Rwanda using quarterly data spanning the period 2000Q1 to 2012Q1. We employ dynamic OLS to estimate the export equation. The model is specified as –

$$lnex_{t=}\alpha_1+\alpha_2 lnreer_{t-2}+\alpha_3 lny_t^*+\varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Where $\mathbf{lnex_t}$ is exports , $\boldsymbol{lnreer_{t-2}}$ *is* lagged trade weighted CPI based real effective exchange rate, $\mathbf{lny_t^*}$ is foreign income (world GDP) as a proxy for external demand and $\boldsymbol{\varepsilon_t}$ is the disturbance term.

All variables are transformed into natural logarithms and Real exchange rate lagged by two quarters to allow for lags in the effect of relative price changes.

The results obtained from the estimation of the above specified exports function is presented below.

Table 7: Export Elasticities

variable	coeffient	Std err	T statstic	Prod
Lnreer(-2)	1.1	0.588	1.87	0.067
lnwgdp	2.9	0.22	13.3	0.000
R^2=80 **Prob(F-statistic) 0.000000**				

***Source**: Authors' estimation*

The results indicate that the exchange rate elasticity of exports is not significant at 5% while the foreign income elasticity of exports is high(2.9) and significant at 5%, showing that the external demand plays a larger role than the exchange rate in boosting the demand for Rwandan exports.

This finding retaliates the results revealed on the level of exchange rate misalignment. These estimates are within the range of other studies on trade elasticities (Goldstein and Khan, 1985, cheung, chin and Fuji, 2007)

6. Conclusion and Policy lessons

The main goal of this paper was to evaluate REER misalignments and their impact on external sector competitiveness.

The general finding points out to the existence of long-run relationship between real effective exchange rate and the proposed set of economic fundamentals. The normalized estimates confirm that productivity(balassa-samuelson effect), openness, terms of trade, government consumption and capital inflows are important long run determinants of the equilibrium exchange rate in Rwanda. However, the level of misalignment was not very high, fluctuating between 00.4% and 2.33%. This indicates that the REER path is not a high level to prompt a significant impact on Rwanda's external sector competitiveness.

We also find out that Rwandan exports respond more to external demand than exchange rate changes confirming that exchange rate movement has a small effect on Rwandan exports compared to external demand insinuating greater dependence of the Rwandan exports to external environment.

Finally, the relevance of any empirical study lies in plausibility of its findings, accuracy of its predictions and its simplication of measures to be taken to achieve the desired outcomes. Although episodes of overvaluation and undervaluation were discovered, it's worth noting that neither overvaluation nor undervaluation is desirable for the attainment of long-run REER stability in particular and macroeconomic stability in general.

In view of this, the paper recommends a number of but not limited to the following recommendations-

The government of Rwanda should put in place different strategies to facilitate diversification of the country's export base to avoid terms of trade deterioration due to changes in international economic environment particularly the decline in commodity prices.

Though Rwanda's export sector is less sensitive to exchange rate movements, effective monitoring of exchange rate developments remains vital to avoid higher levels of volatility which could lead to poor performance of the country's tradable sector.

References

Aziz, Jahangir and Sajjid Chinoy (2012): "India: More Open than You Think", JP Morgan note.

Baffes, J., I. Elbadawi, and S. O'Connell. (1999)."Single Equation Estimation of the Equilibrium Real Exchange Rate."World Bank, Policy Research Department, Washington, DC.

Balvers, R.J. and Bergstrand, J.H. (2002)."Government expenditure and equilibrium real exchange rates', Journal of International Money and Finance", vol. 21, pp. 667-692.

Bayoumi, T., P. Clark, S. Symansky, and M. Taylor, (1994). "The Robustness of Equilibrium exchange rate calculations to alternative assumptions and methodologies", in estimating equilibrium exchange rates, ed.by J. Williams (Washington institute of international economics).

Caballero, R., and V. Corbo, (1989). "How Does Uncertainty about the Real Exchange Rate Affects Exports?" Policy Research Working Paper Series No. 221 (Washington: World Bank).

Clark, P. and R. MacDonald, (1998) "Exchange Rates and Economic Fundamentals: A Cointegration Analysis of the PPP and the UIP for UK," Journal of Econometrics, Vol. 53

Devarajan, R. (1997) Real Exchange Rate Misalignment in the CFA Zone, Journal of African economies,oxford,vol.6,No.1,pp.35-53.

Dollar, D., (1992) Outward-Oriented Developing Economies Really Do Grow More Rapidly: evidence from 95 LDCs, 1976-1985.Economic Development and Cultural Change 40(3),523-544.

Dooley, M.P., Folkerts-Landau, D., Garber, P., (2003). An Essay on the Revived Bretton Woods. NBER Working Paper 9971, September.

Edwards, S. (1994). "Real and monetary determinants of real exchange rate behavior: Theory and evidence for developing countries". Williamson, J. (Ed).Estimating equilibrium exchange rates, Washington D.C.: Institute for Development Economic Research, pp. 61-92.

Edwards, S. (1995)."Why are Saving Rates so Different across Countries? An International Comparative Analysis.", NBER Working Paper 5097.

Elbadawi, I. and R. Soto. (1997). "Real Exchange Rate and Macroeconomic Adjustment in Sub-Saharan Africa and Other Developing Countries." in Elbadawi, I. and R. Soto, (eds.), Foreign Exchange Market and Exchange Rate Policies in Sub-Saharan Africa, Supplementary Edition of the Journal of African Economies.

Elbadawi, I., (1994). "Estimating Long Run Real Exchange Rates," in Estimating Equilibrium

Evidence from 95 LDCs, 1976-1985. Economic Development and Cultural Change 40(3), 523-544

Exchange Rate Calculations to Alternative Assumptions and Methodologies," in Estimating Equilibrium Exchange Rates, ed. by J. Williamson (Washington: Institute for International Economics).

Frankel, J.A., Rose, A.K., (1996).Currency crashes in emerging markets: An empirical treatment. Journal of International Economics 41(3-4), 351-366

Ghura, D. and T. J.Greenes (1993). "The Real Exchange Rate and Macroeconomic Performance in Sub-Saharan Africa," Journal of Development Economics. 42: 155 – 174.

Hinkle, L. E. and P. J. Montiel (1999). Exchange Rate Misalignment. World Bank, New York: oxford university press.

Hodrick, R., and E. Prescott, (1997). "Postwar U.S. Business Cycles: An Empirical Investigation," Journal of Money, Credit and Banking, Vol. 29 (February), pp. 1–16.

Iossifov, P. and E. Loukoianova (2007). Estimation of a Behavioral Equilibrium Exchange Rate Model for Ghana, IMF Working Paper WP/07/155 (Washington: International Monetary Fund).

Johansen S. and K. Juselius, (1992). "Testing Structural Hypotheses in a Multivariate cointegration analysis of the PPP and the UIP for UK," journal of econometrics, vol(July/September,pp.211-44.

Kaminsky, G., Reinhart, C.M., (1999). The Twin Crises: The Causes of Banking and Balance of Payments Problems. American Economic Review 89(3), 473-500.

Krueger, A., (1978).Exchange Rate Determination. Cambridge: Cambridge University Press.

Krugman, P.R., (1979). A Model of Balance of Payments Crises. Journal of Money, Credit, and Banking 11(3), 311-325.

MacDonald, R., and J. Nagayasu, (1998). "On the Japanese Yen-U.S. Dollar Exchange Rate: A Structural Econometric Model Based on Real Interest Differentials," Journal of the Japanese and International Economies, Vol. 12 (March), pp. 75–102.

Maesofernandez, F.C. Osbat, B. Schnatz (2001).Determinants of the Euro Real Effective Exchange Rate: A BEER/PEER Approach European Central Bank (ECB) Working Paper Series, No. 85.

Razin, O., Collins, S.M., (1999). Real Exchange Rate Misalignments and Growth. In: Razin, A., Sadka, E., eds., The Economics of Globalization: Policy Perspectives from Public Economics. Cambridge, New York and Melbourne: University Press, pp. 59-81.

Rodrik, Dani (1994). "King Kong Meets Godzilla: The World Bank and the East Asian Miracle,"in Albert Fishlow, Catherine Gwin, Stephan Haggard, Dani Rodrik and Robert Wade, eds., Miracle or Design? Lessons from East Asian Experience, Washington, DC, O

Sachs, J.D., (1985).External Debt and Macroeconomic Performance in Latin America and East Asia. Brookings Papers on Economic Activity 1, 523-64.

Serven, L., and A. Solimano, (1991). "An Empirical Macroeconomic Model for Policy Design: The Case of Chile," Policy Research Working Paper Series No. 709 (Washington: World Bank).

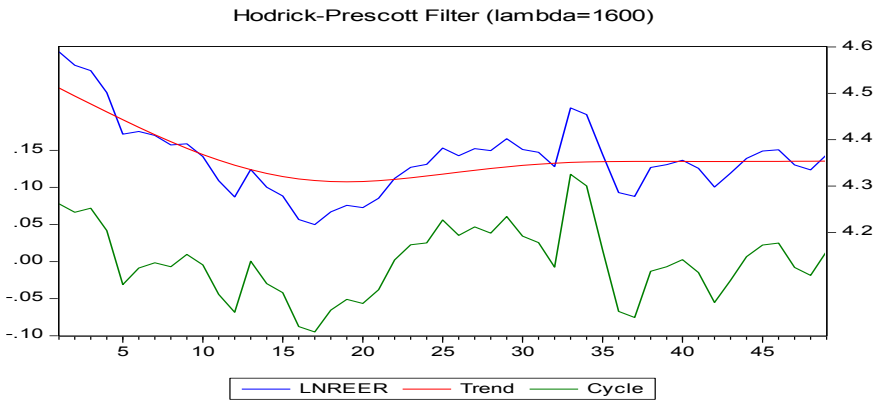
Williamson J. (1994). "Estimates of FEERs", in Estimating Equilibrium Exchange Rates, Institute of International Economics. John Williamson, Editor.

World Bank, (1984).Toward a Sustained Development in Sub-Saharan Africa. Washington, DC: The World Bank.

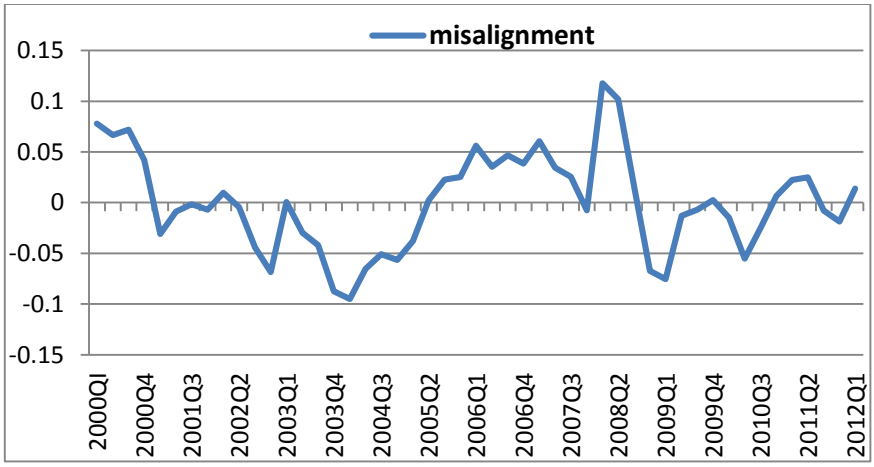
Yotopoulos A. Pan and Sawada Yasuyuki (2005). "Exchange Rate Misalignment: A New Test of Long-Run PPP Based on Cross-Country Data", CIRJE Discussion Paper, February

APPENDICES

Appendix: 1 Permanent and transitory components



Appendix 2.Misalignment



***Source**: Authors' estimation*

Appendix 3.Descriptive Statistics

Variabl		Maximum	Minimum	Std. Dev.	Variance
logreer	4.35	4.58	4.21	0.0	4.35
logprod	10.7	11.0	10.4	0.1	10.7
logopen	-	-	-	0.5	-
logtot	3.36	3.42	2.85	0.3	3.36
loggov	-	-	-	0.4	-
lognfa	5.26	6.5	3.58	0.8	5.26

Source: *Authors' estimation*

Appendix 4: Real effective exchange rate

There are alternative ways of measuring the REER and the choice of index to be used depends on the objective of study.

If the objective is to capture the effect of a productivity shock on real exchange rates, the GDP based real exchange rate index seems to be appropriate. However, if the objective is to measure the impact of capital inflows on the economy as well as the international competitiveness of a country, the trade weighted CPI based index is more appropriate. This is essentially due to the fact that capital inflows are assumed to be distributed between the tradable and non -tradable sector and then influence their relative prices. The definition of weight depends also on what kind of competitiveness we are interested.

We define in this paper the REER as the product of the nominal effective exchange rate (NEER) and the effective relative price indices. There are two alternative ways of defining the REER, which differ by the averaging method

used which are Arithmetic Mean method (AM) and Geometric Mean method (GM)

By using the Arithmetic method, the REER is defined as follow

$$REER_t = \sum_{j=1}^{k} (NEER_{it})(P^*_{it} / P_t) \quad (1)$$

Where; $NEER_{it} = \sum_{i=1}^{k} w_{it} * E_{it}$ (2)

p^*_{it} is the price in the partner trade i representing the price of tradable and P_t is the CPI of home country as a proxy for price of non-tradable, $NEER_{it}$ is the Nominal Effective Exchange Rate for Rwanda with respect to the partner i; w_{it} is the weight for the trading partner i, E_{it} is the nominal exchange rate calculated in uncertain, between Rwanda and the partner i at period t, k is the number of trading partners.

Alternatively, the REER using GM method is defined as follow

$$REER = \frac{NEER_{it} * EP_{ft}}{P_{dt}} \quad (3)$$

Where $NEER_{it} = \prod_{i=1}^{k} E_i^{w_i t}$; $EP_{ft} = \prod_{i=1}^{k} P_{ft}^{w_{it}}$

w_{it} Is the weight for the trading partnering i.

To compute REER for Rwanda, we chose 2008 to determine trading partner's weights especially given that in this year, it was possible to identify

final destination of Rwandan key exports. We use data on export and imports (value of 2008) to identify important trading partners of Rwanda and their weights. 21 countries were selected and they cover 90.6% of total foreign trade volume of Rwanda. Weights of these countries have been calculated by defining two specific countries groups: Euro including selected trading partners members of Euro area; USA including United States of American and other trading partners of Rwanda for which transactions are paid in USD. These countries are China, United Arab Emirates; India; Hong Kong; RD/ Congo; Swaziland and Egypt.

We have calculated 3 series of the REER using GM method and different weights obtained from imports, exports and total trade, as follow:

$$REER_t = \frac{NEER_t * WCPI_t}{RwandaCPI_t}.$$

With

1. $NEER_{Xt} = \prod_{i=1}^{n} exrate_{it}^{Wx_i}$;

2. $NEER_{mt} = \prod_{i=1}^{n} exrate_{it}^{Wm_i}$;

3. $NEER_{Tt} = \prod_{i=1}^{n} exrate_{it}^{WT_i}$;

And,

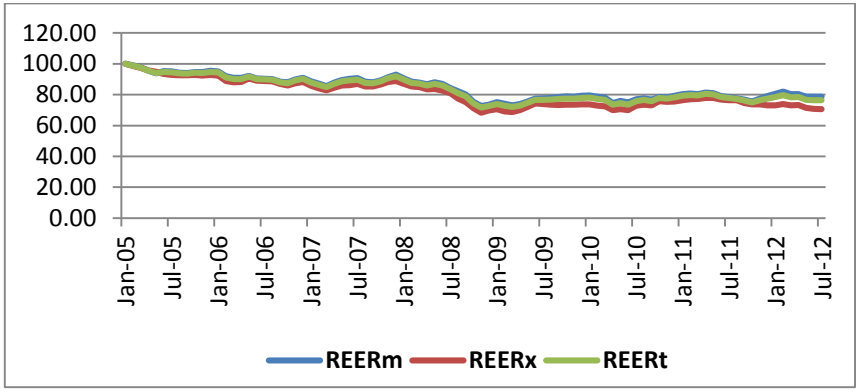
1. $WCPI_{xt} = \prod_{i=1}^{n} CPI_{it}^{Wx_i}$

2. $$WCPI_{mt} = \prod_{i=1}^{n} CPI_{it}^{Wm_i}$$

3. $$WCPI_{Tt} = \prod_{i=1}^{n} CPI_{it}^{WT_i}$$

The following graph show the trends of the three time series of REER obtained by using different weights from imports (REERm), exports (REERx) and total trade (REERt).

Appendix 4b: Development of REER in Rwanda



***Source**: Monetary Policy and Research*

Determinants of interest rate spread in Rwanda

Authors[12]:

Mr. Mathias Karangwa Mr. Christian Nyalihama

Abstract

This paper examines the determinants of interest rate spread in Rwanda using various approaches, with a particular focus to bank characteristics while at the same time capturing latest developments in Rwanda's financial sector. Using a sample of commercial banks operating in Rwanda, the results from Arellano-Bond dynamic panel Generalized Method of Moments (GMM) estimation show that credit risks, operating cost and inflation positively influence interest rate spread in Rwanda. Panel data fixed effects and random effect estimation also confirmed these results. The findings above imply that banks need to adopt consolidation and cost minimization strategies and should strengthen their credit management strategies to help reduce credit risk.

[12] The authors got useful comments from Dr. Thomas Kigabo

1. INTRODUCTION

The financial system stability assessment on Rwanda conducted by the IMF in 2011 acknowledges positive developments in Rwanda's banking industry such as increased entry of new banks and growing competition that have led to the decline in profit margins and effective spreads for Rwanda's banks. However, this study used only the accounting framework to decompose interest rate spread into income statement items (i.e. Profit, provisions, overhead costs and reserves). The accounting framework is often used for descriptive analysis. A thorough analysis of the determinants of interest rate spread requires the use of the bank profit maximization model to derive an appropriate empirical model relating spread to its determinants that may not necessarily be income statement items.

Empirical studies show that financial liberalization encourages the development of the financial sector and thus brings forth competition which leads to the decline in interest rate spreads. Generally, interest rate spreads have remained high in the developing world due to low competition, high reserve requirements, and risk aversion for banks, high operating costs, macroeconomic and political instabilities, among others. The Rwandan government has since March 1995, introduced a number of reforms aimed at supporting sustainable economic growth. These reforms include the financial sector liberalization program geared towards rehabilitation and re-energization of the banking system, revision of certain banking acts, reorganization and recapitalization of certain banks with financial problems and strengthening of the regulatory and supervisory framework, among others.

Although these reforms have led to various improvements in financial intermediation, the interest rate spread in Rwanda has remained volatile and relatively higher.

High bank spreads, among other factors, hinder the private sector's access to credit, (Rebei, 2014) and point to inefficient financial sector intermediation (Samuel & Valderrama, 2006). Besides, the spread is an important link in monetary policy transmission. Hence, it is paramount to identify the main factors behind of interest rate spread movement.

The only empirical study about the determinants of interest rate spreads in Rwanda was conducted by Kigabo and Barebereho in 2007. Their findings pointed at lack of competition and risk aversion as the major determinants of interest rate spreads in Rwanda. Since 2007, financial sector development has increased and new banks have entered the market leading to improvements in the performance of the sector. This paper aims at investigating the determinants of interest rate spreads in Rwanda, paying special attention to bank characteristics while at the same time capturing latest developments in Rwanda's financial sector.

The rest of the paper is organized as follows: Section II reviews the literature on interest rate spreads. Section III explains developments in interest rate spreads in Rwanda using a descriptive approach. Section IV covers the methodology used in this study. Section V presents and interprets the empirical results. Finally, section VI gives the conclusion and policy implications.

2. LITERATURE REVIEW

Interest rate spread, defined as the difference between the lending rate and the deposit rate, is always considered as an important indicator of the efficiency of banks, as economic agents between savers and borrowers. When the interest rate spread is high, it hampers lending thereby constraining economic growth. In literature, the determinants of interest rate spread are always classified into bank specific characteristics, macroeconomic conditions, the legal environment and the market structure of banking system.

a. Banks specific characteristics

Regarding banks specific characteristics which determine interest rate spread, Gambacorta (2006) identified size, credit risks, liquidity risks, overhead costs and deposits strengths. Other important variables include non-performing loans and liquidity mismatches.

Bank size, usually measured by total assets or total loans, may be an important determinant of net interest margins and spreads if there are economies of scale in banking. Previous studies have found a negative relationship between bank size and operating costs and between bank size and interest rate spreads (Dabla-Norris & Floerkemeier, 2007).

Liquidity, often measured by the ratio of cash and liquid securities to total assets, also affects the behaviour of banks interest rates (Kashyap and Stein, 2000; Gambacorta, 2004).

In case of a competitive market for deposits, higher liquidity will tend to be negatively associated with spreads and net interest margins (Dabla-Norris & Floerkemeier, 2007)

Credit risk is in some cases measured here as the ratio of loans to deposits and short-term liabilities. The higher this ratio, the more the bank is exposed to loan default risk, and the higher is the interest rate margin to cover this risk (Ahokpossi, 2013). Hence, credit risk is positively related to the interest rate spread.

Cost of intermediation (screening, monitoring, branching costs) have a positive effect on the interest rate on loans and a negative effect on that on deposits and may reflect bank inefficiency. Various studies have shown that operational inefficiency leads to higher costs of intermediation and therefore to higher margins. Hence the larger the banking inefficiencies, the higher interest rate spreads will be (Dabla-Norris & Floerkemeier, 2007; Gambacorta, 2005; Ahokpossi, 2013).

Deposits strength which is measured as ratio between deposits and bonds plus deposits (Gambacorta, 2006) reflects the ability of a bank to raise funds and if the deposits strength is low, banks are likely to quickly adjust upward their lending rates, deposits rates and subsequently spreads.

Non-performing loans ratio is measured as the amount of non-performing loans relative to total loans granted and is expected to be positively related with lending rates and the spread (Crowley, 2007) as it reflect at some extent the level of risk.

Liquidity mismatch or maturity mismatch is measured as short-term liabilities versus long-term assets. The lower is this ratio, the higher is liquidity risks, and the relationship with the spread is expected to be negative (Ahokpossi, 2013).

Capitalization is also another important bank specific characteristic and can be measured either as the ratio of capital to total assets or proxied by the capital adequacy ratio. This is an important indicator of risk associated with a particular bank. That is why it affects their pricing behaviour. If equity is sufficiently low and it is too costly to issue new shares, banks reduce lending in order to meet regulatory capital requirements and widen their interest rate spread. (Gambacorta, 2005)

There other factors which influence banks pricing behaviour especially deposits rates such as menu costs and switching cost resulting from durable relationships between banks and customers (Bernstein, 2003).

b. Macroeconomic conditions

Secondly, macroeconomic conditions are key determinants of banks interest rates. Literature singles out GDP growth, inflation, policy rates, money market rate, macroeconomic volatility, exchange rate and economic agents' expectations as macroeconomic variables likely to affect banks pricing behaviour.

GDP growth measures the growth in output of an economy. Economic growth is negatively related to bank prices and costs, although the extent to which these variables are affected may be significantly different (Carbo Valverde,

2007). Hence, the effect on the spread is not clear as according to Carbo Valverde (2007), banks prices and costs could be affected in different proportions.

Another important variable is inflation which reflects changes in price index of basket of goods. Inflation constitutes a macroeconomic risk (Ahokpossi, 2013) and therefore affects positively the lending rate and negatively the deposits rate (Gambacorta, 2007). Changes in inflation could also lead to higher spreads by increasing the risk premia that banks need to charge (Crowley 2007). Theory predicts that the riskiness of borrowers is likely to rise with the level of interest rates, possibly in a nonlinear way. Banks will typically want to be compensated for higher risk, which yields a positive relationship between the levels of interest rates and spreads (Gelos, 2006).

Regarding policy rates and money market rates, literature insists on the fact that their effect on banks interest rates depends on many factors including notably market structure and bank specific characteristics. This is an important dimension of monetary policy transmission mechanism. In fact, as much as a bank enjoys more market power, the adjustment of banks rates from movement in policy rates and money market rates would be slow.

Other remaining variables such as exchange rate, agents' expectations and proxy of macroeconomic volatility which reflects market risks are usually associated with higher lending rates and higher spreads.

c. Market structure

The structure of the markets on which commercial banks are operating is a key determinant of banks interest rate settings. Market structure is often reflected by market competition and market concentration (measured by Herfindahl index or Lerner index).

In the literature the impact of concentration on banks pricing behavior is usually summarized by two hypotheses. One assumes that banks will collude and use market power to extract rents (structure performance hypothesis) while the other assumes that concentration would increase the overall efficiency of the sector, implying that more efficient banks will grow more rapidly than less efficient banks. If this is the case, at least up to some point, banks would price their services more competitively, rather than less competitively (efficient structure hypothesis). (Corvoisier and Gropp, 2001 citing Berger and Hannan (1989),) (Bernstein, 2003) This means that in the first case lower competition should result in higher lending rate, higher spreads and lower deposits rate, while in the second case a decrease in managerial costs due to increased efficiency should have an opposite effect.

d. Legal and institutional environment

This may encompasses other factors which affect banks pricing behaviour such as creditor rights and the quality of the legal framework, degree of development of financial markets, the existence of constraints on financial intermediation, availability of information on borrowers, etc. Higher recovery rates and shorter times to repossess collateral in countries with better legal environments are expected to reduce bank spreads (Gelos, 2006).

Existing empirical literature shows that spreads are higher in developing countries and lower in developed countries. Interest rate spread in developing countries has remained high due to lack of changes in the structure and institutional behaviour of the banking system shown by concentration, the conditions of free entry and competitive pricing; high reserve requirements, which is an implicit financial tax; adverse selection and adverse incentive (moral hazard) effects which result into the increase in non-performing loans and provision for doubtful debts; high operational costs; the higher cost to capital that banks hold to cushion themselves against risk; and macroeconomic instabilities as reflected by volatilities in inflation and economic activity (GDP). Below, literature on developing countries as well as emerging and developed countries is reviewed.

Starting with developed countries, Kosmidou et al. (2002) studied the profitability of banks in the United Kingdom (UK). They used net interest margin and return on assets as measures of performance. The determinants of performance were hypothesized to be cost to income ratio (COST) as an indicator of efficiency in expenses management; ratio of liquid assets to customer and short term funding (LIQUID) to represent liquidity; ratio of loan loss reserves to gross loans (LOSRES) as an indicator of banks' asset quality; ratio of equity to total assets (EQAS) representing capital strength; and the total assets of a bank representing its size (SIZE), The rate of GDP growth (GDPGR) and inflation (INF), concentration in the banking industry (CONC) and stock market capitalization (MACPASS). The results show that the capital strength of these banks has a positive and dominant influence on their profitability, the other significant factors being efficiency in expenses

management and bank size. These bank-specific determinants are robust to the inclusion of additional macroeconomic and financial market measures of bank performance, which add little to the explanatory power but nevertheless appear to have positively influenced profitability.

A very recent study about spreads was carried out in Greece by Ljupka et al. (2011) and modeled spread as a function of bank size (proxied by total bank assets), market share, non-performing loans, liquidity, capital adequacy, return on assets, operating costs and share of foreign ownership. They concluded that lending rates are mostly influenced by bank size and market share and to a lesser extent by deposit rates and non-performing loans. In addition, policy variables such as the domestic policy rate and the foreign interest rate also appear to be quite important. Furthermore, the bank size and the market share, as well as the differential between domestic and foreign rates, are the most important factors affecting interest rate spreads, while the effect of other factors is less clear-cut.

Regarding emerging countries, Dabla-Norris and Floerkemeier (2007) investigated the determinants of bank spreads n Armenia. They used net interest margin as measure of bank efficiency.

Interest spread was modeled as a function of Bank size (log of total assets), non-interest income, capital adequacy, return on assets, current liquidity, deposit market share, bank portfolio shares of industry, agriculture and consumer loans, bank market shares of industry, agriculture and consumer loans, foreign ownership of the bank, foreign bank participation and market concentration. Their findings stress the importance of bank-specific characteristics in explaining the variation of interest rate spreads and margins

across banks and across time. They find that larger and more liquid banks with less exposure to agricultural and consumer loans are associated with lower spreads.

Banks exhibiting higher market power, as measured by individual market shares, are associated with higher spreads but with lower margins.

Banks specific characteristics were also found to influence the spread by Chortareas et al. (2003) who studied the market structure, profits and spreads in the Mexican banking industry over the 1996-2003 period. They considered concentration (HHI), market share, inefficiency (cost to income ratio), capital ratio, total assets, proportion of loans to total deposits (PREDEP), real GDP and inflation as determinants of spreads. They concluded that inefficiency is negatively related to spreads while the capital ratio is positively related to spreads.

Other factors were found to be insignificant. Their findings give strong support to the efficient market hypothesis (due to the significance of the inefficiency variable) and weak support to the structural conduct performance hypothesis. In Brazil, Afanasieff and Villa Lhacer (2002) used a two-step approach based on Ho and Saunders (1981), McShane and Sharpe (1985), Allen (1988), Angbazo (1997) and Wong (1997) to model interest rate spread. At stage one, spread is modelled as a function of a time dummy and a vector of bank characteristics (Number of employees, ratio of non-interest bearing deposits to total operational assets, ratio of interest bearing funds to total earning assets, operating costs, bank liquidity, the ratio of service revenues to total operational revenues, the bank net worth and bank leverage). At stage two, pure spread is modelled as a function of macroeconomic variables

(volatility of the market interest rate, the inflation rate, and the output growth rate). The results suggest that macroeconomic variables are the most relevant factors to explain the behavior of bank interest spread in Brazil.

The two-step approach was also used in Latin America by Brock and Suarez (2000) to study the determinants of interest rate spreads. Spreads were taken to depend on the ratio of non-performing loans, capital ratio, cost ratio, liquidity ratio and time effects as captured by the time dummies. Their analysis shows that high operating costs raise spreads as do high levels of non-performing loans, although the size of these effects differs across the countries. In addition, reserve requirements in a number of countries still act as a tax on banks that gets translated into a higher spread. Beyond bank specific variables, uncertainty in the macroeconomic environment facing banks appears to increase interest spreads. The combination of these microeconomic and macroeconomic factors is a cause for concern in Latin America. As spreads widen, the cost of using the financial system becomes prohibitive to some potential borrowers. In addition, the results suggest that bank capital requirements may not prevent excessive risk taking by banks when bank spreads are high.

Barajas et al. (1998) studied the determinants of spreads in Columbia and hypothesized spreads to be dependent on costs, financial taxation, and market power and loan quality. They conclude that average spread for the pre-liberalization and post-liberalization period did not differ much. Nonetheless, the composition of spread differed between the two periods. Market power reduced while responsiveness to loan quality increased during liberalization. Another key driver of spreads was operational costs and financial taxation.

In Central America, Dick A. (1999) used the accounting approach to conduct a descriptive analysis of the spread.

He also specified an econometric model including average production costs, average regulatory costs, average credit risk, macroeconomic factors, other factors such as size and average capital. His study covered five Central American countries of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, all considered to be underdeveloped and therefore have higher spreads. This analysis indicates that operating costs are the most important component within the spread, and that there is a positive association between these costs and the spread in all the Central American countries. Additionally, the degree of market power does not appear to be a key determinant in the formation of the spread, for the exception of Costa Rica. From a policy perspective, these results suggest that reforms that provide incentives for the entrance of new participants should continue.

This would increase the degree of competition in the industry and force the decrease of operating expenses (as long as the proper assessment of banking costs functions is consistent with this policy).

In East Caribbean countries, determinants of interest rate spread were examined by Grenade (2007) and Randall (1998). Grenade (2007) considered a behavioural model in which spread depends on regulated saving deposit rate, opportunity cost of noninterest bearing reserves, liquidity risk, operating efficiency, provision for loan losses, economic activity (real GDP growth), Market power and country and time dummies to account for cross sectional and time differences. They concluded that the observed spreads can be attributed to the high level of market concentration, high operating costs and

non- performing loans and the central bank's regulated savings deposit rate. On the other hand, Randall (1998) included asset rate, level of efficiency (measured by marginal cost), elasticity of loan demand with respect to the lending rate and income elasticity as determinants of interest rate spread. He concluded that operating costs were the key determinants of observed interest rate spread and recommends that policy should aim at expanding the market size of the efficient banks so as to encourage banks' efficiency.

Furthermore, Khan and Khan (2010) assumed that interest rate spreads in Pakistan depend on the share of non-remunerative deposits, share of non-interest income, ratio of administrative expense to total expenses, degree of concentration (Herfindahl-Hirschman Index), real GDP growth and interest rates (deposit and lending rates). The results indicate that spreads of commercial banks are primarily driven by the banks' low cost of funding; operating expenses; and opportunities to earn income from non-core business activities. Specifically, the share of non-remunerative deposits in total deposits and administration expense in total expense are positively correlated with banking spreads, while the share of non-interest income in total income negatively affects banking spreads. Further, market concentration and macroeconomic variables, such as real GDP and interest rates also have a positive influence on commercial bank spreads in Pakistan.

Another study on spreads in Pakistan was carried out by Khawaja (2002) and modeled interest rate spread as a function of concentration, deposit inelasticity, market share, liquidity, administrative cost, non-performing loans of banks, loans equity, real output, inflation and real interest rate.

Results show that inelasticity of deposit supply is a major determinant of interest spread whereas industry concentration has no significant influence on interest spread. One reason for inelasticity of deposits supply to the banks is the absence of alternate options for the savers. The study also points at the on-going merger wave in the banking industry and expects it to limit the options for the savers. Given the adverse implications of banking mergers for a competitive environment, to maintain a reasonably competitive environment, merger proposals may be subjected to review by an antitrust authority with the central bank retaining the veto over merger approval.

Ramful (2001) investigated the determinants of interest rate spread in the Mauritian Banking industry. He modeled spread to be explained by deposit interest rate, ratio of operating costs to total assets, Treasury bills rate, reserve requirements, ratio of provisions for bad debts to total loans, ratio of non-interest income to total asset and market share. He concluded that interest rate spread in Mauritius is used not only to cover the costs of operating expenses and required reserves but also reflects the prevalence of market power and compensates for the quality of loans.

Another study on Mauritius was carried out by Seetaram et al. (2006) and modeled interest rate spread in an error correction model. They hypothesized that the spread depends on aggregate operating costs, aggregate liquidity, aggregate credit risk, aggregate required reserves, real GDP growth, inflation rate and the discount rate. By large, results from the study show that, at the micro level, banks sustain a widening spread when the profit margin is threatened by increased operating costs. Rising credit risk due to distress borrowing are also associated higher risk premiums on bank lending rates.

Increase in non-interest bearing reserve requirements are observed to result in a widening of banking spread as banks face reduced liquidity.

At the macro level, it is observed that banks tend to profit in inflationary environment as the spreads widen with banks charging higher risk premium. Reducing operating costs, financial taxation and inflation and improving loan quality and liquidity are key issues in an attempt to narrow the banking interest rate spread.

For Tunisian banks, Ben Naceur (2003) studied the determinants of their profitability (or performance proxied by return on assets and net interest margin). Bank profits were hypothesized to depend on the ratio of overhead to total assets, the ratio of equity capital to total assets, the ratio of bank's loans to total assets, the ratio of noninterest bearing assets to total assets and the log of bank assets , inflation and GDP per capita growth, relative size calculated as the ratio of the stock market capitalization to total assets of deposit money banks, financial market development and as a measure of the size of the equity market calculated as stock market capitalization divided by GDP, size of the banking sector measured by the ratio of total assets of the deposit banks to GDP and bank concentration measured as the fraction of bank assets held by the three largest commercial banks in the country.

Regarding developing countries, a comprehensive study that compares thirty three low and middle income countries was carried out by Tennant and Folawewo (2005) and analyses how spreads respond to changes in bank development (proxied by bank assets/GDP and real per capita GDP), reserve ratio, market size (proxied by population size), inflation, exchange rate

volatility, public sector borrowing as a percentage of total loans, discount rate and treasury bills rate.

Variables such as economies of scale, Treasury bill rate, bank development, exchange rate volatility and real per capita GDP were found to be insignificant whilst other variables like reserve ratio had a significant influence on spread.

Bawumia et al. (2005) examined the structure of spreads in Ghana. They included provision for doubtful debts, operating costs, deposit market share, liquidity reserve ratio, the logarithm of the Consumer Price Index, Treasury bills rate, bank net worth (shareholder's funds) and non-interest income as determinants of interest rate spreads in Ghana. Their findings show that market share and operating costs were key drivers of interest rate spread. The significance of market share implied presence of structural impediments such as market concentration and lower price competition among banks. They also found out that nonperforming loans and the existence of liquidity reserves had influence on interest rate spread in Ghana.

More profitable banks are associated with higher margins, while higher capital adequacy and liquidity ratios are associated with lower margins. Higher concentration in loan and deposit markets has a positive and economically significant effect on both spreads and margins. The presence of foreign banks does not directly seem to have contributed to lower spreads and margins, reflecting the limited presence of first-tier international banks in the Armenian banking sector. However, we find that foreign bank origin matters for banking efficiency, with first-tier (western) foreign banks having a spill-

over effect on interest rate spreads. The presence of banks from other countries, however, is associated with higher spreads.

Finally, macroeconomic variables were found to have only a minimal impact on both spreads and margins (Era D. et al., 2007).

Basing on Ho and Saunders (1981), a study carried out in Swaziland by Khumalo et al. (2011) considered a number of determinants of interest rate spread. These factors were liquidity, intermediation, equity ratio, overhead costs, provisions, competition/concentration (Herfindahl-Hirschman Index), ownership (market share in loans and deposits markets, inflation, exchange rate volatility and the treasury bills rate. Their findings reveal that increases in overhead costs, liquidity, equity, market power treasury bills rate and changes in the exchange rates have significant effects on the rise in narrow interest rate margin while intermediation has a negative effect. On the other hand a rise in overhead costs has a significant positive effect on the net interest margin whereas liquidity has a negative effect.

Using a behavioural model, Kujeri and Younus (2009) assumed that interest rate spreads in Bangladesh depend on the ratio of loans to total outstanding loans, operating costs, market share, ratio of non-interest income to total assets, interest rate on deposits, statutory reserve requirement, savings directorate certificate rate, inflation rate, growth rate of real GDP, ratio of taxes (before provisions and tax) paid by banks to net income, ratio of provisions to total loans and a dummy for financial sector reforms. Their findings suggested that the higher the non-interest income as a ratio of total assets of a bank, the lower its spread. Similarly, market share of deposits of a bank, statutory reserve requirements, and statutory certificate interest rates affect the spread.

The analysis in terms of bank groups shows that spread is significantly influenced by operating costs and classified loans for state owned commercial banks (SCBs) and specialized banks (SBs); while inflation, operating costs, market share of deposits, statutory reserve requirements, and taxes are important for the private commercial banks (PCBs). On the other hand, non-interest income, inflation, market share, and taxes matter for the foreign commercial banks (FCBs).

In Malawi, Mlachila and Chirwa (2002) modeled spread to be explained by provisions, non-financial costs, deposit market share, competition, required liquidity reserve ratio, bank discount rate, inflation, change in industrial production index and a dummy for financial sector reforms. Nonetheless, they conclude that spreads increased after financial liberalization and were mainly driven by high monopoly power, high reserve requirements, high central bank discount rate and increased inflationary pressures.

About studies on the EAC region, in Uganda, Beck and Hesse (2006) examined the determinants of spreads for Ugandan banks. The regressors included were: the ratio of overhead costs to total assets, return on assets (measured as the ratio of profits to total assets), ratio of provisions to total assets, liquidity ratio, market share for deposits and loans (HHIs), foreign ownership of banks, loan shares to different sectors, GDP growth, Inflation, real treasury bills rate and change in the exchange rate. Findings showed that while foreign banks charge lower interest rate spreads, there was no robust and economically significant relationship between privatization, foreign bank entry, market structure and banking efficiency.

Similarly, macroeconomic variables can explain little of the over-time variation in bank spreads. Bank-level characteristics, on the other hand, such as bank size, operating costs, and composition of loan portfolio, explain a large proportion of cross-bank, cross-time variation in spreads and margins. However, time-invariant bank-level fixed effects explain the largest part of bank variation in spreads and margins. Further, there was tentative evidence that banks targeting the low-end of the market incur higher costs and therefore higher margins.

In Kenya, Njuguna and Ngugi (2000) hypothesized spreads to be dependent on money market interest rate (inter-bank rate), interest rate on government securities, loans and deposits and they conclude that disequilibrium in the loans market is a major factor in driving the spread and has substantial feedback effects, which reflect persistence of the disequilibrium. Institutional and policy factors impact on transaction costs and compound the effects of risks and uncertainty in the market, thus exacerbating the spread. Disequilibrium in the loans market is a major factor that propels the widening of interest rate spread. The situation is mainly explained by the availability of deposit resources, the alternative investment channels for banks and the ease of portfolio adjustment at the end of the period. Institution constraints, market micro-structures and policy actions explain substantial variations in interest rate spread.

This is because of their impact on the transaction costs and a compounding effect from risk and uncertainty in the market.

Performance in the loans market reflects the macroeconomic environment where macroeconomic stability serves to reduce the risk premium and ensure positive returns for investment, reducing the credit risk. It also reflects the moral-hazard and adverse-selection problems that are compounded by poor monitoring and evaluation of the investment projects as the banks relegate their screening roles to the background. This also reflects weak enforcement of loan contracts, which impacts on transactions costs and the risk premium on loans. High implicit taxes (reserve requirements) increase the spread through the lending rate as banks aim to maintain their profit margins. This is propelled by demands to finance fiscal deficit using low-cost funds. An attractive Treasury bills rate in a non-competitive market compels banks to shift their portfolio towards risk-free quality assets, and this reduces their intermediation role. In addition, high minimum capital for investment in Treasury bills reduces the banks' incentive to increase deposit rates (Njuguna & Ngugi, 2000).

Ngugi (2001) also investigated the determinants of interest rate spreads in Kenya. In her study she included the following regressors: operational costs, interest rate elasticities, reserve requirements, demand and supply of funds, costs of adjustment in the secondary market, returns on other financial assets, and policy actions. She concluded that the interest rate spread increased because of yet-to-be gained efficiency and high intermediation costs. The increase in spread in the post-liberalization period stemmed from the failure to meet the prerequisites for successful financial reforms and the lag in adopting indirect monetary policy tools and reforming the legal system.

Variations in the interest spread are attributable to bank efforts to maintain threatened profit margins.

For example, banks that faced increasing credit risk as the proportion of non-performing loans went up responded by charging a high risk premium on the lending rate. High non-performing loans reflect the poor business environment and distress borrowing, which is attributed to the lack of alternative sourcing for credit when banks increased the lending rate, and the weak legal system in enforcement of financial contracts. Fiscal policy actions saw an increase in Treasury bill rates and high inflationary pressure that called for tightening of monetary policy (Ngugi, 2001).

As a result, banks increased their lending rates but were reluctant to reduce the lending rate when the Treasury bill rate came down because of the declining income from loans. They responded by reducing the deposit rate, thus maintaining a wider margin as they left the lending rate at a higher level. Thus there was an asymmetric response of lending rates to Treasury bill rates. High implicit costs were realized with the tight monetary policy, which was pursued with increased liquidity and cash ratio requirements. Consequently, banks kept a wide interest rate spread even when inflationary pressure came down (Ngugi R. W., 2001).

For Rwanda, Kigabo and Barebereho (2007) mainly attributed larger interest rate spreads to bank specific characteristics and market structure variables. Factors such as lack of competition among banks, bank size and the volume of non-performing loans as well as risk aversion of banks (which can be

measured by loan loss provisioning) were found to play a major role in determining interest rate spread differentials across banks.

They recommended that increasing market transparency and reducing information asymmetries would help reduce spreads.

3. STRUCTURE AND CHARACTERISTICS OF THE RWANDAN BANK INDUSTRY

Rwanda's financial sector has undergone rapid changes following the financial liberalization which started in early 1990s but became fully-fledged in 1995. Before 1995, there were only five banking institutions (BCR, BK, BACAR, Caisse d' Epargne du Rwanda and BPR) and seven non-banking financial institutions (BRD, Caisse Hypothecaire du Rwanda, SONARWA, SORAS, communal development fund, Episcopal Development Office and the Special Guarantee Fund). Monetary policy was conducted using direct instruments such as credit ceilings (global ceilings and potential d'engagement) as well as regulated interest rates (Goldmark, 1987).

The financial liberalization that became active in 1995 led to the adoption of indirect monetary policy instruments (removal of credit ceilings and allowing interest rates and exchange rates to be market driven).

At present, the number of banking and non-banking financial institutions has increased as shown in the table below:

Table I: Banking and non-banking financial institutions in Rwanda

Institution	Number of Institutions
Banks	**16**
Commercial banks	10
Development banks	1
Cooperative banks	1
Microfinance banks	4
Microfinance institutions	**491**
UMURENGE SACCOs	416
Other SACCOs	62
Microfinance institutions LTD	13
Insurers	**14**
Public	2
Private	12
Insurance intermediaries	**330**
Insurance brokers : 10	10
Insurance agents: 309	309
Loss adjusters :11	11

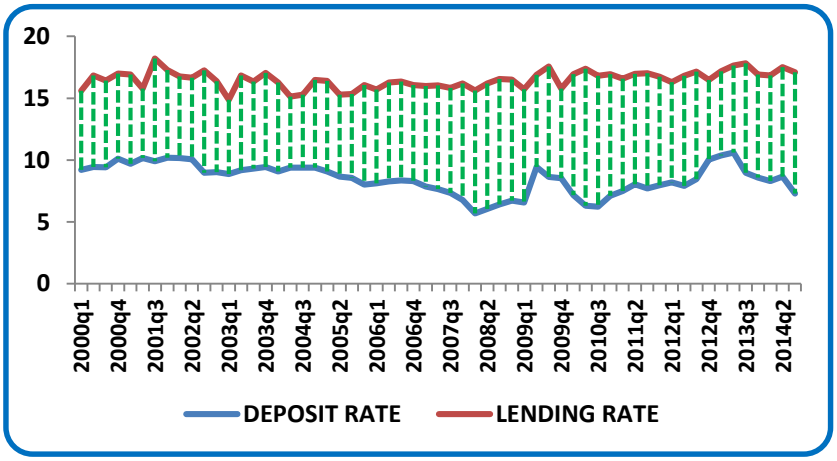
Source: *BNR, Bank Supervision Department.*

3.1. Interest rate spread in Rwanda

While deposit rates have fluctuated at around 9% since 2000, lending rates have remained high, standing at around 17%, and thus keeping the interest rate spread high.

Deposit rates in Rwanda tend to fluctuate more than lending rates. The latter are particularly high given some structural problems such as high operational costs.

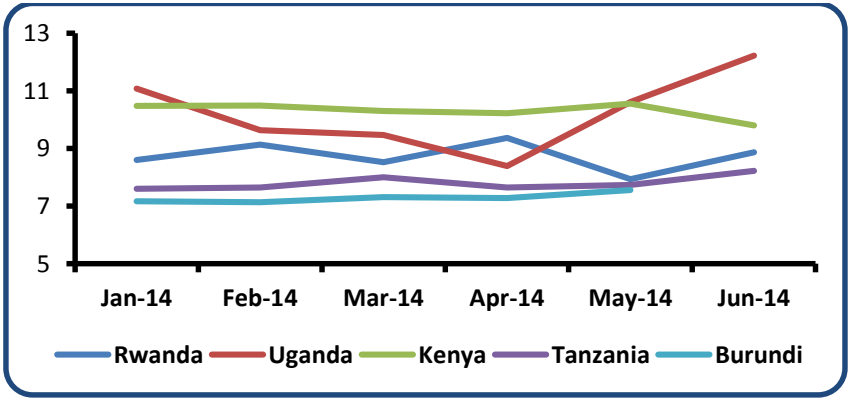
Figure I: The trend of interest rate spread in Rwanda



Source: *BNR, Monetary Policy and Research Department*

Compared to other EAC countries, interest rate spread is low in Rwanda, Burundi and Tanzania but higher in Uganda and Kenya. Note that the share of remunerated deposits out of total deposits in Kenya and Uganda's banks is higher than in Rwanda and for Kenya in particular, the share of interest expenses in total expenses is larger.

Figure II: Interest rate spread in EAC

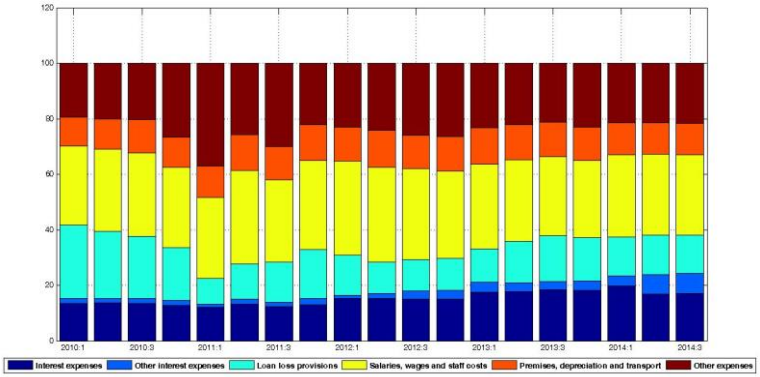


Source: *BNR, Monetary Policy and Research Department*

a. Decomposing operating costs

Using the accounting framework, the main factors behind the persistence of higher interest rate spread in Rwanda are identified as higher operating costs in the banking sector. They are composed of salaries, wages and staff costs, interest expenses and other expenses which have continued to have a big share in total operating costs.

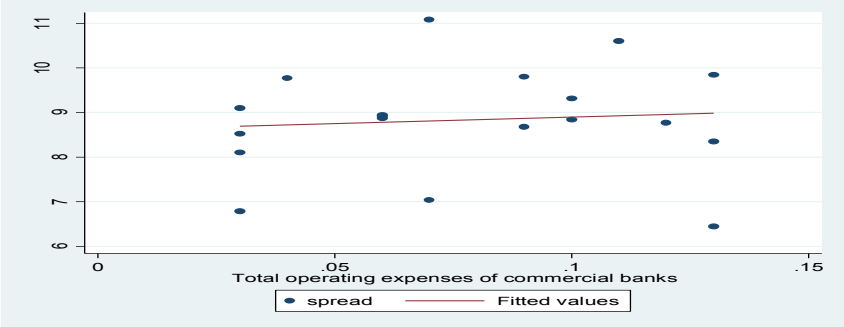
Figure III: Decomposition of operating costs (% YoY)



Source: *BNR, Monetary Policy and Research Department*

Total operating costs for commercial banks in Rwanda are positively correlated with interest rate spread because as they increase, banks tend to shift the burden to clients in form of increased lending rates. However, data shows that Rwandan banks cannot hike lending rates so much as indicated by slightly increasing positive correlation between the spread and total operating costs.

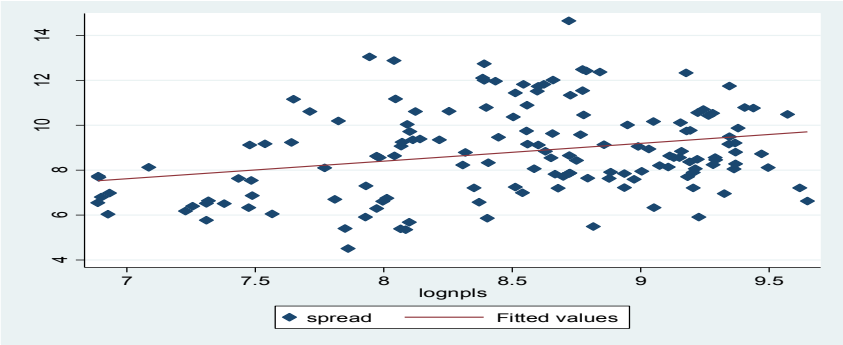
Figure IV: Correlation of interest rate spread with operating costs



Source: *BNR, Monetary Policy and Research Department*

Another important determinant of interest rate spread is the level of non-performing loans. As expected, it is positively correlated with interest rate spread for Rwanda's commercial banking system.

Figure V: Correlation of interest rate spread with non-performing loans

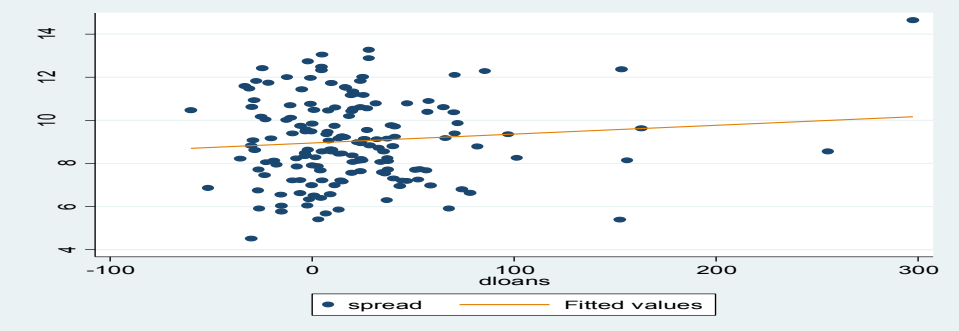


Source: *BNR, Monetary Policy and Research Department*

With regards to the scale of operations, approximated by growth in total loans (dloans), the graph below shows that interest rate spread and the scale of operations are positively correlated and this may be due to the fact that banks

still incur higher operating costs which they transfer onto clients by charging higher lending rates.

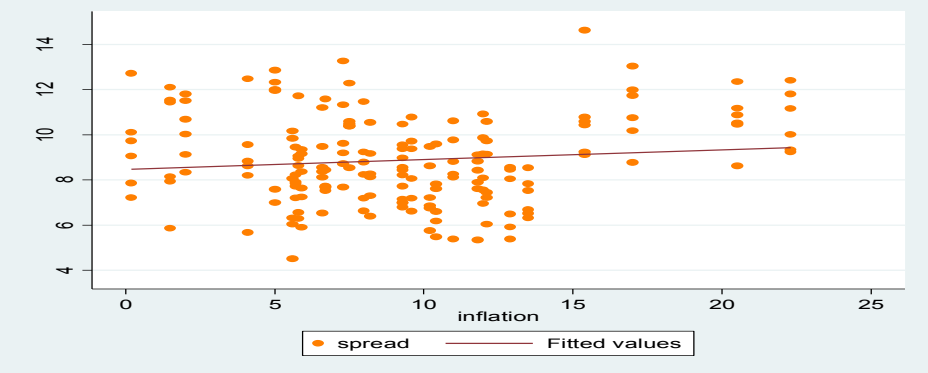
Figure VI: Correlation of interest rate spread with scale of operations



Source: *BNR, Monetary Policy and Research Department*

Another important macroeconomic factor that affects interest rate spread in Rwanda is inflation. As expected, inflation is positively correlated with interest rate spread implying that commercial banks care about the level of inflation when setting interest rates.

Figure VII: Correlation of interest rate spread with inflation



Source: *BNR, Monetary Policy and Research Department*

b. Variability of interest rate spread across banks and time

As a measure of variability, the coefficient of variation is calculated as the ratio of the standard error to the mean of a given series. Variability over time is calculated by considering the coefficient of variation when the individual observations that make the series up are the average rates (for all the banks) for each quarter. Conversely, the variability across banks show the coefficients of variation when the observations making the series up are the average rates (for every month) and for each bank.

Table II: Coefficient of variation over time and across banks

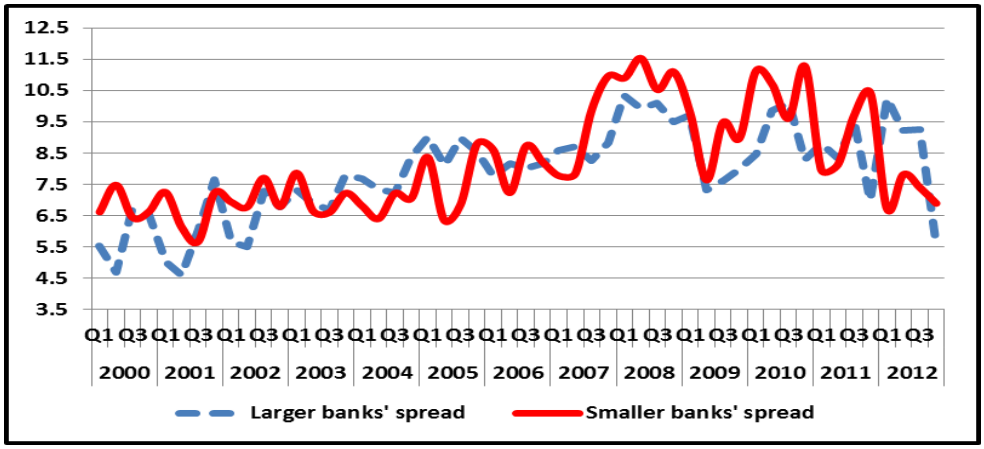
	Lending rate		Deposit rate		Spread	
year	Across time	Across banks	Across time	Across banks	Across time	Across banks
2000	0.0175	0.0850	0.0164	0.1000	0.0236	0.2306
2001	0.0432	0.0835	0.0134	0.1242	0.1263	0.2943
2002	0.0241	0.0683	0.0369	0.1556	0.0794	0.2673
2003	0.0263	0.0600	0.0155	0.0999	0.0724	0.1755
2004	0.0180	0.0617	0.0206	0.1083	0.0406	0.1352
2005	0.0412	0.0585	0.0424	0.2143	0.1067	0.2416
2006	0.0261	0.0529	0.0089	0.1753	0.0509	0.1955
2007	0.0176	0.0500	0.1068	0.2485	0.1178	0.2223
2008	0.0092	0.0362	0.0356	0.2381	0.0244	0.1207
2009	0.0354	0.0681	0.1680	0.3558	0.1051	0.3685
2010	0.0247	0.0691	0.0333	0.2361	0.0277	0.1928
2011	0.0225	0.0960	0.0579	0.1807	0.0772	0.2587
2012	0.0163	0.0860	0.1180	0.2720	0.1116	0.2989

***Source**: Authors' calculations*

The coefficients of variation indicated in table 3 above show that variability is high across banks than across time implying that there is heterogeneity in terms of bank-specific characteristics. This support the use of panel data to determine the key determinants of interest rate spreads in Rwanda.

Considering the spread in larger banks (the first three banks in terms of asset share) against smaller banks (the remaining commercial banks), average spread for smaller banks is 8.2% compared to 7.9% for larger banks. Smaller banks tend to incur higher operational costs which they recover by earning higher profit margins while bigger banks, which have already expanded are therefore more competitive tend to benefit from economies of scale without necessarily raising interest rates. In addition, , the total operating costs as a percentage of total assets was on average standing at 7.8% for big banks and 8.4% for small banks between 2008Q1 and 2014Q3.

Figure VIII: Interest rate spread by category of banks (2000q1-2012q4)



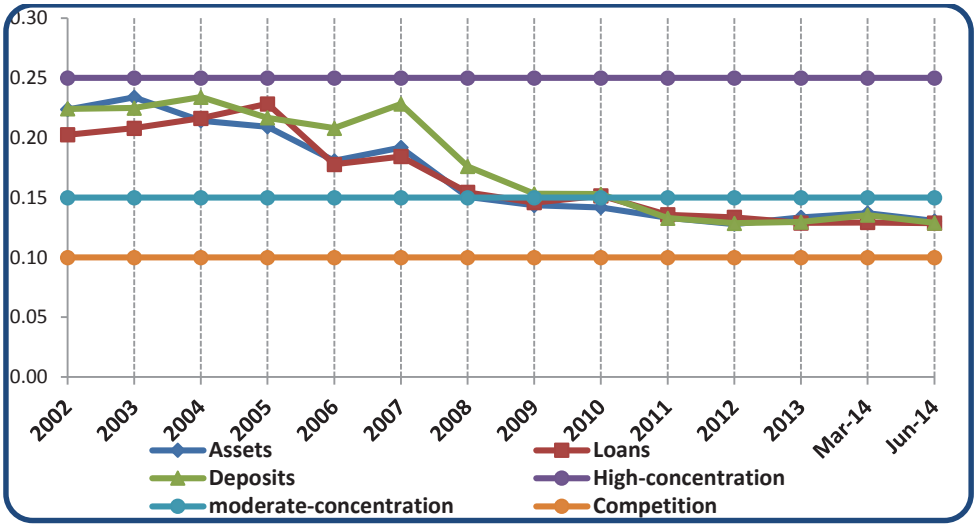
Source: *Authors' calculations*

3.2. Competition among banks

As shown by the figure below, the commercial banking sector competition has improved over time. The HHI that is below 0.01 implies higher competition while when the HHI is below 0.15, then the market is un-concentrated. When the HHI is between 0.15 and 0.25, there is moderate concentration and when the HHI is above 0.25, there is high concentration.

Since around 2008 up to present, the market is less concentrated (oligopolistic) and approaching high competition. This improvement in competitiveness is due to entry of new banks (including foreign-owned ones) in the banking industry and the extension of bank network across the country.

Figure IX: Evolution of banking sector competition



Source: *BNR, Monetary Policy and Research Department*

4. METHODOLOGY

4.1. Theoretical Considerations

Empirical literature shows that two approaches have been used to study the determinants of interest rate spread. The first is the accounting identity framework which breaks up the balance sheet of banks into different components to show key contributors to the spread. This approach is however useful for descriptive analysis.

The second is the dealership or profit maximization model developed by Ho and Saunders (1981) and further developed by, among others, McShane and Sharpe (1985), Allen (1988) and Angbazo (1997). This model views banks as optimizing agents in the credit market acting as intermediaries between the demand and supply of funds. Given the cost outlay, the bank seeks to attain the highest possible profit margin. Banks receive deposits at random intervals, which they use to satisfy stochastically received loan requests. The dealership model is an extension of the firm theoretical or micro-model which is originally based on the approach of Klein (1971) and Monti (1972) and further developed by Zarruck (1989) and Wong (1997). The firm theoretic model assumes that banks operate in a static framework where the demand and supply for loans and deposits clears both markets. The profit maximization model considers all the behavioral assumptions of the banking firm and is therefore used to derive behavioral equations that can be estimated using econometric techniques (Demirgüc-Kunt and Huizinga 1999, Randall 1998, Barajas et al. 1999).

Given the fact the accounting identity framework is mainly used for descriptive analysis, this paper uses the second approach to enable econometric estimation of the model relating the spread to its various determinants not limited to items of the bank balance sheet.

These determinants include bank-specific characteristics, characteristics of the banking sector and indicators of macroeconomic instability.

4.2. Empirical Model

In this paper, we adopted the empirical model developed by Martinez Peria and Mody (2004) in which interest rate spread is hypothesized to be a function of bank-specific variables, bank industry-specific variables, and the macroeconomic environment.

We used quarterly panel data for six commercial banks (BK, BCR[13], ECOBANK, BANCOR, COGEBANQUE and FINABANK[14]) from the first quarter of 2004 to the first quarter of 2012. KCB Rwanda Ltd started operations in Rwanda in December 2008, while Banque Populaire du Rwanda upgraded from being a cooperative bank to a commercial bank in 2008 and Equity bank joined Rwanda's financial market in 2012. Due to this these three banks were excluded from the sample.

After carrying out panel data augmented dickey fuller unit root tests (see appendix), we estimated the following model:

$$spread_{it} = b_0 + b_1 dcredit\_risk_{it} + b_2 logoc_{it} + b_3 Size_{it} + b_4 Market\_share_{it} + b_5 inflation_t + e_{it} \quad \text{.....(1)}$$

Where:

i= 1… 6 (number of banks);

t= from first quarter of 2006 to the first quarter of 2012.

[13] BCR has been renamed to I&M bank

[14] FINABANK has been renamed to GT bank

ε is the white noise error term, capturing all other factors that might influence interest rate spread but not included in the model above.

Spread is the interest rate spread, defined as the difference between the lending and deposit rate.

logoc is the logarithm of operating costs. Operating cost (oc) is the ratio of personnel charges and noninterest expenses to total assets. According to Lerner (1981) banks with higher operating costs are expected to have higher interest spreads. Consequently, a positive sign is expected.

Size is the share of each bank's assets in total assets of commercial banks. Bank size is used as a proxy for the average size of operations of a particular bank (Ayesha Afzal, Nawazish Mirza, 2010). The dealership model predicts that the unit margins are an increasing function of the average size of operations. The justification is that, for a given value of credit risk and of market risk, an operation of greater size would mean a greater potential loss, so the bank will require a greater margin. As a result a higher operation size reflects higher economic costs in case of default. A positive sign is expected. However, in relation to the economies of scale, bank size can have any size.

Credit risk is measured as the ratio of net loans to total assets. According to the dealership model, as the probability of defaults on loans increases, the bank margins rises to compensate for the losses. Similarly, the micro-model (see Wong, 1997) stipulates that, as the probability of defaults rises, the optimal interest margin increases. Consequently, high default risk may lead wider interest spreads. Hence, a positive relationship is expected.

Market power is measured by a bank's market share of either loans (msh_loans) or deposits ($msh\_deposits$). Banks with greater market share are likely to enjoy more market power (Norris and Floerkemeier, 2007). Banks dominating the banking system may collude to exercise market power, leading to augmented interest rate spreads and supernormal profits. On the contrary, even if they do not collude, greater market power will result in higher spreads on a standalone basis. The market share is expressed in percentages, calculated as follows:

$$msh\_loans = \left(\frac{loans_{it}}{\sum_{i}^{n} loans_{it}} \right) * 100 = s_i(loans) \quad \text{.....(2)}$$

$$msh\_deposits = \left(\frac{deposits_{it}}{\sum_{i}^{n} deposits_{it}} \right) * 100 = s_i(deposits) \quad \text{.....(3)}$$

The market share for a commercial bank therefore ranges from 0% to 100%, the latter being an upper bound, an extreme at which one bank would be taking the lion's share.

Inflation and bank spreads are thought to be related to relative price changes. If inflation is not anticipated, bank assessments may not be truthful and may yield high liquidity, and credit risk. An increase in inflation deteriorates the net present value of future cash flows and therefore erodes the real value of money reserves and ultimately increases the solvency risk of banks (Thorsten Beck and Heiko Hesse, 2006).

Indeed, high inflation rates are generally associated with high loan interest rates, and therefore, high incomes (Samy Ben Naceur, 2003). Thus, inflation and interest rate spread are positively related. Finally, logprov is the logarithm of provisions for doubtful debts and this is also expected to positively affect spread.

Since we used panel data, three sets of models were estimated and compared in order to choose for the one that best captures realities of interest rate spreads among Rwanda's commercial banks.

In the first place, we assumed individual random effects to take heed of some random shocks thought to be significant in the explanation of the endogenous variable and have affected certain banks and not others at precise periods, for example the reorganization and the recapitalisation of FINABANK and BCR which took place in 2004. The random effects model is defined as:

$$spread_{it} = \beta X_{it} + u_{it} \quad \text{.....(4)}$$

Where: $u_{it} = \alpha_i + \varepsilon_{it}$, X_{it} stands for a set of bank characteristics, market/industry as well as macroeconomic variables. u_{it} is the between-entity error while ε_{it} is the within-entity indicator.

For $i = 1, N$ and $t = 1, T$. Let $E(\alpha_i) = E(\varepsilon_{it}) = 0$, $Var(\alpha_i) = \delta_\alpha^2$, $Var(\varepsilon_{it}) = \delta_\varepsilon^2$ and $E(\alpha_i, \varepsilon_{it}) = 0$

The presence of α_i leads to serial correlation in the u_{it}, $E(u_{it}, u_{is}) = \delta_\alpha^2$ for $t \neq s$; thus, failure to account for α_i leads, at a minimum, to incorrect

standard errors and inefficient estimation. If α_i is correlated with X_{it}, failure to account for α_i leads to heterogeneity (omitted variables) bias in the estimate of β.

The presence of random effects is tested using the Breusch-Pagan LM test (whose statistic follows the chi-square distribution with one degree of freedom) stated as:

$$LM = \frac{NT}{2(T-1)}\left[\frac{\sum_N\left(\sum_T \varepsilon_{it}\right)^2}{\sum_N\sum_T \varepsilon_{it}^2}\right]^2 \quad \text{.....(5)}$$

Secondly, we assumed the fixed effects model basing on the premise that something within the individual entity/bank may impact or bias the predictor or outcome variables and we need to control for this. This is the rationale behind the assumption of the correlation between the entity's error term and predictor variables. Fixed effects remove the effect of those time-invariant characteristics from the predictor variables so we can assess the predictors' net effect.

The fixed effects model is stated as:

$$spread_{it} = \beta_1 X_{it} + \alpha_i + u_{it} \quad \text{.....(6)}$$

Where: X_{it} stands for a set of bank characteristics, market/industry variables as well as macroeconomic variables. u_{it} is the between-entity error, α_i represents coefficients on a set of dummy variables indicating membership in cross-sectional unit i. To test for presence of fixed effects, the F test is used to test joint significance of the included dummy variables. In effect, we have 6 cross-sections then we test for fixed effects by testing the hypothesis that

$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6$ which is simply a joint significance test of individual characteristics.

Lastly, the pooled model assumes that there is perfect homogeneity between all six commercial banks (intercepts and slopes are similar). All banks are assumed to have similar coefficients (slopes and intercepts) such that observations for each bank are stacked together. The pooled model is as stated below:

$$spread_t = \beta_1 X_t + \alpha + u_t \quad \text{.....(7)}$$

Where: X_t stands for a set of bank characteristics, market/industry variables as well as macroeconomic variables. u_t is the between-entity error. To test for poolability, a comparison of the pooled model (the restricted model) and either the random effects model or fixed effects model (the unrestricted model) can be made using the restricted F test which is stated as:

Where: RSS is regression sum of squares and "df" refer to the degrees of freedom, while "j" is the number of restrictions (also equivalent to the difference between the number of coefficients for the restricted and unrestricted model). To choose between the fixed effects model and the random effects model, the Hausman test (H) is often used and appears as below:

$$H = \left[\hat{\beta}_{FE} - \hat{\beta}_{RE}\right]' \left[Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})\right]^{-1} \left[\hat{\beta}_{FE} - \hat{\beta}_{RE}\right] \quad \text{.....(9)}$$

This statistic follows a chi-square distribution with k-degrees of freedom, where k refers to the number of extra coefficients in the fixed effects model.

Given that GMM estimates are more efficient and mindful of the persistence of higher interest rate spreads during the sample period, we compare the results of the fixed effects model with those of the dynamic panel data regression (Arellano-Bond estimation). The latter enables the use of the lagged dependent variable as one of the explanatory variables to account for persistence.

5. PRESENTATION AND INTERPRETATION OF RESULTS

During this study, we estimated the random effects model and tested the null hypothesis of no random effects.

The Breusch-Pagan LM test for random effects gave a chi-square value of 0.0 and a p-value of 1.0, thus we did not reject the null hypothesis and concluded that there are random effects. We then estimated the fixed effects model and tested for the presence of fixed effects (or joint significance of dummy variables).

The F-statistic obtained was 5.12 with a p-value of 0.00, thus rejecting the null hypothesis and conclude that there are fixed effects. To choose between the fixed effects model and random effects model, we used the Hausman test and got a chi-square value of 4.61 and a corresponding p-value of 0.4657 implying that the fixed effects model is as good as the random effects model since there are no systematic differences between the two models.

We then compare results of the fixed effects and random effects model with the GMM results (Arellano-Bond linear dynamic panel-data estimation).

The results are presented in the table below:

Table III: Estimation results

Variables	Random effects	Fixed effects	GMM: Arellano-
Logoc	0.67***	0.78***	0.52***
Credit risk	2.52**	1.89	2.08*
Inflation	0.12***	0.12***	0.12***
msh_deposits	0.02	-0.04	0.40**
Intercept	-2.76	3.71*	-2.92
Spread(lag)			0.36***

*, **, *** Imply significance at 10%, 5% and 1% respectively

Source: *Authors' estimation*

Basing on the Arellano-Bond results, as credit risk increases, commercial banks raise their interest rate spreads as a hedge against such risks. Rwandan commercial banks also adjust interest rates in response to the general macroeconomic conditions. Inflation which measures macroeconomic instability positively influences the spread. Other factors influencing spread are market power, measured by the market of deposits and the lagged term of interest rate spread. The latter implies that it takes time for commercial banks to sort out the structural problems, such as higher operating costs, in order to reduce interest rates.

The moderate effect of inflation on the interest rate spread is perhaps due to the fact that inflation has for a long time been maintained at moderate levels and therefore less influential in the formation of expectations by economic agents. Results also show that the lag of spread positively and significantly

influences the current period's spread implying that it takes time for commercial banks to sort out the structural problems, such as higher operating costs, in order to reduce interest rates.

Being a GMM estimator, the Arellano-Bond gives the most efficient results for panel data. We present results below, with different measures of market power: Market share in both loans and deposits markets respectively.

Table IV: Estimation results with different measures of market share

Variables	**With msh_loans**	**With msh_deposits**
Logoc	0.53***	0.52***
Credit risk	2.43**	2.08*
Inflation	0.10***	0.12***
msh_deposits		0.40**
msh_loans	-0.09*	
Intercept	-2.02	-2.16
Spread(lag)	0.36***	0.36***

*, **, *** Imply significance at 10%, 5% and 1% respectively

Source: *Authors' estimation*

In both models, operating costs, credit risk, inflation and the lag of the spread positively influence the spread. Results differ for market power (measured by market shares in the loans and deposits markets) and bank size. Intuitively, the model with market share in the loans market gives better results in a sense that transactions involving bigger loans are always granted at relatively lower lending rates.

6. CONCLUSIONS AND POLICY IMPLICATIONS

This paper builds on a study by Kigabo and Barebereho (2007) who hypothesized that interest rate spread in Rwanda depends on non-performing

loans, provisions for doubtful debts, over-head costs, bank size (measured by bank assets), deposit market share, deposit market concentration and inflation.

Kigabo and Barebereho (2007) found that interest rate spreads in Rwandan commercial banking sector were mainly influenced by deposit market share, and provisions for doubtful debts. Using bank level quarterly data, our findings confirm that risks associated with lending out funds affect the spread. Both operating costs and credit risk significantly and positively affect interest rate spreads in Rwanda's commercial banks. Other variable found to be responsible for pushing up spreads in Rwanda is inflation although its effect is moderate. This may indicates that by achieving low and stable inflation in recent years, BNR's monetary policy has become more credible and effective, thereby making inflation less influential in the formation of expectations by economic agents and banks pricing less prone to inflation movement. The insignificance of market power is an indication that price-based competition has improved over time among Rwanda's commercial banks.

Given that the spread is an important link in monetary policy transmission and ideally spread movement should in some way reflect monetary policy decisions, the findings above imply that banks need to adopt consolidation and cost minimization strategies but also make use of the technological innovations to help in lowering operational costs and improving operational efficiency. The findings also show that credit risk increases spread. Banks should devise mechanisms to screen out potential defaulters to help reduce loan defaults. Indeed, a strong credit reference bureau, used and accessed by

all banks, is a valuable tool to provide information about potential borrowers as it would help reduce information asymmetries in the commercial banking industry. Banks should strengthen their credit management strategies to help reduce credit risk.

Finally, appropriate monetary and fiscal policy measures are should also be sustained in order to maintain stability in prices and the general macroeconomic environment. In the wake of rising inflation, coordination of monetary and fiscal policy as well as other policies can be pursued to help attain the low and stable inflation objective. Narrowing down the interest rate spread will enhance effective monetary policy transmission by improving the interest rate pass through.

REFERENCES

Afanasieff, T.S. and Villa Lhacer, P.M. 2002, "The Determinants of Bank Interest Spread in Brazil," Banco Central do Brazil, Working Paper Series 46

Ahokpossi, C. 2013, "Determinants of Bank Interest Margins in Sub-Saharan Africa," IMF working paper, WP/13/34. (Washington: International Monetary Fund).

Allen, L. 1988, "The determinants of bank interest margins: a note," *Journal of Financial and Quantitative Analysis*, 23, 231-235.

Angbazo, L. 1997, "Commercial bank net interest margins, default risk, interest-rate risk, and off-balance sheet banking," *Journal of Banking and Finance*, 21, 55-87.

Ayesha A. and Nawazish M. 2010, "The Determinants of Interest Rate Spreads in Pakistan's Commercial Banking Sector," Center for Research in Economics and Business Working Paper

Barajas A., Steiner R. and Salazar N. 1998, "Interest rate spreads in Banking: costs, financial taxation, market power, Loan quality in the Columbian case 1974-96," IMF working paper, WP/98/110(Washington: International Monetary Fund).

Bawumia, M. , Belnye, F and Ofori, M.E. 2005, "The Determination of Bank Interest Spreads in Ghana: An Empirical Analysis of Panel Data," Working paper, WP/MPAD/BOG-05/09.

Beck, T and Heiko, H. 2006, "Bank efficiency, ownership and market structure why are interest spreads so high in Uganda?" retrieved from: http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-4027.

Ben Naceur, S. 2003, "The determinants of the Tunisian banking industry profitability: panel evidence," retrieved from http://www.mafhoum.com/press6/174E11.pdf.

Brock, P. L. and Rojas-Suarez, L. 2000, "Understanding the behavior of bank spreads in Latin America," *Journal of Development Economics*, 63, 113-134.

Chortareas, G.E., Garza-Garcia, J.G. and Girardone, C. 2004, "Market Structure, Profits, and Spreads in the Mexican Banking Industry". Working Paper Series (ISSN 2041-1596), Paper Number: 09/09.

Corvoisier, S. and Gropp, R. 2001, "Bank concentration and retail interest rates," European Central Bank Working Paper N 72.

Crowley, J. 2007, "Interest Rate Spreads in English-Speaking African Countries," IMF working paper, WP/02/6. (Washington: International Monetary Fund).

Dabla-Norris, E. and Floerkemeier, H. 2007, "Bank Efficiency and Market Structure: What Determines Banking Spreads in Armenia?" IMF working paper, WP/07/134. (Washington: International Monetary Fund).

Demirguc-Kunt, A. and Huizinga, H. 1998, "Determinants of commercial bank interest margins and profitability: some international evidence," retrieved from: www.elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-1900.

Dick, A. 1999, "Banking Spreads in Central America: Evolution, Structure and Behavior," Development Discussion Papers, Central America Project Series. Development Discussion Paper No. 694

Gambacorta, L. 2004, "How do banks set interest rates? " NBER working paper N 10295.

Gambacorta, L. 2005, "How do banks set interest rates? " Bank of Italy Working paper N 542, retrieved from: www.ideas.repec.org/p/bdi/wptemi/td_542_05.html.

Gelos, G.R. 2006, "Banking Spreads in Latin America," IMF working paper, WP/06/44. (Washington: International Monetary Fund)

Georgievska, L., Kabashi, R., Manova – Trajkovska, N. Mitreska, A. and Vaskov, M. 2011, "Determinants of lending interest rates and interest rate spreads," Discussion paper, Bank of Greece

Goldmark, S.1987, Financial Sector Review of Rwanda; Conducted under a subordinate agreement to Michigan State University pursuant to the Rwandan Employment and policy Analysis Project under Harvard University/ Michigan State University Subcontract Agreement DAN-5426-C-00-4098-00

Grenade, K.H.I. 2007, "Determinants of commercial banks interest rate spreads: some empirical evidence from the Eastern Caribbean Currency Union," ECCB working paper series, WP/07/01

Ho, T. S. Y. and Saunders, A. 1981, "The determinants of bank interest margins: theory and empirical evidence," *Journal of Financial and Quantitative Analysis*, 16, 581-600.

IMF 2011. Rwanda: Financial System Stability Assessment, IMF Country Report No. 11/244

Kashyap, A.K. and Stein, J.C, 1999, "What Do A Million Observations on Banks Say About the Transmission of Monetary Policy? " retrieved from: web.mit.edu/jcstein/www/recall.pdf.

Khan, M.H. and Khan, B. 2010, "What Drives Interest Rate Spreads of Commercial Banks in Pakistan? Empirical Evidence based on Panel Data". SBP Research Bulletin, Volume 6, Number 2, 2010

Khawaja, Musleh-ud, I. 2007, "Determinants of Interest Spread in Pakistan". Pakistan Institute of Development Economics (PIDE) Working Papers, 2007:22

Khumalo, S. , Olalerakan, Y.D and Okurut, F.N. 2011, International Journal of economics and business studies. Vol. 1, no.1

Kigabo, R.T. and Barebereho, J. 2007, "Determinants of banking interest rate spreads in Rwanda". *Economic Review n° 002*, National Bank of Rwanda

Klein M.A. 1971, "A theory of the banking firm", *Journal of Money, Credit, and Banking*, 3, 205-18.

Kosmidou, K., Tanna, S. and Pasiouras, F. 2002, "Determinants of profitability of domestic UK commercial banks: panel evidence from the period 1995-2002," retrieved from http://repec.org/mmfc05/paper45.pdf.

Kujeri, M.K and Younus, S. 2009, "An Analysis of Interest Rate Spread in the Banking Sector in Bangladesh". *The Bangladesh Development Studies*, Vol. XXXII, No. 4

Lerner E. 1981, "Discussion: The determinants of bank interest margins: theory and empirical evidence", *Journal of Financial and Quantitative Analysis*, 16, 601-2.

Martinez Peria, M.S. and Mody, A. 2004, "How Foreign Participation and Market Concentration Impact Bank Spreads: Evidence from Latin America," *Journal of Money, Credit and Banking*, 36(2), 511-537.

McShane, R. W. & Sharpe, I. G. 1985, "A time series/cross section analysis of the determinants of Australian trading bank loan/deposit interest margins: 1962-1981", *Journal of Banking and Finance*, 9, 115-136.

Mlachila, M. and Chirwa E. W. 2002, "Financial reforms and interest rate spreads in the commercial banking system in Malawi," IMF working paper WP/02/6. (Washington: International Monetary Fund)

Monti M. 1972, "Deposit, credit and interest rate determination under alternative bank objectives," in G.P. Szego and K. Shell (eds.), Mathematical Methods in Investment and Finance, North Holland, Amsterdam.

Ngugi R. W. 2001, "An empirical analysis of interest rate spread in Kenya." AERC Research Paper 106.

Njuguna S. N. and Ngugi, R.W. 2000, "Banking Sector Interest Rate Spread in Kenya." KIPPRA Discussion Paper No 5.

Ramful P. 2001, "The determinants of interest rate spread: empirical evidence on the Mauritian banking sector", Bank of Mauritius. Retrieved from https://www.bom.mu/pdf/Research_and_Publications/Research_Papers/spread.htm

Randall, R. 1998, "Interest rate spreads in the Eastern Caribbean, " IMF working paper. WP/98/59. (Washington: International Monetary Fund).

Rebei, N. 2014, "Determinants of Interest Rate Spreads in Solomon Islands," IMF working paper. WP/14/105. (Washington: International Monetary Fund).

Samuel, W. and Valderrama, L. 2006, "The Monetary Policy Regime and Banking Spreads in Barbados," IMF Working Paper 06/211 (Washington: International Monetary Fund).

Saunders, A. and Schumacher 2000, "The determinants of bank interest rate margins: an international study", *Journal of International Money and Finance*, 19, 813-832.

Seetaram Navneet, Seetanah Boopen, Rojid Sawkut , Ramessur Shalinia, and Seetanah Binesh (2007). "Interest rate spread determination in an error correction model," retrieved from http://www.melbournecentre.com.au/Finsia_MCFS/2009/Papers%20for%20website/1_Seetanah_Interest%20rate%20spread.pdf.

Tennant D. and Folawewo A. 2006, "Macroeconomic and market determinants of banking sector interest rate spreads: empirical evidence from low and middle income countries, "retrieved from https://sta.uwi.edu/conferences/salises/documents/Tennant%20%20D.pdf.

Valverde, C.S., Fernandez, F.R. 2007, "The determinants of bank margins in European banking", retrieved from: www.ugr.es/~franrod/CarboRodJBF.pdf.

Wong, K. P. 1997, "On the determinants of bank interest margins under credit and interest rate risks," *Journal of Banking and Finance*, 21: 251–271.

Zarruck, E., 1989, "Bank margin with uncertain deposit level and risk aversion," *Journal of Banking and Finance*, vol. 13, 797-810.

National Bank of Rwanda
KN 6 AV.4
P.O. Box: 531 Kigali, Rwanda
Tel, (+250) 788 199000
E-mail: info@bnr.rw
Swiftcode: BNRWRWRW
Twitter: @BnrInfo

Printed by Prograph Ltd