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Foreword

The bi-annual publication of the economic review is intended to avail information to the public on economic matters, focusing on features and challenges of the Rwandan economy. This 12th volume of the NBR economic review consists of five papers, with topical issues related with improving the understanding of monetary policy challenges in Rwanda, in Region and developing mechanisms to facilitate the transition towards a more modern forward-looking monetary policy framework. The papers aim at providing concrete evidence-based analysis and policy recommendations that can help to improve the effectiveness of monetary policy in Rwanda.

The review starts with a paper that analyzes the determinants of interest rate spread in Rwanda. The paper notes that the deposit rate has been more volatile than the lending rate mainly due to the fact that the deposit market is driven by large depositors who have negotiating power and also due to the emergence of other investment opportunities, such as the treasury bills. The deposit rates are also more responsive to economic activities given that the latter affects the balance sheets of depositors. In addition to the cost of funds, the rigidity in the lending rate is driven by operating costs, loans' market concentration and credit risk (loan loss provisions). Finally, the study concludes that the interest rate spread is positively related with operating costs, credit risk and market power in the loans market but is inversely related with the treasury bills rate. Policy recommendations from this study include putting in place measures to increase savings mobilization and complementing bank loans with alternative sources of financing, especially through capital markets development. There is also need to speed up the structural transformation of the economy to reduce the riskiness of some important sectors such as agriculture. Banks should reduce information asymmetry by using available facilities, such as the credit reference bureau, to screen potential borrowers. In addition, the NBR should facilitate borrowers to have access to information about reference lending rates for each bank as this increases their negotiating power.

Building on the first paper, the second paper dwells on explaining the determinants of nonperforming loans in Rwandan banking sector. To investigate these effects, the study applied econometric model estimation using fixed effect panel model that looked at both bank level and macroeconomic indicators over the period 2012Q1-2017Q2. The findings of the model estimation show that an increase in real growth of the economy, bank size, return on assets or growth of loans leads to a decrease of NPLs, while an increase in real interest rate, inflation or exchange rate depreciation leads to poor bank assets quality. Aiming to identify specific causes of loan defaults that may not be captured by econometric estimation, an interview to banks and

borrowers was also conducted. The survey revealed that the main causes of NPLs are loan diversion, as well as low capacity in project preparation and management

The third paper assessed the circumstances under which EAC member constituents can form an optimum currency area and therefore should opt for a single currency. The work reviews conditions for countries to qualify for suitable candidates to a currency union including the labor and capital mobility across the region, the openness to trade, the real shock synchronization, the nominal convergence which implies inflation, exchange and interest rates convergence, the fiscal adjustments or fiscal transfers in the case of asymmetric shocks among others. Results show, a general convergence of pairwise inflation, interest rate and exchange rate differentials toward Kenya, taken as benchmark country. However, income differences with Kenya remained large over time. Bearing in mind that convergence is never perfect but an issue that take time to be fixed, we check for real business cycles correlations over short periods of time to check for gradual convergence. Results point to positive but non-significant correlations between EAC per capita incomes pointing to persistent asymmetric shocks. We suggest that while working toward a monetary union, countries need to keep eyes on convergence criteria before stepping into a monetary union because the exit is too costly and very painful.

The fourth paper assesses the existence of second round effect from food and energy prices and evaluates the time extent of the shock of these prices on headline and core inflation. Using gap-model and impulse response function, findings showed no significant evidence of second round effect from food and energy inflation and that shocks from energy and food price are transitory. Hence, keeping other factors constant, monetary policy should not respond to food and energy shocks.

The last paper tests the forecast accuracy of different models via in-sample and out of-sample tests and proposes a methodology for Now-casting GDP in Rwanda, which is key for formulating monetary and fiscal policies. The paper tests the forecast accuracy for the current quarter (nowcast) and the following quarter (forecast) of two sets of models: Bridge Equations (BE) using single variables (high-frequency indicators of economic activity) in Auto-Regressive Distributed Lags (ARDL) estimations and Multiple Linear Equations (MLE) using up to three variables in OLS estimation. For both BE and MLE, we test five possible ways of combining forecast equations, each with different sets of weights.

We find that the combination enhances the accuracy of nowcasts and forecasts, as measured by six different measures of error. Moreover, combining again the combined BE estimate with the combined MLE estimate adds further to accuracy of both nowcasts and forecasts.

Comments and questions can be sent to the Director Monetary Policy and Research Department on kndahiriwe@bnr.rw or Monetary_Policy_Res_Group@bnr.rw , KN 6 Avenue 4, P.O Box 531 Kigali-Rwanda.

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Governor

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DETERMINANTS OF INTEREST RATE SPREAD IN RWANDA

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ABSTRACT

This paper builds on Kigabo and Barebereho (2007) and Karangwa and Nyalihama (2014) to update empirical analysis of the determinants of the interest rate spread, in addition to examining the determinants of the deposit rate and the lending rate in Rwanda. Using data for 2006q1-2017q1, random and fixed effects models for the deposit rate and lending rate are estimated while GMM is used for estimation of the interest rate spread model. Using descriptive analysis, the paper also highlights structural issues that can be dealt with to help reduce interest rate spread in Rwanda to the levels observed in middle income countries and therefore ensure that the financial sector efficiently contributes to the realization of Rwanda's development agenda.

The paper notes that the deposit rate has been more volatile than the lending rate mainly due to the fact that the deposit market is driven by large depositors who have negotiating power and also due to the emergence of other investment opportunities, such as the treasury bills. The deposit rates are also more responsive to economic activities given that the latter affects the balance sheets of depositors. In addition to the cost of funds, the rigidity in the lending rate is driven by operating costs, loans' market concentration and credit risk (loan loss provisions). Finally, the study concludes that the interest rate spread is positively related with operating costs, credit risk and market power in the loans market but is inversely related with the treasury bills rate.

Policy recommendations from this study include putting in place measures to increase savings mobilization and complementing bank loans with alternative sources of financing, especially through capital markets development. There is also need to speed up the structural transformation of the economy to reduce the riskiness of some important sectors such as agriculture. Banks should reduce information asymmetry by using available facilities, such as the credit reference bureau, to screen potential borrowers. In addition, the NBR should facilitate borrowers to have access to information about reference lending rates for each bank as this increases their negotiating power.

Keywords : Rwanda, interest rate spreads financial intermediation
JEL Classification : E43, E44, G21, O56

I. INTRODUCTION

Rwanda's financial sector has undergone rapid changes following the financial liberalization which started in early 1990_s but became full-fledged in 1995. Just like in many other countries, financial liberalization implied coming up with a number of financial sector reforms including, liberalization of interest rates and supporting the increased use of indirect monetary policy instruments (removal of credit ceilings and allowing interest rates and exchange rates to be market driven).

These reforms also include the progressive overhaul of the regulatory and supervisory system to facilitate financial market development. The commitment to a market-oriented financial system is aimed at opening up the domestic financial market, encourage entry of new banks, including foreign ones, and hence increase competition among banks, resulting into financial innovations and efficient financial intermediation. As result, the number of banks in Rwanda increased over time from 8 banks in 1995 to 18 banks in 2017, including 11 foreign banks, rising competition among banks, modernization of payment systems and improving financial inclusion. However, this has not contributed to reduce interest rate spread, which may be an indicator of inefficiencies in the banking sector (Kigabo & Barebereho 2007; Karangwa & Nyalihama. 2014).

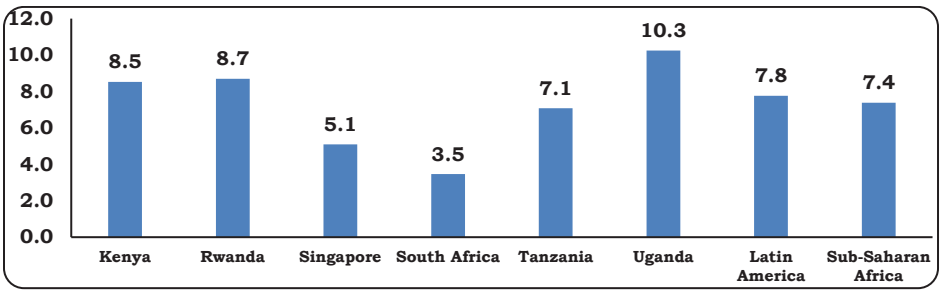
Proponents of financial liberalization thesis suggested that this would remove distortions from financial repression characterized by low savings and low investments and promote freer financial markets where credit is allocated according to market conditions (Arestis 2005). Indeed, with financial liberalization in most of Sub Saharan African countries, interest rates are market determined (Akinsola & Odhiambo 2017). Nevertheless, following implementation of financial liberalization policies, there have been numerous challenges including banking crises and widening interest rate spread in several Sub Saharan African Countries (Akinsola & Odhiambo 2017).

As the spread is defined here as the difference between the lending rates paid by borrowers to banks and deposits rate paid by banks to depositors/savers, high spread has implications on incentives to borrowers and savers and this may negatively affect their saving and investment decisions, thereby hampering financial system development. Conversely, reduction in spread is associated with financial depth (e.g. Rousseau, 1998) and developed financial system eases external finance constraints faced by economic agents and ultimately spur economic growth (Levine 2005).

Indeed, interest rate spread for Rwanda stood at 8.7% on average in 2006-2015, the second highest in the East African Community, after Uganda's

10.4%. These rates are quite high compared to those observed in economies with developed financial systems. For example, average interest rate spread stood at 3.5% in South Africa and 5.1% in Singapore during the same period. As Rwanda aims at becoming a middle income country, this will require higher and sustained rate of economic growth, supported among others by a developed and efficient financial system. On this, it is important that the level of interest rate spread supports financial sector development in Rwanda. For the last decade, interest rate spread in Rwanda has remained high as lending rates remained rigid.

Figure 1: Interest rate spread in selected countries (2006-2015 average)



Source: Based on financial structure database of Demirguc-Kunt and Levine, 2017

Rwanda's financial sector still faces structural challenges given that deposit/GDP ratio averaged 13.64% in 2006-2015 and credit/GDP stood at 13.79% while loan/deposit ratio at 99.63%. These numbers imply that the Rwandan banking system mobilizes less savings which limits their capacity to finance the economy. Indeed, numbers on overhead costs, interest rate spread and net interest margin indicate that Rwanda's banking sector is still facing some intermediation challenges.

Table 1: Financial structure and intermediation for selected economies (% average, 2006-2015)

	Liquid liabilities/ GDP	Private credit/GDP	Deposit/ GDP	Loans/Deposit	Overhead/Total earning assets	Spread	Net interest Margin
Kenya	41.82	29.81	37.51	79.43	5.79	8.50	7.99
Rwanda	16.04	13.79	13.64	99.63	7.99	8.69	9.54
Tanzania	21.56	11.14	17.88	62.11	5.70	7.10	7.51
Uganda	17.94	10.65	14.32	74.03	7.00	10.40	10.15
South Africa	42.17	70.20	59.56	117.80	2.99	3.50	3.06
Singapore	120.48	102.21	113.52	89.64	0.97	5.10	1.79

Source: Based on financial structure database of Demirguc-Kunt and Levine, 2017 update

High and rigid interest rate spreads indicate that the financial sector is less competitive, shallow and is still facing market risks, scale diseconomies and regulatory constraints. Persistently high interest spreads can constrain investment and growth through low savings, borrowing and investment. Cross country, industry level and country case analyses confirm that countries with higher levels of financial development experience better resource allocation, higher GDP per capita growth and low levels of poverty (Levine 1997; King & Levine 1993; Levine et al. 1999; Beck, Demirguc-Kunt et al. 2001).

The first paper about the same topic on Rwanda attributed high interest rate spread to lack of competition among banks, bank size, volume of non-performing loans and credit risk (Kigabo & Barebereho 2007). Later, Karangwa & Nyalihama (2014) blamed credit risk, high overhead costs and inflation for the persistence of high spreads in Rwanda. This study revisits the empirical analysis of the determinants of interest rate spread, in addition to the analysis of the factors driving the deposit and lending. Updating the analysis of the determinants of interest rate spread in Rwanda aims at taking note of the dynamic effects of financial sector reforms and increased financial liberalization as well as of recent macroeconomic developments, and propose policy recommendations to reduce the spread

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

II. LITERATURE REVIEW

The cost of intermediation is often approximated by use of interest rate spread and/or net interest rate margin, rendering the two terms to be interchangeable in most of the literature about the determinants of interest rate spread. Measurement of intermediation cost as the difference between average lending and deposit interest rates, however, has some empirical drawbacks since for a particular day, banks do not charge only one loan rate or pay a single deposit rate. For example, a weighted average lending rate masks a lot of information concerning interest charges by loan maturity, customer type and loan type/purpose. Moreover, it is not an uncommon

practice for banks to increase their revenues from loans and payments to depositors charging/paying fees and commissions. These fees and commissions, while not included as interest charged/paid, effectively increase the cost/revenue faced by bank borrowers/lenders (Brock & Rojas Suarez 2000).

As noted by Brock and Rojas Suarez (2000), the use of net interest margin, that is, the difference between a bank's interest earnings and expenses as a percentage of interest earning assets, as a proxy of intermediation cost has its own weaknesses as well. This definition does not take into account bank charges and income revenue associated with fees and commissions that, can effectively increase the costs paid by bank borrowers and reduce revenues received by depositors. An additional problem is that, by including all interest earning assets and liabilities, net interest margins may deviate significantly from the marginal spread that reflects the bank's marginal costs and revenues. This is particularly true in countries where banks hold non-interest bearing required reserves as well as a significant amount of low-yielding assets (largely government bonds). The concept is also subject to important misrepresentations when banks experiencing serious difficulties are allowed to capitalize themselves by issuing bonds to be bought by the government or the central bank at below market prices.

Because there is no easy way to deal with the measurement problems discussed above, this study opts to approximate the intermediation cost by using the ex-ante interest rate spread, defined as the difference between the weighted lending rate and the weighted deposit rate.

II.1. Literature on determinants of the lending and deposit rate

As profit maximizing agents, banks set interest rates on deposits and loans and incur costs for maintaining deposits and extending loans, all of which affecting their profit margins and interest rate spread in general. Therefore, to better understand the determinants of interest rate spread, it is necessary to start with the exploration of the determinants of the lending and deposit rates. While literature on interest rate spreads in low income countries is in plenty, literature on the determinants of deposit and lending rates remains scanty.

II.1.1. Literature on determinants of the lending rate

Using quarterly data from 2001 to 2006 for 13 banks, Villalpando and Guerrero (2007) focused on analysing whether there are significant differences in the way banks react to monetary policy shocks in Mexico. They conclude that higher real GDP and money market volatility lead to higher

lending rates while the effect from inflation is not significant. Concentration (proxied by share in total deposits) also lead to higher lending rate, in line with the structure performance hypothesis, which states that banks can use their market power to extract rents from their customers (Corvoisier & Gropp 2001; Berger & Hannan 1989) by setting less competitive prices, that is lower deposit rates or higher lending rates and this ultimately widens the spread. Various measures of bank efficiency were also considered but found to be not significant. Besides, banks with larger loans portfolio tend to charge lower loan rates and, finally, the monetary policy shock was found to affect positively and significantly the loan rate as well as the deposit rate. Meanwhile, Cihak (2004) focused on the factors behind lending rates and domestic spread in Croatia from 1993 to 2003 and concluded that bank size, liquidity and capital adequacy are associated with lower lending rates while nonperforming loans, domestic ownership, money market rate and deposit rates affect positively the level of lending rate. The positive effect from money market rate was also confirmed by Kauko (2005) for Finland. His results from OLS regression suggest that the main determinants of lending rate were found to be the money market rate, the bond rate, the bond rate volatility, the lending risks (measured by the rate of corporate bankruptcy), the business cycle and dummy variable for European monetary union era. The last two had a negative effect on lending rate while the remaining affected it positively.

Almost the same results were obtained by Georgievska et al (2011) in the case of Macedonia. Lending rate was mainly influenced by bank size, market structure, domestic policy rate, foreign interest rate and at a lesser extent deposits rates and nonperforming loans. These results were obtained from a panel estimation of a sample of 17 banks in the period between 2001 and 2009. Specifically, bank size were found to affect negatively lending interest rate as it was expected that increase in bank size would contribute to lower lending rates. Capital adequacy also has a negative impact. On the other side, deposit rates affect positively lending rates but with a coefficient lower than 1 implying an incomplete transmission from deposit rate to lending rate which may be explained by competition on the market. Besides, the positive impact from market share suggests that increase in concentration in domestic banking sector would cause increase in lending rates. Similarly increase in nonperforming loans lead to increase in lending rates.

Mohsin (2011) examined the degree of pass through from central bank rate to deposits and lending rate in Pakistan. Results from panel data from 2001 to 2011 indicate a low lending rate pass through in the long run while deposits rate pass through is absent in the long run and low in the short run, implying that impact of monetary policy on deposits and lending rates is limited in

Pakistan. This sluggishness in deposits rate has also been the case in Chile and Berstein and Fuentes (2003) attempted to investigate the factors behind. Using monthly data from 1995 to 2002, they found that stickiness of deposits rates increases with market concentration and banks specific characteristics such as solvency, credit risks and market share affect the adjustment of deposits rate to changes in policy rate.

For the case of Uganda, Willmott (2012) adopted a different methodology to identify the drivers of lending rates in Uganda; by decomposing the lending rates into funding costs (weighted average of deposit rate, interbank rate and rediscount rate), operational costs, capital reserve costs, risk costs and residuals. The funding cost which is cost faced by banks to raise the funds to lend is by far the largest driver of lending rates followed by the residuals which partially capture banks' profits, capital reserve costs and at a very low extent operational cost and risk costs. In addition the results show that there is a little competition among the 3 largest banks while among the medium sized banks, competition is more obvious.

II.1.2. Literature on determinants of the deposit rates

Kiser (2003) examined the case of US focusing on the impact from substitutability of different types of deposits and the conditions on the loan markets. The empirical results show that both bank risk, which affects its cost of wholesale funds, and local lending conditions, which influence the pricing of its output, affect retail deposit rates. The lower cost of wholesale funds lead to lower retail deposit rates, and that conditions in loan markets can feed back into deposit pricing. These results also suggest that banks with local market power are likely to pay lower deposit rates, confirming the importance of local competitive conditions. Variables considered include market power indicator (HHI), loan demand (per capital income, population density and unemployment rate), operating cost (median loan officer wage), operating risks (mortgage delinquency rates), retail deposits operating cost (the ratio of the expense of premises and fixed assets to the value of such assets, average salary per employee, and employees per branch), retail deposits supply (Per capita income, population density, and population) among others.

Also for the US, Rosen (2003) attempted to assess how the structure of local market and bank specific factors affect deposit rates in United States and from estimation of panel data from 1988 to 2000, he found that increase in concentration (measured by Herfindahl index) is associated with lower deposit

rates especially in urban markets. Increase in bank size on the other hand was found to be associated with higher deposit rates although as large banks increase their market shares, deposit rates are more influenced by market concentration. In this analysis, bank specific factors such as return on assets and nonperforming loans were taken into consideration. Bernstein (2003) also found that concentration affects deposits rate movement as higher concentration lead to sluggishness in Chile, while other variables like solvency, loan risks and size were also key determinants. However, the results obtained by Hannan and Prager (2004) were partially in contrast with those previously obtained by Rosen (2003) especially on the effect of the bank size on deposit rates. Here it is worthy to mention that the methodologies used were also different as Hannan and Prager (2004) used OLS to investigate factors explaining deposit interest rate offered by large multimarket banks in United States in the context of observed uniform rate for a given state or geographical area. The main findings are that larger banks offer lower deposits rate than smaller banks and banks which operates in more markets offer lower deposit interest rates than those operating in fewer markets. The latter is consistent with the negative relationship between concentration and deposits rates obtained by Rosen (2003).

For the case of Netherland, Vink (2010) confirmed that bank size affect negatively the deposit rates. He took into account several factors including market concentration, market power, bank size, bank capital, market rate, liquidity and operational inefficiency in order to investigate the determinants of deposit rates in Netherlands. Using panel analysis for the period 1995-2009, he found that bank size has a significant and negative effect on deposit rate while the market rate has a significant positive effect. Results obtained by Kauko (2005) using OLS for Finland data, also highlighted the positive effect of money market rate and bond rate on banks deposit rate. Again this positive effect of the money rate is confirmed by Villalpando and Guerrero (2007) for Mexico.

Among arguments supporting the negative relationship between bank size and deposit rates is that larger banks have generally access to cheaper wholesale fund from the larger organization (Hannan & Prager 2004) and that larger banks have relatively less pressure as they boast a large deposits base.

Lastly, Stesevic (2008) for Montenegro found that both lending interest rates and households' consumption affect positively the deposits rate while market capitalization had a negative effect. This is partially in accordance with the theory as an increase in household's consumption would imply less savings and less supply for deposits while increase in lending interest rate is an opportunity for banks to raise more money with a better remuneration.

II.2. Literature on determinants of interest rate spread

Literature categorizes the determinants of interest rate spread into four groups namely, bank specific characteristics (such as bank size, capital structure, management efficiency, ownership patterns, quality of loan portfolio, operational costs and share of liquid and fixed assets), market structure of the banking sector (especially the degree of competition or market share in the deposits and loans market), financial regulation by the central bank (reserve requirements, discount rate, deposit insurance funds, capital adequacy controls and interest rate ceilings) and macro-economic stability proxied by the general price level, exchange rate and GDP as a measure of economic activity (Dabla-Norris et al. 2007; Georgios E. et al. 2003; Ramful 2001; Beck & Hesse 2006; Njuguna S. & Ngugi 2000; Ngugi 2001, Chirwa & Mlachila 2002).

Size is usually measured by total assets (often in logarithm). Kashyap and Stein (2000) argued that banks size matters in lending behavior of banks in case of a monetary policy shock by raising the cost of capital to borrowers as the effect of a monetary tightening on bank interest rates should be more pronounced for small banks which finance themselves from deposits and equity. Bank size can be a proxy of inefficiency if it is not managed properly, thereby lead to high spreads (Hossain, 2010).

The 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 (Gambacorta 2005), implying that higher cost of intermediation or alternatively inefficiencies in the banking system would lead to higher lending rates, lower deposits rates and larger spread . Various studies have shown that operational inefficiency leads to higher costs of intermediation and therefore to higher margins (Ahokpossi 2013). There other cost factors which influence banks pricing behavior especially deposits rates are menu costs and switching costs resulting from durable relationships between banks and customers (Bernstein, 2003).

The efficiency hypothesis proposition is that smaller banks are likely to face higher overheads costs than larger ones due to economies of scale (Demirguc-Kunt & Huizinga 1999; Barajas et al. 1999; Brock & Rojas-Suarez 2000). The small market size in Rwanda implies that banks may possibly be operating well below their minimum efficiency scales, and hence cannot reap economies of scale. Banks in small markets tend to have higher operating costs than banks in larger developed markets (Randall 1998).

Liquidity, often measured by the ratio of cash and liquid securities to total assets, also affects the behavior of banks interest rates (Kashyap & Stein, 2000; Gambacorta 2004). Besides, Sorensen and Werner (2006) argue that banks with excess liquidity and banks that are less dependent on marked-based funding (measured as the ratio of deposits from non-banks to total liabilities) tend to adjust their interest rates more slowly, as they are relatively less sensitive to changes in market rates.

Credit risk focuses on the likelihood of borrowers failing to honour their loan obligations and this is exacerbated by inadequate legal systems, especially contract enforcements (Laeven & Majnoni 2005 and Demirgüç-Kunt et al. 2004) and informational infrastructure (Stiglitz and Weiss, 1981). The inefficient legal systems and information inadequacies do not only cause interest rates to be high, but will also crowd-out borrowers who would have obtained credit in a world without information asymmetries. In such circumstances, the creditor imposes a higher interest rate to compensate for the likelihood of some debtors defaulting.

Non-performing loans ratio is measured 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. The higher the non-performing loans, the more banks set aside loan loss provisions as a hedge against possible loan defaults. In line with their profit maximizing behavior, banks can only keep their profits high if they increase interest income and this is often done by raising the interest rate they charge on loan advances.

Liquidity mismatch or maturity mismatch is measured as short-term liabilities versus long-term assets and has a positive effect on short-term lending rate and a negative effect on deposits rate. According to Gambacorta (2005), the absolute values of the coefficients are greater in the case of lending rate, implying a stronger adjustment on credit contracts than on deposits. Since this can be interpreted as an increase in the costs for banks.

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 behavior. Well-capitalized banks face lower costs of borrowing and low risk of bankruptcy. As a result, well-capitalized banks should charge lower margins (Ahokpossi 2013). Moreover well-capitalized banks set deposit prices less competitively. (De Graeve et al. 2004), implying that well capitalized banks should charge lower lending rate.

The structure of the markets within which commercial banks operate 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 & Gropp, 2001). 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.

Financial regulation increases credit risk and spread because it affects the banks' pricing behavior as the existing legal systems cannot adequately protect the creditors' rights and ensure efficient enforcement of loan contracts (Laeven & Majnoni 2005, Demirgüç-Kunt et al. 2004). In such circumstances, the creditor imposes a higher interest rate to compensate for the likelihood of some debtors defaulting.

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 the pricing behavior of banks.

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), implying that lending rates and deposits rates are negatively affected by economic growth. However Gambacorta (2007) argued that lending rate is positively affected by GDP growth. 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. For small open economies that are highly dependent on agriculture, a negative relationship is expected between real growth rates and the spreads since a slowdown in economic activities in the country can exert upward pressure on lending rates through its impact on banking profitability as a result of the deteriorating asset quality as many borrowers find it difficult to service their obligations (Mugume et al. 2009).

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, economic theory suggest that banks should consider money markets rates and policy rates as determinants of lending rate (Borio & Fritz 1995). 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.

Empirical studies on the determinants of interest rate spread are many. Hossain (2010) used panel data for 43 banks from 1990 to 2008 in Bangladesh and Chirwa and Mlachila (2006) used the alternative measure of spread for the case of Malawi, identified market power as a key determinant of interest rate spread. Dabla-Norris and Floerkemeier (2007) also found positive effect from market power on interest rate spread in Armenia using panel data from 2002 to 2006.

Non-performing loans ratio was also singled out as an important driver of interest rate spread. For instance, Were and Wambua (2012), using annual panel data from 2000 to 2001 for 33 banks in Kenya, and Nampewo (2012), using cointegration technique on quarterly data from 1995 to 2010 for Uganda, found a significant and positive effect of non-performing loans on interest rate spread. Other variables identified in these studies were policy rate, liquidity risks and costs for Kenya and policy rate, t bills rate and real GDP in Uganda.

Another key determinant of interest rate spread singled out in various studies is the operating costs. Randall (1998) used 2SLS on panel data from Eastern Caribbean Central Bank member countries between 1991 and 1996 and found that operating costs are the key determinant of the interest rate spread.

Though using net interest margin instead of spread, Ahokpossi (2013) also found that operating cost are associated with higher margins using a sample of 456 banks in 41 sub Saharan African countries. Proxies of risks such as exchange rate volatility and inflation volatility were found to positively affect interest rate spread in Uganda (Nampewo, 2012).

III. DYNAMICS OF DEPOSIT RATE, LENDING RATE AND INTEREST RATE SPREAD IN RWANDA

From a minimum of twelve (12) banking and non-banking institutions in 1995 to 507 as at June 2017 (BNR, August 2017), Rwanda's financial sector has become more diversified albeit still dominated by banks in terms of size as measured by the ratio of bank assets to total assets and asset to GDP ratio. The post-1995 financial sector developments are linked with the increased financial sector liberalization and ongoing efforts to increase financial inclusion and access to finance. There has been entry of new banks into the system, including those with foreign ownership and this is expected to continue pushing up competition among banks, with possible downside effects on the interest rate spread.

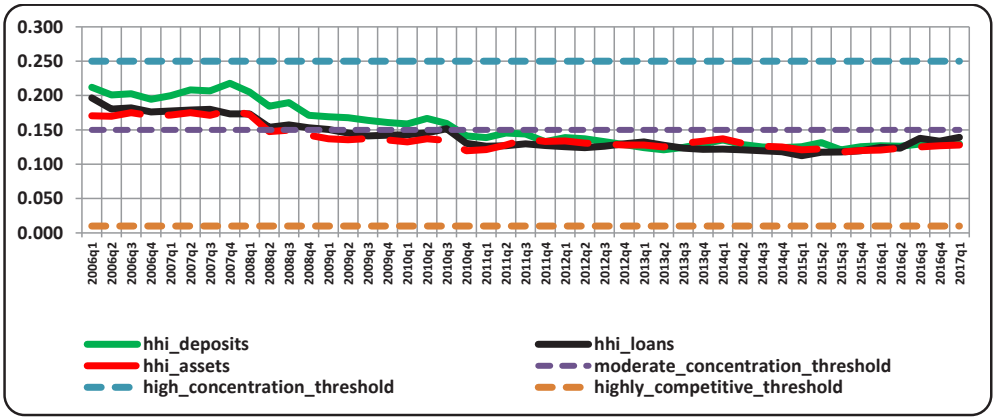
Table 2: Financial structure

Financial Sector	Number			Size(% of Total Assets)			Assets/GDP (%)		
	2010	2016	Jun-17	2010	2016	Jun-17	2010	2016	Jun-17
Banking sector	14	16	17	71.3	66.9	66.8	21.6	35.9	36.3
Insurance	8	15	16	10.2	9.7	9.5	3.2	5.5	5.2
Pension	1	1	1	14.8	17.1	17.2	6.4	9.4	9.3
MFIs	524	472	473	3.7	6.3	6.4	2.6	3.5	3.5
Total	**547**	**505**	**507**	**100**	**100**	**100**	**33.8**	**54.4**	**54.3**

Source: BNR, Monetary Policy and Financial Stability Statement (MPFSS, August 2017).

As a result, 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 un-concentrated (oligopolistic). This improvement in competiveness is due to entry of new banks (including foreign-owned ones) in the banking industry.

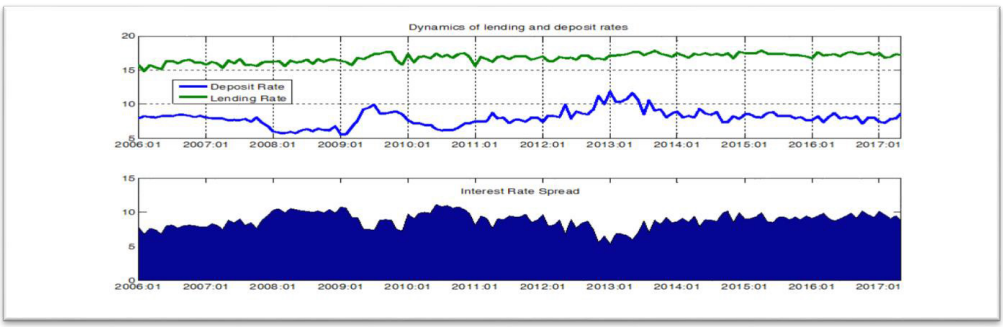
Figure 2: Evolution of banking sector competition



Source: Own calculations

Despite the observed positive impact of financial liberalization which led to less concentration on banking market, Rwandan data shows that the wedge between the average lending and deposit rate has consistently remained stuck at such a high level (figure 2) and this has raised concerns among various economic agents, including high profile policy makers. This is indeed a challenge given that Rwanda aims at becoming a middle income country and financial sector will be key in that journey by availing enough resources to economic agents and ensuring the financing of the economy in an efficient way.

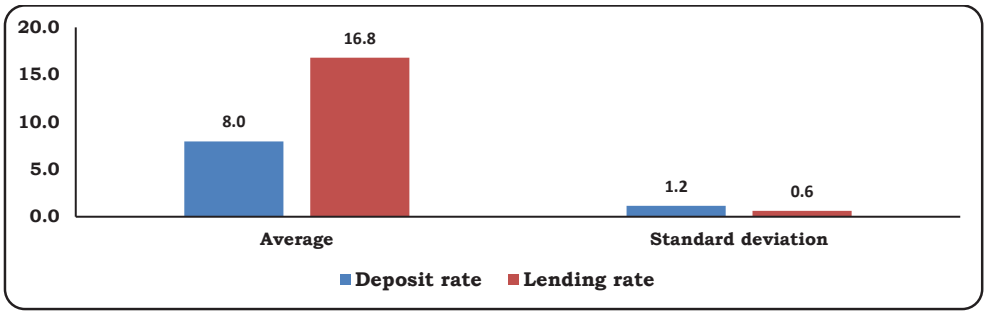
Figure 3: Interest rate spread



Source: BNR (2017)

Simple analysis of Rwandan data shows that while deposit rate have been relatively fluctuating and less elevated, lending rates have been rigid and quite high over the past. Indeed, **figure 4** shows that deposit rates have remained lower and more volatile, on average, compared to the lending rates.

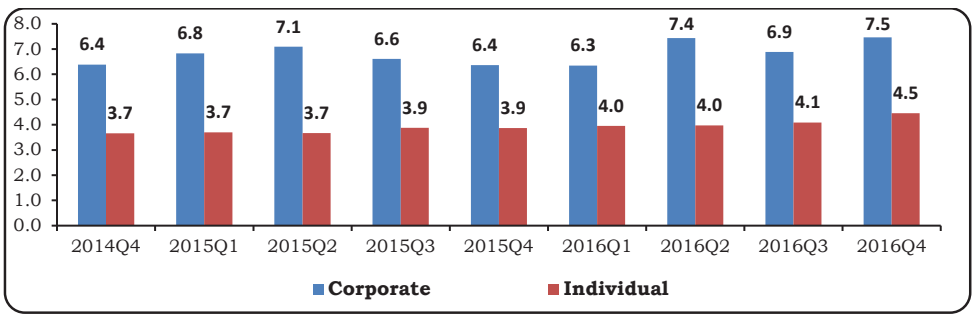
Figure 4: Dynamics in lending and deposit rates (Jan. 2006-Sept. 2017)



Source: BNR (2017)

The movements in the deposit rate can be influenced by many factors, such as the monopoly power of large depositors in the deposit market and prices of risk-free assets, such as the treasury bills rate. Recent data shows that corporate savers have been able to negotiate for a higher deposit rate compared to individual savers.

Figure 5: Deposit rate by category of savers



Source: BNR (2017)

This is because these corporates, composed of other financial institutions, social Security Funds, Public enterprises and other non-financial corporations, have the largest share in the deposit market, granting them power to negotiate for better rates.

Table 3: Share by category of depositors in total deposits in Rwanda banking sector

Category of depositors	2012	2013	2014	2015	2016	17-Sep
Institutions	50.4	52	54.3	55.2	52.2	54.9
Households and NPISH	49.6	48	45.7	44.9	47.8	45.1

Source: BNR (2017)

Consistent with the expectations, the T-bills rate and the deposit rate are positively correlated with a correlation coefficient of 0.52. This is because savers usually take note of the return on the risk-free asset before contemplating to put their money on a savings account. As government increases its domestic borrowing to finance the fiscal deficit, the treasury bills rate tends to rise. This in turn becomes a lucrative investment alternative for both corporates and individuals. For banks to continue attracting deposits, they have to increase the rates they offer to depositors, hence a positive correlation between the deposit rate and the treasury bills rate makes economic sense. As the deposit rate increases, the interest rate spread declines.

Regarding the lending rate, literature suggests that the deposit rate is the cost of funds and should therefore be positively correlated with the lending rate. As mediators between savers and borrowers, banks offer a certain savings rate to the depositors and then base on this and on other factors to price their loan advances. For the case of Rwanda, the correlation between the deposit and lending rate is indeed positive, albeit not so strong (0.28). This suggests that other factors, other than the cost of funds, could be responsible for keeping the lending rate at such elevated levels.

As expected, the interest rate spread and the lending rate are positively and strongly correlated (correlation coefficient of 0.54), implying that an increase in the lending rate leads to a proportionate increase in the interest rate spread, assuming that other factors remained constant. Conversely, the deposit rate and the interest rate spread are negatively correlated (correlation coefficient of -0.85), implying that an increase in the deposit rate contracts the spread, assuming the lending rate remains fixed.

Meanwhile, the banking sector in Rwanda faces other constraints notably related to low level of savings, resources mobilisation and reliance on lending activities as the main sources of income while banking financing to the economy is still low compared some neighbouring countries and middle income countries. By end 2016, private sector credit to GDP ratio in Rwanda stood at 19.4% whereas private sector loans to deposits ratio reached 0.90.

IV. METHODOLOGY

The empirical specifications of the determinants of banks' spreads have been based on the behavioral assumptions of the banking firm (Hannan & Liang 1993; Randal 1998; Barajas et al. 1999; Brock & Rojas-Suarez 2000; Saunders & Schumacher 2000). This study will therefore specify and estimate a behavioral equation relating the interest rate spread to its various

determinants. In addition, behavioral equations for the lending rate and the deposit rate are specified and estimated. All the three equations are specified as panel data fixed and random effects models and thereafter, the best model is chosen based on the Hausman test.

a. The interest rate spread model

Following Hannan and Liang (1993), Randal (1998), Barajas et al., (1999), Brock and Rojas-Suarez (2000), Mlachila M. et al. (2002), and Saunders and Schumacher (2000), the econometric model for the interest rate spread to be estimated is specified as follows:

$$spread_{it} = \beta_0 + \beta_1 \text{inflation}_{\ t} + \beta_2 \text{logoc}_{\ it} + \beta_3\ \text{msh\_loans}_{\ it} + \beta_4 log\_provision_{\ t} + \beta_5\ \text{tbills\_rate}_{\ t} + \varepsilon_{it}$$

Where:

i= 1… 6 (number of commercial banks);

t= from first quarter of 2006 to the first quarter of 2017.

$\mathcal{E}$ is the white noise error term, capturing all other factors that might influence interest rate spread but not included in the above model

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

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 (Beck & Hesse, 2006). Indeed, high inflation rates are generally associated with high loan interest rates, and therefore, high incomes (Ben Naceur 2003). Thus, inflation and interest rate spread are positively related.

Treasury bill rates are positively related to interest spreads as documented in Chirwa and Mlachila (2004), Brock and Rojas-Suarez (2000), Demirguc-Kunt and Huizinga (1999).

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.

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 (Dabla-Norris & 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:

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

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

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. For the present study we choose the market share of loans.

Logprov is the logarithm of loan loss provisions. According to Cihak (2004), higher NPLs mean higher loan loss provisioning, which increases costs for banks and is reflected in higher lending rates and spreads.

b. The deposit rate model

Following the aforementioned studies on determinants of deposits rate, we adopted the deposit rate model, taking into account variables used in other studies and the reality of the Rwandan economy. This econometric model is specified as follows:

$$\mathbf{deposit\_rate}_{it} = \alpha_1 + \alpha_2\, \mathbf{tbills\_rate}_{it} + \alpha_2 lrgdp_t + \alpha_3 logoc_{it} + \alpha_4 \mathbf{msh\_deposit}_{it} + \varepsilon_{it}$$

Where:

i= 1… 6 (number of banks);

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

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

Tbills_rate is measured as the average T-bills rate and is expected to positively affect the deposit rate as it is an alternative assets for economic agents.

Lrgdp is the log of real GDP. It is usually consistent with increase in demand for deposits and is expected to have a positive sign because as the economy grows there is a greater likelihood of an increase in Bank deposits. This especially true when a big number of the working population falls in the public sector employment (Boadi et al. 2015).

Logoc is the logarithm of operating costs. Operating cost (Oc) is the sum of personnel charges and noninterest expenses and it is expected that higher operating costs lead to lower deposits rate (Kiser, 2003).

Msh_deposits is the bank's market share in the deposit market, which is a measure of monopoly power. The increase in market share may result from the fact that banks offer higher deposits rates to attract deposits. This is consistent with the efficient structure hypothesis, which states that a concentrated structure increases the overall efficiency of the sector and banks price their deposits more competitively (Vink 2010).

c. The lending rate model

Similarly, following Cihak (2004), Kauko (2005) and Giorgievska (2011) and considering also the reality of the Rwanda economy, the next econometric model was estimated:

$$\mathbf{lending\_rate} = \boldsymbol{\delta_1} + \boldsymbol{\delta_2}\,\mathbf{log\,oc_{it}} + \boldsymbol{\delta_3}\mathbf{hhi\_loans_{it}} + \boldsymbol{\delta_4}\mathbf{deposit\_rate_{it}} + \boldsymbol{\delta_{11}}\mathbf{logprov_{it}} + \boldsymbol{\varepsilon_{it}}$$

Where:

Logoc is the logarithm of operating costs. Operating cost (Oc) is the ratio of personnel charges and noninterest expenses to total assets and is expected to have a positive relationship with the lending rat

Hhi_loans is the logarithm of the Herfindahl-Hirschman index for loans, which is a measure of competitiveness on loans market. It is expected to be associated with higher lending rate according to some empirical evidence (Cihak 2004).

Logprov is the logarithm of loan loss provisions. As previously explained, higher provisions increases costs for banks and is reflected in higher lending rates (Cihak 2004). *Deposit rate* is the weighted average deposits rate by banks and is expected to affect positively the lending rate (Georgievska et al 2011, Cihak 2004).

V. RESULTS

Before presenting estimation results from both fixed and random effects models for lending and deposits rates models and GMM for spread model, we first examine the stationarity of the variables to be included in the respective models. Using the Levin, Lin & Chu Panel data unit root test, we find that all variables, except the log of nominal exchange rate I (0). However, the log of the nominal exchange rate is also I(0) if the Harris-Tzavalis test is used. Consequently, all variables are included in the respective models in level form. All variables, except msh_loans, hhi_loans and msh_deposits, are found to be I(0) at 1%; hhi_loans is I(0) at 5% while msh_loans and msh_deposits are both I (0) at 10% significance level.

Table 3: Unit root tests

Variable	**Stationarity test**		**Test**
	Adjusted t* [z]	**Probability**	
Spread	-6.6	0.00	Levin, Lin & Chu
Logprov	-2.3	0.00	Levin, Lin & Chu
Logoc	-2.5	0.00	Levin, Lin & Chu
Inflation	-1.9	0.02	Levin, Lin & Chu
msh_loans	-1.5	0.07	Levin, Lin & Chu
Hhi_loans	-1.7	0.05	Levin, Lin & Chu
msh_deposits	-1.6	0.06	Levin, Lin & Chu
Tbills_rate	-1.9	0.03	Levin, Lin & Chu
Deposit_rate	-3.3	0.00	Levin, Lin & Chu
Lending_rate	-1.4	0.00	Levin, Lin & Chu
Logexch_nom	-33.4	0.00	Harris-Tzavalis
Lrgdp	-3.5	0.00	Levin, Lin & Chu

Source: Own calculations. Adjusted t* for Levin, Lin & Chu test; **z** for Harris-Tzavalis test

V.1. Empirical results for spreads, lending and deposits rate models

We present the results of GMM estimation of interest rate spread model for Rwanda. Given the positive relationship between the treasury bills rate and the deposit rate, the former is inversely related with the interest rate spread. Operating costs and provision have a positive effect on the interest rate spread, which is in line with the expectations and empirical findings in many other countries. While the treasury bills rate and operating costs are significant at 1%, Provision and market concentration are significant at 10% level of significance and inflation is not statistically significant.

Table 4: Interest rate spread models

	(1) Spread
L.spread	0.403*** (5.78)
Logoc	0.841*** (5.29)
msh_loans	-0.0542* (-1.87)
tbills_rate	-0.250*** (-4.01)
Logprov	0.204* (1.91)
Inflation	0.0204 (0.72)
N	195
R^2	

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The operating costs have a highly positive and significant effect on interest rate spread in Rwanda and this may be due to the fact that banks tend to shift the high cost of operations to their customers either in form of high lending rates or low deposit rates or both. Indeed, banks in small markets tend to have higher operating costs than banks in larger developed markets (Randall 1998). In Rwanda, operating costs are dominated by salaries, wages and staff costs, followed by other expenses which include losses on fixed assets and on forex transactions. Keeping other factors unchanged, operating

costs have the biggest impact on interest rate spread since a 1% increase in these costs results into about 0.8% increase in the interest rate spread.

A 1% increase in the treasury bills rate leads to 0.25% reduction in the interest rate spread, holding other factors constant. Although some empirical evidences in other countries have pointed out a positive relationship, in our case an increase in the Treasury bills rate tends to exert an up-ward pressure on deposits rate as some economic agents prefer to invest in government securities since they are highly risk free. Given that lending rate are relatively sticky, the upward movement in Tbills rate reduces the spread. Ngugi (2001) had also found this negative relationship in case of Kenya as in short run, Treasury bill rate co moved with deposit rate while the effect on lending rate was asymmetric. Higher provision as an indicator of higher risks perception lead to increase in interest rate spread. Besides, provisions are costs and more they increase, more banks adjust upward their lending rates and subsequently interest rate spread ceteris paribus.

More market power on loans market led to lower spread but the effect is trivial. Some studies such as Martinez Peria and Mody (2004) had rather found a different relationship as high concentration led to higher spread in case of Latin America.

Regarding the lending rate models, the Hausman test fails to reject the null hypothesis of no systematic difference between the coefficients of the fixed and random effects models, with chi2(4) = 2.23 and Prob>chi2 = 0.69. We therefore present the results of the two models for comparison purpose.

Table 5: Lending rate models

	(RE) lending_rate	(FE) lending_rate
Logoc	0.274**	0.288**
	(2.46)	(2.57)
hhi_loans	0.00161***	0.00181***
	(4.07)	(4.34)
deposit_rate	0.0677**	0.0671**
	(2.50)	(2.46)
Logprov	0.179***	0.180***
	(4.66)	(4.68)
_cons	12.56***	12.40***
	(14.84)	(16.33)
N	263	263
R^2		0.238

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As expected, operating costs has a positive impact on the lending rate as banks tend to minimize losses from these costs by raising their lending rates. Results show that a 1% increase in the overhead costs leads to about 0.3% increase in the lending rate, keeping other factors fixed. Operating costs are significant at 5%.

Loan loss provisions also have a significant positive impact on the lending rate. They are significant at 1% in both the fixed and random effects model. Estimations show that a 1% increase in the loan loss provisions leads to almost 0.2% increase in the interest rate spread in both models, keeping other factors constant.

Concentration in the loans market, measured by the hhi_loans, is also significant at 1% and positive as expected. However, its isolated impact on the lending rate is very minimal, implying that banks do not collude to set interest rates but rather face some kind of price-competition. As expected, the deposit rate, which is the cost of funds, has a positive and significant effect on the lending rate given that a 1% increase in the deposit rate leads to 0.06% increase in the lending rate, assuming other factors unchanged, and this effect is significant at 5%.

Though significant, the small coefficient on the deposit rate implies that the cost of funds is not a very big issue to blame for the rigidity in the lending rate. Similar to the lending rate model, the Hausman test for the deposit rate models fails to reject the null hypothesis of no systematic difference between the coefficients of the random and fixed effects model, with chi2(4) =5.45 and Prob>chi2 = 0.2438. In view of this, we present results of both models.

Table 6: Deposit rate models

	(FE) deposit_rate	(RE) deposit_rate
tbills_rate	0.494***	0.488***
	(8.71)	(8.56)
Lrgdp	3.461***	3.211***
	(3.36)	(3.20)
Logoc	-0.185	-0.271
	(-0.48)	(-0.71)
msh_deposits	0.128***	0.0681**
	(2.93)	(2.03)
_cons	-20.71***	-17.47***
	(-3.74)	(-3.32)
N	270	270
R^2	0.251	

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As expected the treasury bills rate, which is a risk-free asset, has a positive and significant effect on the deposit rate. In addition to being an alternative investment opportunity for depositors, the treasury bills is risk-free, making it more attractive. Thus, a 1% increase in the treasury bills rate leads to about 0.5% increase in the deposit rate.

Just like in Uganda and Ghana, GDP has a strongly positive and significant effect on the deposit rate. It indicates that once the economic grows there is a greater likelihood of an increase in bank deposits. For the case of Rwanda, a 1% increase in real GDP leads to more than 3% increase in the deposit rate, holding other factors constant.

VI. CONCLUSIONS AND RECOMMENDATIONS

In line with Rwanda's objective of transitioning to middle income status, this study uses middle income countries such as Singapore and South Africa as benchmarks, to identify some of the structural issues that influence the level of interest rate spread in Rwanda. Considered as the measure of bank intermediation (Sologoub, 2006) and of the cost of bank intermediation (Robinson, 2002), interest rate spread influences the mobilization of savings and optimal allocation of funds to productive investments which in turn determines the pace of economic growth.

Findings of the study show that interest rate spread remains high in Rwanda, just like in other developing economies. The study highlights that Rwanda is facing some structural bottlenecks such as the low level of savings mobilization, overdependence on loans from banks to finance investments, low level of deposit base and lack of alternative sources of financing due to shallow capital markets. Indeed, economic financing from banks remains low and mostly short-term in nature, given the low base of long-term deposits, lack of alternative sources of finance and the predominance of a large non-monetized informal sector, with risky sectors such as agriculture.

Empirical findings show that the increase in operating costs, market power in the loans market and loan loss provisions tend to increase the interest rate spread in Rwanda. Conversely, the increase in the treasury bills rate leads to a reduction in the interest rate spread given that it serves as an alternative investment opportunity to depositors, forcing banks to raise deposit rates in order to attract savings. Keeping other factors constant, this leads to the narrowing of the interest rate spread. In addition, the lag of the interest rate spread is also significant, indicating that the drivers of the interest rate spread, which are largely structural bottlenecks in Rwanda's financial sector, are quite persistent. The study also concludes that the observed rigidity in

the lending rates is influenced by operating costs, market power in the loans market and to some extent by the cost of funds. The dynamics in the lending rate is driven by availability of investment opportunities, in both real and financial assets, market power in the deposit market and the performance of the economy. The latter influences the balance sheets of economic agents, granting them the capacity to save in banks.

In view of the above findings, the study recommends that if Rwanda is to move to middle income status, there is need for banks to increase savings mobilization so as to raise deposit/GDP ratio to levels observed in middle-income countries. Continued implementation of sound macroeconomic policies can help to create an enabling environment for the realization of this agenda. The study also recommends the acceleration of capital markets development to complement the banking sector in availing investment funds to the economy and to help reduce overdependence on bank loans.

The study also recommends that measures to address structural challenges in the loans market need to be adopted. These include re-organization of important economic sectors, such as agriculture, to reduce their riskiness and thus ease their access to finance. Concerning individual borrowers, banks should efficiently use available facilities, such as the credit reference bureau, to ensure proper screening of borrowers. Borrowers should also be enabled to know the reference lending rates for each bank and this job can be done by the BNR as a regulator. In addition to this, banks need to improve on the capacity of their staff in terms of assessing loan applications to reduce financing of risky projects. Banks are also encouraged to be more innovative by tailoring their financial products to needs of their clients.

This study also affirms that the treasury bills rate has a positive and significant effect on the deposit rate and a negative effect on the spread, keeping other factors constant. This calls for continued efficient coordination between monetary and fiscal authorities to ensure efficient liquidity management.

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DETERMINANTS OF NON-PERFORMING LOANS IN RWANDAN BANKING SECTOR

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ABSTRACT

The study aimed at identifying the determinants of nonperforming loans in Rwandan banking sector by estimating a fixed effect panel model that looked at both bank level and macroeconomic indicators over the period 2012Q1-2017Q2.

The findings of the study show that an increase in real economic growth, bank size, return on assets or growth of loans leads to a decrease of NPLs, while an increase in real interest rate, inflation or exchange rate depreciation leads to poor bank assets quality. Aiming to identify specific causes of loan defaults that may not be captured by econometric estimation, an interview to banks and borrowers was also conducted. The survey revealed that the main causes of NPLs are loan diversion, as well as low capacity in project preparation and management. The study recommends banks to enhance appraisal and monitoring of projects, while borrowers need to be equipped in project preparation and management.

Key Words: Fixed Effect panel Model, Survey, Non-Performing loans, Banking Sector.

JEL Classification: C23, C42, C51, G21

1. INTRODUCTION

The importance of a resilient and healthy banking sector to a country's economic growth and development is well-established in economic literature. Efficient banking systems help countries to grow, partly by widening access to external finance and channeling resources to the benefitting sectors. They can do so, if banks generate the necessary income to cover their operational costs they incur in due course (Ongore & Kusa, 2013). However, in their business of lending, banks are faced with defaults by loan borrowers that result into non-performing loans (NPLs), a hindrance to the efficiency of banks activities. In fact, Beck et al. (2013), identified non-performing loans (NPLs) as one of the major factors contributing to credit risk for commercial banks and have been advocated by several financial authorities such as the European Banking Authority as a pillar one risk to the banking system. Studies have identified NPLs to have a detrimental impact on conduct of monetary policy and real growth of the economy through its negative effect on credit growth.

In Rwanda, non-performing loans (NPLs) are gradually above the National Bank of Rwanda (NBR) medium term target of 5 percent and have been identified as one of the major challenges contributing to credit risk for banking sector. As a measure of credit risk, NPLs ratio was counted a double digit in pre-2010 period. But since then due to measures undertaken by NBR for strengthening the prudential and regulatory frameworks, the banks internal credit policies and high economic growth recorded in the last decades, NPLs continued to show a downward trend to stand at 9.6 percent by end June 2011 from 12.6 percent in June 2009. To further reduce the incidence of NPLs, NBR enacted the regulation in 2011 on credit classification and provisioning by the banks. The purpose of the regulation was to ensure that banks promptly identify their non-performing credit facilities and undertake adequate collection efforts. The new regulatory environment in addition to loan writing off by banks and a robust macroeconomic performance helped to reduce the level of NPLs further to their lowest level of 5.7 percent and 5.9 percent by end June 2012 and 2015, respectively.

NPLs ratio started picking up right from 2015 to a level of 7.3 percent in June 2016, and then stood at 8.2 percent by end June 2017, the highest level since 2011. The recent rise in NPLs is widely spread across banks and is evident in all economic segments. Recognizing the problem, policymakers have placed their concern on resolution of the NPLs problem as a priority in enhancing the stability of financial sector. However, the conditions may seem challenging to monetary authorities in absence of obvious factors

which cause deterioration of assets quality. In fact, several studies have been carried out in this field, but neither has thoroughly attempted to determine the possible factors influencing the level of NPLs for the case of Rwanda by using both econometric and survey approaches.

Hence, the basis for undertaking this study is to examine the potential determinants of NPLs in Rwandan banking sector. First, the study used econometric model that looked at both bank level data and macroeconomic indicators over the period 2012Q1-2017Q2. The second fold of the research encompassed the survey approach on both banks and loan borrowers to identify their specific causes of defaults. By this means, the findings obtained through these approaches can serve as basis for NBR in formulation of monetary policy decisions as well as in enhancing the stability of the financial sector.

The rest of the paper is organized as follows: Section 2 presents some stylized facts about NPLs in Rwandan banking sector. Section 3 provides the review of the existing literature on determinants of NPLs. Section 4 presents the methodology which encompasses both the econometric and survey approaches used to analyze the determinants of NPLs. Section 5 covers the interpretation of both model estimations and survey results, whilst, section 6 provides the main conclusion and policy recommendations.

2. NPLs IN CONTEXT OF RWANDAN BANKING SECTOR

The banking sector continued to dominate the Rwanda's financial sector with over 66 percent of the total financial sector assets as at September 2017. The Rwandan banking sector has experienced significant growth in the last two decades and the latter has been observed in all aspects of the sector. Changes in banking sector occurred in terms of number of banks and established regulatory frameworks. With respect to the number of banks, the banking sector as at end September 2017 was comprised of 16 banks up from 4 banks in 1994. As of reported period, these banks are spread across the country with a network of 265 branches, 75 sub-branches, 213 outlets and 3,547 banking agents (NBR, 2017).

On balance sheet side, assets of banks have been growing over time at a reasonable pace. The total value of assets of banks almost tripled from RWF 573 billion in 2008 to RWF 1.2 trillion in 2012 and stood at RWF 2.6 trillion by end 2017Q3. The increase of assets of banks was mainly attributable to increase of shareholder's funds and loans. Shareholder's funds increased from RWF 100 billion in 2008 to RWF 266 billion in 2012 and stood at RWF 463 billion by end of 2017Q3 owing to high growth of profits of banks and

fresh capital injection. Conversely, customer's deposits increased from RWF 382 billion in 2008 to RWF 741 billion in 2012 and stood at RWF 1.7 trillion by end of 2017Q3 mainly on account of banking sector expansion (NBR, 2017). The increase of shareholders' funds and deposits facilitated banks to amplify lending to the economy. The banking sector loans that constitute 58 percent of total assets of banks increased from RWF 338 billion in 2008 to RWF 747 billion in 2012 and stood at RWF 1.5 trillion by end of 2017Q3 due to increased demand for funds owed to the good economic conditions.

With increasingly attractive investment climate, Rwanda has created a favorable environment for business start-ups, entrepreneurship and private sector actors and the latter combined with prudent public expenditure, contributed to making Rwanda one of the fastest growing economies in the world notching up an average GDP growth between 6 percent and 8 percent in last two decades. In addition, inflation rate and exchange rate depreciation have been reduced to single digits in line with robust fiscal and monetary policy frameworks. Stable macroeconomic environment has benefited the growth of the banking sector which in turn continued to be one of the pillars of economic growth and development.

The growth of balance sheet and income statement of banks has induced the banking sector to remain stable and resilient. The financial soundness indicators (Table 1 below) point out the stability of the banking sector despite the deterioration of assets quality. The capital adequacy ratio of banks remain high standing at 22.2 percent as at end 2017Q3, representing 7.2 percentage points above the minimum regulatory ratio of 15 percent. In addition, the liquidity ratio of banks on a consolidated basis stood at 42.9 percent, at most remained more than double the minimum regulatory requirement of 20 percent.

Table 1: Selected Financial Soundness Indicators, %

FSIs	Jun-13	Jun-14	Jun-15	Jun-16	Jun-17	Sept-17
Capital Adequacy Ratio	23.1	24.0	22.5	21.8	21.0	22.3
Liquidity Ratio	49.4	48.7	45.8	42.0	39.0	42.9
FX exposure/Core capital	-2.2	-1.8	-5.7	-7.1	-6.1	-7.2
NPLs /Gross Loans	6.9	6.6	5.9	7.0	8.2	7.7
Return on Assets	2.1	2.1	2.4	1.7	1.7	1.6
Return on Equity	10	12	13	9	10	9
Growth of loans	2.1	3.7	5.0	2.5	3.0	1.7

Source: NBR

On the other hand, banks remained profitable as measured by return on assets and return on equity, though started declining since 2015 as a consequence of reduced pace of bank lending and rising levels of NPLs. The tightness of banks' lending appetite negatively affected interest income of banks which is directly translated to reduced profits of banks. Moreover, the effect of high NPLs directly eroded the profitability of banks through high provisioning for rising non-performing assets and costs associated on attempts to recover bad loans. Indeed, growing NPLs evolves the opportunity costs of non-interest earning assets that could have been invested elsewhere and provide earnings.

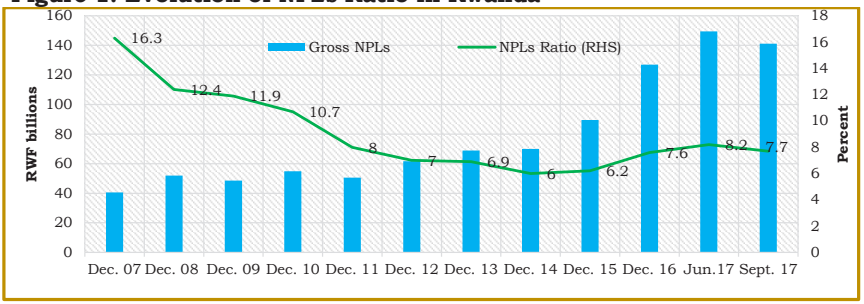
Indeed, prior to 2011, NPLs ratio was in double digit as they stood at 16.3 in 2007 and 10.7 in 2010, high above the NBR medium term objective of 5 percent. In a bid to reduce the level of NPLs, NBR took measures to strengthen prudential and regulatory framework and put in place banks internal credit policies. In line with this, NBR strengthened its supervisory role for banks and required banks to write-off bad loans that were overdue for long. In addition, NBR introduced credit reference bureau in July 2010 in a move to reduce the information asymmetry that existed between creditors and borrowers in Rwanda. To further reduce the incidences of NPLs, NBR enacted the regulation in 2011 on credit classification and provisioning. The purpose of the regulation was to ensure that banks promptly identify their non-performing credit facilities and undertake adequate correction efforts.

Among other regulations that were enacted with aim of enhancing efficiency and effectiveness of the banking sector include the regulation on risk management enacted in 2011. This regulation aimed at promoting the adoption of risk management principles and procedures to provide for an effective risk management program and internal control systems so as to enable banks to properly identify measure, monitor and control their risk exposures. In addition, regulation on banking placement was also enacted in 2011. This regulation aimed at establishing rules to minimize risks arising from concentration of placements or deposits in financial institutions in Rwanda or abroad. Other key regulations include the regulation on consolidated supervision gazetted in 2011, the regulation on capital and liquidity requirements of banks enacted in 2009 and modified in 2017 and the regulation on corporate governance of banks among others.

As a result, NPLs ratio gradually reduced to record 8 percent in 2011 and further to 6 percent in 2014, the lowest level of NPLs since 2006. This tremendous performance was also helped by the robust economic

performance which positively affected bank clients' ability to service the loans.

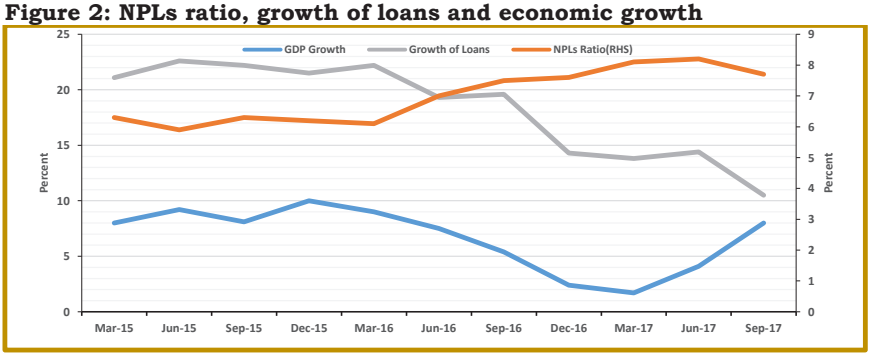
Figure 1: Evolution of NPLs Ratio in Rwanda



Source: NBR

Despite the above move to curb NPLs to or below the medium term objective, NPLs ratio reversed the trend and started picking up since 2015, increased to 8.2 percent in 2017Q2 from 6.2 percent in 2015, though slightly declined to 7.7 percent in 2017Q3 due to banks write offs of bad loans. The recent uptick in NPLs is mainly attributable to the deceleration of banks' lending in addition to the subdued economic performance (see figure 2 below).

Figure 2: NPLs ratio, growth of loans and economic growth



Source: NBR and NISR.

With regard to sectoral loan distribution, table 2 indicates that the, banks' lending activities are concentrated in mortgage and trade with the shares of 35.1 percent and 22.9 percent to total bank loans in 2017Q3, respectively. The distribution of loans across different economic sectors supposedly reflects sectoral demand for loans and risk profile of the respective economic sectors.

On one hand, the economic sectors with high NPLs ratio tend to have less loans compared to the economic sector with low NPLs ratio. On other hand, the economic sectors with both less loans and low NPLs ratio hypothetically reflects sectoral demand for loans which in turn reflects the structure of the economy.

Table 2: Share of Loans by Activity Sector

Activity Sector	% of total loans			
	15-Jun	16-Jun	17-Jun	17-Sep
Personal loans	9.8	7.7	7.1	8
Agricultural, fisheries& livestock	2.3	2.1	1.6	1.8
Mining activities	0	0.1	0.1	0.1
Manufacturing activities	9.4	9.1	9	8.9
Water & energy activities	2.3	2.2	2.8	2.6
Mortgage industries	33.9	36.6	35.1	35.1
Trade	21	19.6	21.9	22.9
Hotel	10.4	11.2	9.7	8.9
Transport & warehousing	6.1	6.7	8.1	7.4
OFI &Insurance	1.7	1.5	1.6	1.5
Service sector	3.1	3.2	3.1	2.8

Source: NBR

Across the economic sectors, NPLs ratios differ greatly from one sector to another. The highest NPLs ratio (Table 3) is observed in agriculture sector and manufacturing sector with the ratio of 14.5 percent and 11.2 percent, respectively. The NPLs ratio has been consistently higher in agriculture sector compared to other sectors resulting from the adverse effects of weather conditions and mined by traditional farming methods that are still dominant in the sector. However, the banking sector exposure to agriculture is still low as loans to this sector count for 1.8 percent of total outstanding loans as at end September 2017. The on-going government effort to de-risk the sector is vital as would provide investment opportunities for banks, as well as improve the quality of their asset portfolios.

Second to agriculture as at September 2017 is the manufacturing sector with the NPLs ratio of 11.2 percent (from 8.8 percent in June 2017); third is service sector with 10.6 percent (from 10.7 percent in June 2017); fourth is trade with 7.7 percent (from 8.8 in June 2017). Trade is followed by hotel sector with 6.3 percent (from 9.8 in June 2017). Mortgage, the highest financed sector (with 35.5 percent of total loans) holds one of the lowest NPLs at 5.8 percent (from 5.1 percent in June 2016).

Table 3: NPLs Ratio for Selected Sectors

Activity Sectors	NPLs per total loans of the sector (%)				% share/Total NPLs
	Jun-15	Jun-16	Jun-17	Sep-17	Sep-17
Personal loans	7.2	6.4	7.8	5.3	6.7
Agricultural& livestock	14.9	16.9	18.2	14.5	4.2
Mining activities	2.8	0.9	0	0.5	0
Manufacturing	1.1	6	8.8	11.2	16
Water & energy	2.6	0.2	0.1	0	0
Mortgage industries	4.5	5.1	5.8	5	28.2
Trade	7.1	6.9	8.8	7.7	28.1
Hotel	6.1	9	9.8	6.3	9
Transport & warehousing	4	3.1	3	2.5	2.9
OFI &Insurance	4.2	4.2	0.4	0.2	0
Service sector	6.5	4.5	10.7	10.6	4.8

Source: NBR

3. LITERATURE REVIEW

Several studies on non-performing loans are established on classical views. The works by Bernanke, Gertler and Gilchrist (1998) on financial accelerator stipulate that credit markets are procyclical and the asymmetric information between lender and borrower amplifies the spread of credit market shocks to the economy. Among the variety of risks banks are exposed to, credit risk plays an important role in banks performance. It is at most reflected as non-performing loans (NPLs) whose increase is a major cause of financial fragility and consequently threatens the growth of the economy. Earlier works such as by Altman and Saunders (1997) and Brown Bridge (1998) contend that NPLs are important elements contributing to progression of bank failures. Recent studies have deliberated this further citing NPLs ratio as a valid indicator in ascertaining the assets quality among the lending institutions (Greenidge and Grosvenor, 2010; Ezeoha, 2011; Milenković, Pjanić and Andrašić, 2013; MF, 2006). According to Boudriga et al (2009), NPLs is a major concern for both banks and local regulators.

Several scholars who worked on determinants of non-performing loans have identified macroeconomic factors, bank-specific factors and borrower's specific factors as three grand factors contributing to deterioration of banks loan quality. On one part, number economic theories and empirical studies such as by Fisher, (1933), Kiyotaki and Moore, (1997) Geanakoplos, (2009), Salas and Saurina, (2002), Fofack, (2005), Jimenez and Saurina, (2006), and

Dash and Kabra, (2010) to mention have confirmed that macroeconomic conditions matter for credit risk. These studies have established the link between business cycle and banking soundness whereby the changes in macroeconomic conditions directly affect the borrower's ability to service the debt. Other authors have cited bank specific factors as key determinants of NPLs through influence on bank's profitability (Bercoff et al., 2002; Khemraj and Pasha, 2009; EL- Collins, 2011; Ekanayake, 2015; Maude, Jibreel G., 2017). While Godquin (2004) and Wondimagegnehu (2012) to mention, also identified the borrower's specific factors to contribute to growth of NPLs. These studies have been conducted on both country specific and cross country levels. Subsequently, the proceeding subsections provide the details on these specific factors.

3.1 Literature on Macroeconomic, Bank specific and Borrowers specific factors

3.1.1 Macroeconomic Factors

Number of studies indicate that business cycle at all phases of growth is associated with banking stability. For instance, during economic boom, NPLs are relatively low, as loan borrowers become wealthier with income and revenues to service their debts. During such economic boom periods, banks extend more loans even to lower quality borrowers and consequently when economic slowdown sets in, NPLs increases. In other words, Gross Domestic Product (GDP) establish the link between business cycle and banking performance whereby the changes in GDP conditions affect the borrower's ability to service the debt. Besides, increase in unemployment has adverse effect on the cash flow of households, while on corporate businesses reduces production through decline in effective demand. In overall, this results to increase in people's debt burden which in turn translates into deterioration of loan assets of banks.

Other prominent macroeconomic factors associated with the changes in NPLs include the exchange rate and inflation. Exchange rate depreciation in flexible exchange rate regimes with large amounts of lending in foreign currency has positive effect on NPL accumulation. On the other hand, currency depreciation can improve debt servicing capabilities of export-oriented firms and in turn lowers the NPL ratio. The effect of inflation on NPLs is therefore ambiguous. On the one side, in case wages remain unchanged, higher inflation reduces the borrower's repayment capacity and thus weakens the bank's asset quality. On the other side, the increase in inflation can boost the loan payment capacity of the borrower by reducing the real value of

outstanding debt, but specifically in case the interest rates of banks are not adjusted the changes.

3.1.2 Bank specific factors

The traditions of banks as regards to their specific policy choices to optimize efficiency in their risk management are expected to exert pressures on occurrence of NPLs. Banks with asset quality deterioration have incentive in favor of risky credit markets. Like Boudriga et al., (2009), inefficient banks are tempted to engage in more uncertain credits in order to satisfy the prudential rules imposed by monetary authorities. As a result many of the bad debts are attributable to bank owners' imprudent lending strategies specifically the insider lending and lending at high interest rates to borrowers in risky credit markets. In analyzing the sources of loan default, Kohansal and Mansoori (2009) explain that NPLs arises from poor management procedures, loan diversion and unwillingness to repay loans. These authors also mention other number of factors that cause loan default to include Interest rate ceilings usually imposed by the government, monopoly power in credit markets often exercised by informal lenders, large transaction costs incurred by borrowers in applying for loans, and moral hazard problems.

Keeton and Morris, (1997) conclude that both low capital and low equity to assets ratio are significant indicators of cost inefficiency. Clair (1992) portrays the dependence of loan growth and loan quality on level of the bank capital. The high growth of bank loans is associated with poor loan performance results due to the relaxed underwriting standards. Other studies suggest internal factors such as high interest rates, excessive lending, and volatile funds, maturity, cost and terms of credit, banks size, and credit orientation impact significantly on the NPLs (Sinkey and Greenwalt, 1991; Dhal et al., 2003; Waweru and Kalini, 2009). Makri et al. (2014) and Godlewski (2004), assert that highly profitable banks have less incentives to engage in high-risk activities, thus return on asset is suggested to have inverse relationship with NPLs growth.

3.1.3 Borrower's specific factors

Apart from macroeconomic and bank specific factors, other studies have curiously identified the borrowers' determinants of non-performing loans. Using survey analysis by Wondimagegnehu (2012) reveals that poor credit assessment, failed loan monitoring, underdeveloped credit culture, lenient credit terms and conditions, aggressive lending, compromised integrity, weak institutional capacity, unfair competition among banks, willful defaults by borrowers and their knowledge limitation, fund diversion for unexpected

purposes and overdue financing as significant factors influencing the level of NPLs (Godquin, 2004).

3.2 Empirical literature review

This subsection reviews the findings of the general empirical studies in line with their model estimations. Number of studies on developing countries have been tempted to identify the determinants of Non-Performing Loans. Khemraj and Pasha (2009), analyzed the responsiveness of NPLs to macroeconomic and bank specific factors in Guyana using fixed effect panel model in six commercial banks over the period of 1994-2004. They estimated real GDP growth, inflation, and the Real Effective Exchange Rate as macroeconomic variables, while real interest rate, bank size, annual growth in loans, and the ratio of loans to total assets as bank specific variables. The results of their correlation analysis show that NPLs and loans to assets ratio are positively related, implying that banks which take greater risks tend to face a greater risks of NPLs. The authors' analysis also shows that GDP growth had negative relationship with NPLs, while the size of the bank was not be relevant in determining banks credit risk. The results of this study on one way contradicted with the findings of other studies as portrayed by negative relationship between inflation and NPL.

Fofack (2005) investigated the same factors contributing to NPLs in Sub-Saharan African countries. Using a Pseudo-Panel model, the author found economic growth, real exchange rate appreciation, the real interest rate, net interest margins, and inter-bank loans are significant determinants of NPLs in these countries. The author attributes the strong relationship between macroeconomic factors and non-performing loans to the undeveloped nature of some African economies. Using dynamic panel data estimated over 1995–2008 on around 80 banks for Gulf Cooperation Council (GCC) region, Espnoza and Prasad (2010), found that NPL ratio worsens in slowing economic growth, interest rates and risk aversion increase. For bank specific factors, credit growth and efficiency were also found related to future NPLs.

Collins (2011) studied the effects of interest rate spread on the level of non-performing assets of commercial banks in Kenya. Considering interest rate spread as independent and NPLs ratio as dependent variable. The study applied descriptive research design. Both primary and secondary data were considered from 43 commercial banks in 2010 and the findings indicate that the interest rate spread has a positive and significant effect on occurrences of NPLs. Similarly, the study done by Jordan and Tucker (2013) in assessing the impact of NPLs on economic growth as well as the feedback effects in the

Bahamas, the VEC model has been used to analyze a time series data spanned the period 2002-2011. Real GDP, Real GDP_USA, Air Arrivals (proxy of tourism sector output), FDI, Weighted average loan rate, inflation and credit to private sector were considered as explanatory variables whereas NPLs was taken as a dependent variable. The results suggested that the increase in economic growth tends to reduce NPLs and there was the feedback relation between the real GDP and NPLs where the increase in NPLs also appear to have a retarding effect on real GDP.

The study done in Sri Lanka by Ekanayake (2015) on the bank specific and macroeconomic determinants affecting the non-performing loans, GDP, inflation and unemployment have been considered as the macroeconomic indicators and prime lending rate, return on asset (that captures the efficiency of banks),operating expenses to income ratio, loans to asset ratio, provisions for losses that capture the risk profile of bank, growth in loans, markets share in terms of bank's deposits to capture the size of the institutions. Using fixed effect model for estimating panel data spanning from 1999-2012, the results revealed that loans to assets ratio and loan loss provision ratio as measures of banks risk appetite indicated positive correlation with NPLs. This means that banks which are more aggressive in the credit market are likely to incur high NPLs. The study also revealed that the upgrade in banks efficiency as well as the size of the bank have inverse relationship with NPLs. Unlike, lending rate found with significant and positively influence the occurrence of NPLs. With regard to macro-economic variables, GDP growth rate and inflation had significant inverse relationship with NPLs ratio.

Rajha (2016) investigated the determinants of non-performing loans in the Jordanian banking sector during the period 2008-2012. In his study, lagged NPL ratio, Loans to asset ratio, bank size, interest rate were the bank specific factors while growth rate of GDP, inflation and financial crisis were macroeconomic factors. Using panel data regression, the findings revealed that among bank specific factors, the lagged NPLs and the ratio of loans total assets were the most important factors that determine the current nonperforming loans. With respect to the macroeconomic factors, economic growth and inflation rate were found to have a negative and significant effect on non-performing loans, unlike global financial crisis that instigates higher non-performing loans in Jordan.

Ahmad (2017) assessed the factors that may influence the rising level of nonperforming loans in commercial banks of Pakistan using random effect model to estimate the panel data spanned from 2006-2016. The findings revealed that return on Asset, earning per share, capital adequacy ratio and breakup value per share have significant effect on nonperforming loans. Saba

et al. (2012) on US banking sector also investigated the effect bank specific and macroeconomic variables on nonperforming loans from 1985 to 2010 period using OLS regression model. Their findings revealed that real total loans with significantly positive effect on NPLs whereas interest rate and GDP per capita had negative and significant relationship with NPLs. Skarica (2013), estimated the determinants of NPLs in seven Central and Eastern European countries for the period 2007-2012 using fixed effect model. The results of the model indicated that loan growth, real GDP growth rate, market interest rate, Unemployment and inflation rate were considered as determinants of NPLs. However, GDP growth rate and low unemployment rate had negative relationship with NPLs.

For Mileris (2014) analysed macroeconomic factors and their implications on NPLs in commercial banks of the EU countries. With specificity of the Lithuanian macroeconomic indicators, the study proven the tight dependency of NPLs on changes of the country's economic environment. The weakening of GDP growth, exports, compensation of employees, final consumption expenditures of households, unemployment rate, the number of bankrupted companies and government expenditures were found to highly increase the level of NPLs in Lithuanian banks. He notes that business, economic indicators related to households and public finance are crucial in determining the level of credit risk in banks' loan portfolio. Consequently, countries with imperfect macroeconomic conditions have significant higher proportion of loan defaulters.

Besides, Wondimagegnehu (2012) used survey analysis to identify the determinants of nonperforming loans in commercial banks of Ethiopia. His analysis revealed that poor credit assessment, failed loan monitoring, underdeveloped credit culture, lenient credit terms and conditions, aggressive lending, compromised integrity, weak institutional capacity, unfair competition among banks, willful defaults by borrower and their knowledge limitation, fund diversion for un expected purposes and overdue financing as significant factors influencing the level of NPLs. Godquin (2004), loan diversion is an indicator of NPLs and he suggested trainings, basic literacy and health services as the main indicators to ensure a strong positive impact on the loan repayment performance

4. METHODOLOGY

The paper used balanced panel data spanning from 2012Q1-2017Q2 to identify both macroeconomic and bank specific determinants of assets quality deterioration for fourteen (14) banks in Rwanda. This study relies on two basic models, fixed effect and random effect model for the analysis of panel data. The estimation builds on general panel model for individual members $i = 1, \dots, N$ over time periods $t = 1, \dots . T$. The model allows us to consider individual heterogeneity but is also open for additional structures for comparison (Bollen and Brand, 2010).

$$y_{it} = \beta_{yxt} x_{it} + \beta_{yzt} z_i + \gamma_t \mu_i + \varepsilon_{it} \quad (1)$$

Where y_{it} is the dependent variable for the i^{th} case at the t^{th} time period, x_{it} is the vector of time-varying explanatory variables for the i^{th} case at period t, β_{yxt} is a row vector of coefficients at time t that provides the influence of x_{it} on y_{it}. Z_i is a vector of the observed time-invariant explanatory variables for the i^{th} case with β_{yzt} a row vector of coefficients that provide the association between z_i on y_{it} at time t. μ_i is a scalar of all other latent time-invariant variables that affect the dependent variable y_{it}, while γ_t is its coefficient at time t where at least one of these coefficients is set to one to give units in which the latent variable is measured. Then ε_{it} is the individual error term for the i^{th} case at time t with $E(\varepsilon it) = 0$ and $E(\varepsilon_{it}^2) = \sigma_{\varepsilon t}^2$, and is assumed that ε_{it} is uncorrelated with x_{it}, z_i and μ_i while $COV(\varepsilon it, \varepsilon is) = 0 \; for \; t \neq s$.

Considering the above general panel model, the exact specification of the regression model rests on the literature reviewed in which NPLs are explained by both key macroeconomic and bank specific factors. The general regression equation of the form below links the NPLs ratio and key macroeconomic and bank-specific variables as in line with Khemraj and Pasha (2009), and Jiménez and Saurina (2005).

$$NPL_{it} = \beta_{i0} + \beta_1 NPL_{it-1} + \beta_2 RIR_{it} + \beta_3 GRL_{it} + \beta_4 GRL_{it-1} + \beta_5 SIZE_{it} + \beta_6 SIZE_{it-1} + \beta_7 ROA_{it} + \beta_8 ROA_{it-1} + \beta_9 RGDP_t + \beta_{10} RGDP_{t-1} + \beta_{11} INF_t + \beta_{12} INF_{t-1} + \beta_{13} EXCH_t + \beta_{14} EXCH_{t-1} + + \varepsilon_{it} \quad (2)$$

Where β_{i0} represents the intercepts for bank i and captures the behaviour of banks. The dependent variable is the ratio of non-performing loans to total loans (NPL_{it}) of bank i at period t. The explanatory variables include: the ratio of the previous non-performing loans (NPLit-1), return on assets (ROA_{it}), real interest rate (RIR_{it}), Growth of loans (GRL_{it}), bank size ($SIZE_{it}$), exchange rate depreciation ($EXCH_t$), real economic growth ($RGDP_t$), and inflation (INF_t), while ε_{it} is the error term.

From the reviewed literature, real economic growth ($RGDP_t$) has significant and negative relationship with NPLs (Skarica, 2014; Khemraj and Pasha 2009; Fofack, 2005; Rajan and Dhal, 2003). The empirical evidences show that in a strong growth, real GDP improves households' incomes and business; as a result, the borrowers gain enough funds to service their debts, which in turn contributes to lower NPLs.

In relation to inflation (INF_t), though the impact in most studies appeared insignificant, the impact of inflation on non-performing loans in practice can either be positive or negative. On one hand, the moderate level of inflation can instigate the growth of the economy, as a result improves the debtors' capacity to repay the loans. On the other hand, high inflationary pressures on borrowers' side reduces real value of income and weakens their ability to service the loan (Mileris, 2012; Warue, 2013). On banks side, adjust their loan rates in accordance to the level of inflation. As a result, high inflation contributes to rapid erosion of commercial banks' equity and consequently prompts higher credit risk in the banking sectors (Fofack, 2005).

Exchange rate depreciation ($EXCH_t$) may affect loan defaults for those loans nominated in foreign currency and may affect NPLs either positive or negative. Exchange rate depreciation in a flexible exchange rate regime with large amounts of lending in foreign currency may have a positive effect on NPL accumulation. But also may improve debts servicing capabilities of export-oriented firms and hence negatively affect the occurrence of NPLs.

For bank specific variables, the percentage change in loan portfolio for each bank is considered to capture credit growth (GRL_{it}) and shows that the rapid credit growth is expected to have either positive or negative relationship with NPLs.

For real interest rate (RIR_{it}) indicates the eligible price the borrowers have to pay for loans. Indeed, high real interest rate implies an extra debt burden imparted on loan borrowers and thus is expected to increase NPLs.

Studies suggest that fall in banks profitability proxied by return on assets (ROA_{it}) provokes banks to implicate in riskier activities. Since returns on assets is an indicator for banks efficiency in use of assets, poor use of assets leads to more NPLs for the banks and thus we expect to have negative relationship with NPLs.

The literature point out the inverse relationship between size of banks ($SIZE_{it}$), and NPLs. The reason is that the larger banks tend to have better risk management strategies that usually triggers them have superior loan portfolios that their smaller counterparts.

Since NPLs have tendency to persist over time, we included (NPLit-1) as explanatory variable to analyze the effect of previous NPLs on its current level. As per results of the previous existing empirical literature show that the previous NPLs contribute to the occurrence of the current NPLs, we then expect to have a positive sign in our estimation results.

5. RESEARCH FINDINGS

5.1 Data description

In our empirical investigation for determinants of non-performing loans in Rwandan banking sector, we used quarterly data from 2012Q1–2017Q2 for a sample of fourteen banks. The choice of variables, the number of banks and the time is determined by importance of variables to the sector as well as the need to capture the possible large number of banks as limited by the commencing period of their operations in Rwanda. This study used the data from two main sources: The data on bank-specific variables were obtained from the National Bank of Rwanda (NBR) and some data for macroeconomic variables were retrieved from the National Institute of Statistics of Rwanda (NISR) while others were from National Bank of Rwanda.

5.2 Findings

The study used quarterly data spanning from 2012Q1 to 2017Q2. We used Levin-Lin-Chu and Breitung tests for unit root. The test assumes that each individual unit root in the panel shares the same AR (1) coefficient, but allows for individual effects, time effects and possibly a time trend. Lags of the dependent variable may be introduced to allow for serial correlation in the errors. The Levin-Lin-Chu test and Breitung test results clearly show that the null hypothesis of a panel unit root in the level of the series is rejected. We therefore conclude that all the variables are stationary at level or are integrated of order zero ~I(0).

Table 7: Stationarity results

Variables	Stationary tests		Test
	Adjusted t* [z]	Probability	
NPL	-4.7336	0.0000	Levin-Lin-Chu
RGDP	-6.5732	0.0000	Levin-Lin-Chu
ROA	-6.0227	0.0000	Levin-Lin-Chu
RIR	-5.7739	0.0000	Levin-Lin-Chu
EXCH	-6.5512	0.0000	Levin-Lin-Chu
SIZE	-2.9066	0.0018	Levin-Lin-Chu
INF	-5.6525	0.0000	Levin-Lin-Chu
GRL	-4.7502	0.0000	Breitung

Source: Eviews calculations and authors computation

Before setting for model estimation, the Hausman (1978) specification test was carried out to decide the appropriate technique the panel estimation assumes between fixed effect and random effect models. The test compared between the two models under the null hypothesis that the individual effects are uncorrelated with other regressors in the model. The result of the test showed a rejection of the null hypothesis, since the difference in coefficient is systematic as shown by p-value from the test is less than 0.05 (see table in the appendix). Definitely, the result suggests that fixed effect model is appropriate to use and is assumed to produce unbiased estimators and should be used in our estimation model following a systematic difference identified between the coefficients of the model estimated. The effect test also confirmed that the entity's error term and the constant which captures individual characteristics are not correlated with the others.

Using quarterly balanced panel dataset spanning from 2012Q1-2017Q2, the fixed effect model was then estimated as in line with Khemraj and Pasha, (2009) and Jiménez and Saurina, (2005). The estimated covariates include growth of real GDP, inflation and exchange rate depreciation against USD for macroeconomic variables, as well as return on assets ratio, real interest rate, bank size, growth of loans and return on assets as bank specific variables. The diagnostic tests to confirm the validity of the model were conducted. Notably, normality test found residuals normally distributed. Pesaran (2004) CD test rejects the null hypothesis of no serial correlation or autocorrelation, while the issue of multicollinearity was corrected after carrying out correlation analysis. The results portrayed in table 7 below broadly confirm that the occurrence of non-performing loans is contemporaneously influenced by both

macroeconomic and bank specific factors. As in line with the most reviewed empirical studies, all coefficients have expected signs.

Concerning macro-economic variables, the coefficient of real GDP growth is negative and statistically significant at one percent level of significance. The findings confirm that the Rwanda's economic environment plays an important role in determining the debtor's ability to pay back the borrowed funds. Thus the negative relationship between the two variables imply that an increase in one percentage in economic activities improves the debt servicing capacity of debtors and hence reduces the level of loan defaults by 0.23 percentage points. The estimates are in line with the most existing empirical studies which suggest that real growth of GDP explains growth of assets quality.

Inflation variable is positive as expected but found to have statistically insignificant effect on assets quality. The estimates are consistent to those obtained by several existing studies which found inflation with insignificant influence on occurrence of bad loans. The consistence of the results is confirmed by existence of the previous trend in which the inflation dynamics have been less volatile. Hence indicate that the effect of volatility of inflation in Rwanda is marginal on real value of income as well as on eroding debtors' ability to repay the loans mainly through the banks interest rate adjustment.

Moreover, exchange rate depreciation has a high positive and significant role in explaining the occurrence of NPLs in Rwanda. This implies that a one-percentage depreciation in exchange rate in a given period would provoke banking sector assets quality to deteriorate by 0.23%. This is due to the fact that the Rwandan USD exchange rate over the entire period of study exhibited a persistent depreciating trend, implying that Rwandan francs were simply losing to the US dollar. As business sector has a big share in total loans, depreciation of the Rwandan franc would mean that imported goods become costly for traders, leading to the decline in domestic demand and consequently reduction of the loan servicing capacity as importers who took loans from banks to engage into trading businesses incur losses.

Table 8: Cross-section fixed effects estimation results

Variables	Coefficients	t-statics
Bank specific variables		
NPL_{it-1}	0.129**	2.11
RIR_{it}	0.267*	1.85
$SIZE_{it}$	-0.00654***	-2.91
$SIZE_{it-1}$	0.000269	0.12
ROA_{it}	-0.180*	-1.89
ROA_{it-1}	-0.141	-1.39
GRL_{it}	-0.0381***	-5.38
GRL_{it-1}	-0.000564	-0.66
Macroeconomic Factors		
$RGDP_t$	-0.162*	-1.86
$RGDP_{t-1}$	-0.017	-0.20
INF_t	0.439**	2.45
INF_{t-1}	0.0331	0.36
$EXCH_t$	0.230**	2.48
$EXCH_{t-1}$	-0.114	-1.23
N	294	
R2	0.267	

Source: Eviews calculations and authors computation

Note: * implies significant at 10%, ** at 5% and *** at 1%.

In relation to bank specific factors, the coefficient of return on assets ratio is negative and statistically significant at 10% level of significance, implying that the role of banks profitability has greater importance on discourage bank managers to go for high credit risk exposures. Also in terms of bank efficiency perspective, banks efficiency in credit analysis and monitoring of loan customers are more exposed to an increase in assets quality. In this context, the negative and significant relationship with NPLs implies superior role in determining the levels of NPLs in Rwandan banking sector.

As we expected, the coefficient of real interest rate is positive and statistically significant at ten percent level of significance. The findings imply that a one percentage increase in banks real interest rate within and between banks raises NPLs ratio by 0.27%. The fact is that the higher level of real interest rate causes more burden for borrowers to repay the loans. Conversely, the

bank size has a negative relationship with bad loans. The rationale is that the banks with larger assets portfolios tend to have better risk management strategies that usually help to improve the quality of loans portfolios compared to their smaller counterparts. Finally, the growth of loans exhibit strong negative relationship with NPLs. The model also estimated the previous level of NPLs, and the results shows that the coefficient of lagged dependent variable (NPLt-1) is positive and statistically significant at one percent level of significance. This implies that banks with high NPLs in the previous quarters are likely to have high current NPLs if no measures are undertaken.

Though this study focused on the empirical analysis, a mini survey was also conducted, aiming to capture factors that are not perceived to be part of the econometric model.[6] The survey on banks and borrowers reported that low capacity in project preparation and management, as well as loan diversion are also among factors that influence the trend in NPL.

6. CONCLUSION AND POLICY RECOMMENDATIONS

The study aimed at identifying determinants of nonperforming loans in Rwandan banking sector. The study applied econometric model that looked at both bank level and macroeconomic indicators over the period 2012Q1-2017Q2. Applying fixed effect panel model, the findings obtained are in line with results found by numerous existing studies. For bank-specific variables, bank size, return on assets and growth of loans are found to be negatively related to the level of NPLs, while real interest rate is positively related to bank assets quality. For macroeconomic indicators, real economic growth, inflation and exchange rate standout to be the drivers of NPLs. Aiming to identify additional determinants of NPLs that may not be captured by econometric estimation, an interview to banks and borrowers was also conducted. Findings from banks and borrowers show that loan diversion as well as low capacity in project preparation and management are the most prevalent additional causes of loan defaults.

The study recommends banks to enhance appraisal and monitoring of projects, while borrowers are advised to avoid loan diversion behaviors, and to make use of existing services offered by BDF and CESB among others, to build capacity in terms of project preparation and execution. Policy makers are advised to intensify financial literacy campaigns such as on Key Facts Statement, in addition of maintaining macroeconomic stability.

[6] Detailed survey methodology and findings are available on request to the authors.

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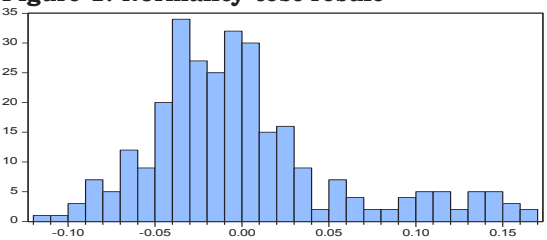
APPENDIX

Figure 1: Normality test result



Series: Standardized Residuals
Sample 2012Q2 2017Q2
Observations 294

Mean	2.62e-17
Median	-0.008347
Maximum	0.166804
Minimum	-0.114241
Std. Dev.	0.056105
Skewness	1.030262
Kurtosis	3.898679
Jarque-Bera	61.90395
Probability	0.000000

Test for autocorrelation/serial correlation

Residual Cross-Section Dependence Test

Null hypothesis: No cross-section dependence (correlation) in residuals

Equation: Untitled

Periods included: 21

Cross-sections included: 14

Total panel observations: 294

Note: non-zero cross-section means detected in data

Cross-section means were removed during computation of correlations

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	264.1305	91	0.0000
Pesaran scaled LM	11.79553		0.0000
Pesaran CD	-0.709690		0.4779

Testing for Fixed Effects

F test that all u_i=0: F(13, 266) = 11.50 Prob > F = 0.0000

Or: testparm _Iid_*

(1) _Iid_2 = 0
(2) _Iid_3 = 0
(3) _Iid_4 = 0
(4) _Iid_5 = 0
(5) _Iid_6 = 0
(6) _Iid_7 = 0
(7) _Iid_8 = 0
(8) _Iid_9 = 0
(9) _Iid_10 = 0
(10) _Iid_11 = 0
(11) _Iid_12 = 0
(12) _Iid_13 = 0
(13) _Iid_14 = 0
F(13, 266) = 11.50
Prob > F = 0.0000

IS EAC AN OPTIMUM CURRENCY AREA?

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ABSTRACT

This analysis intends to investigate the readiness of the EAC countries to form a monetary union. For this purpose, the paper assessed the circumstances under which EAC member countries can form an optimum currency area and therefore should opt for a single currency. The work reviews conditions for countries to qualify for suitable candidates to a currency union including the labor and capital mobility across the region, the openness to trade, the real shock synchronization, the nominal convergence which implies inflation, exchange and interest rates convergence, the fiscal adjustments or fiscal transfers in the case of asymmetric shocks among others.

Since the currency union bears both advantages and costs, it is advised to compare both losses and gains from union to decide yes or not to unite. Among advantages, the study highlights the elimination of cost of transactions related to foreign exchange transactions and the efficiency deriving from the use of one currency. A unique currency has the merits to increase the transparency and bargaining power across the region allowing for easy price discrimination, enhancing firms' competitiveness and, contributing to price stability inside the area. The latter helps to stimulate long-term allocation of resources and provide clearer economic signals to market participants. Coming to the costs of a single currency, the most cited cost is the loss, for individual countries, of the monetary and exchange rate as policy tools for adjustments in case of asymmetric shocks. Taken individually, countries lose the seigniorage or the benefit related to money issuance. Net losses or gains will depend on the structural characteristics of member countries of a monetary union.

The study uses the ADF and the correlation tests to check for nominal convergence, the growth rates correlation and the 3-step regression approach to assess the real convergence. Results show, a general convergence of pairwise inflation, interest rate and exchange rate differentials toward Kenya, taken as benchmark country.
However, income differences with Kenya remained large over time. Bearing in mind that convergence is never perfect but an issue that take time to be fixed, we check for real business cycles correlations over short periods of time for gradual convergence.

Results point to positive but non-significant correlations between EAC per capita incomes pointing to persistent asymmetric shocks. We suggest that while working toward a monetary union, countries need to keep eyes on convergence criteria before stepping into a monetary union because the exit in current conditions is too costly and very painful.

Key words: Optimum Currency Area, Monetary Union, Convergence, Shock Correlations, East Africa Community.

JEL Classification: C32, E61, F45, N17.

I. INTRODUCTION

In Africa, the clue of regional integration originated from the Economic Commission for Africa (ECA) which was proposing the splitting up of Africa into regions to promote the economic development already in mid-1960s. From small and scattered groupings, the pattern and the pace of the integration has been changing over time. Contrary to other regional integration worldwide, African groupings had mostly political motives. McCarthy (1995) noted that the Pan-Africanism which was an expression of continental identity and coherence came in forefront for most of the regional integrations. Additional factors for African economies to unite are the small size in economic terms and a high dependency on agriculture which creates persistent food insecurity.

According to United Nations Food and Agriculture Organization (FAO), ensuring food security was the most challenging issue for the global society, particularly in less developed and food-deficit countries. In 1990s, over 86 low-income and food-deficient countries across the world, 43 were in Africa. There was a need for a coordinated effort to ensure food security. The unification was also expected to increase the bargaining power of African countries, particularly in the area of trade negotiations with the rest of the world. More trade concessions were obtained as a group than individually.

Today, regional integration keeps upward trends and reached the highest level it has never reached before, mostly fostered by continuously improving transportation and communication technologies, growing and changing individuals' tastes, supportive public policies and political motives. Going forward, regional integration is expected to further strengthen.

African regional integrations have realized significant progress towards achieving their objectives in terms of free trade areas, customs unions and the free movement of people with the introduction of intraregional passports (Economic Commission for Africa, 2008) and seek to make the next step to establish monetary integration. The latter is perceived to strengthen trade integration and business cycles correlation and fostering the economic development (Frankel & Rose, 1998, Rose, 2000). Learning from the European Union where a common currency has been beneficial for all member states (Masson & Pattillo, 2005, Jeferris, 2007), Africans' dream is to adopt a single currency. The latter is perceived as the best way to perform a perfect market where all countries will be making transactions using one single currency.

The advantages of the use of a common currency include the elimination of costs related to foreign exchange transactions and the efficiency deriving from the use of one currency. The latter is said to increase the transparency and

the bargaining power across the region integration allowing for easy price discrimination. It is also assumed to enhance firms' competitiveness and, to contribute to price stability inside the area. The market stability helps to send clear economic signals to market participants and therefore stimulates long-term allocation of resources. Coming to the costs of a single currency, the most cited cost is the loss, for individual countries, of the monetary and exchange rate as policy tools for adjustments in case of asymmetric shocks. Net losses or gains from the use of a single currency will depend on the structural characteristics of member countries and the level of the economic integration. The deeper the integration, the higher the benefits for member states. There are some criteria that member countries need to fulfill to qualify for suitable candidates to a monetary union such as the labor and capital mobility across the region, the openness to trade, the real shock synchronization, the nominal convergence which implies inflation, exchange and interest rate convergence, the risk sharing mechanism like fiscal adjustments/fiscal transfers in the case of asymmetric shocks among others.

The present study intends to assess the readiness for the EAC to form a viable and sustainable monetary union. The East African Community was initially established in the 1967 and included Kenya, Tanzania and Uganda after the three countries became independent from the British colonialism. This initiative collapsed in 1977 due to diverging political regimes. Kenya was capitalist, Tanzania socialist while Uganda was facing civil war. The current EAC originated from this old one and was reestablished on July 7th, 2000 and counts, in addition to the three original members, Rwanda, Burundi and South Sudan. Rwanda and Burundi joined the EAC Treaty on 18 June 2007 but became full members of the Community with effect from 1 July 2007. The Republic of South Sudan consented to the Treaty on 15 April 2016 and became a full member on 15 August 2016. The ultimate goal of the EAC is to form a political federation therefore achieving its ambition to become "One People, One Destiny". To this end, the EAC was assigned as mission to 'widen and deepen economic, political, social and cultural integration in order to improve the quality of life of the people of East Africa through increased competitiveness, value added production, trade and investments' (AFSTA Congress, Dakar, Senegal, February, 2017).

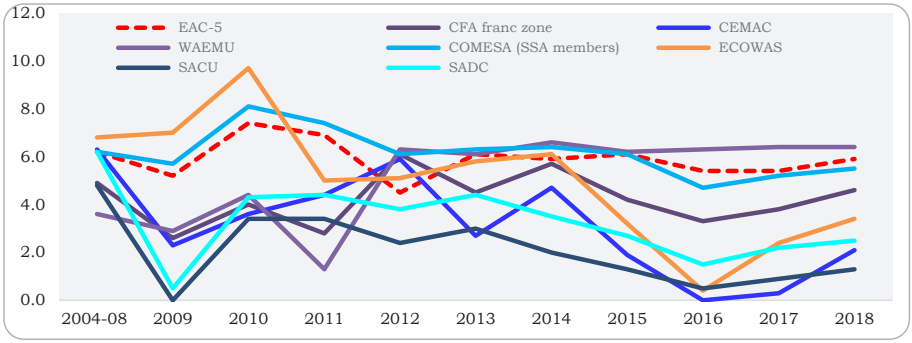
The EAC went successively through different steps from Custom Union (2005) and Common Market (2010) which helped to achieve some great results and plans to move towards a monetary union and political federation. The custom Union allowed member countries to act as a free trade area. This implies abolition or reduction of custom duties imposed on goods and services traded within the region while a common external tariff is applied on goods and

services imported from outside the EAC. Goods which comply with EAC rules of origin and with provisions of the EAC Treaty freely move across the region. The aim of the free trade area is to develop the economies of scale and the comparative advantages of the region. Effective July 2010, the EAC entered the Common Market with objective to accelerate the economic growth and development. In addition to the free movement of goods and services, all factors of production (labor and capital) can move without restrictions across member constituents. With regard to the East African Monetary Union (EAMU), member states expect, as stated in the Protocol of 30 November 2013, to progressively converge to an Optimum Currency Area (OCA) so as to use, with maximum efficiency a common currency. In the meantime, countries are busy to harmonize procedures and policies in the monetary, finance and fiscal areas, payment and settlement systems, accounting and reporting practices and the standardization of statistical information. It is also expected the establishment of one common EAC central Bank and the adoption of a common currency in 2024. Ultimately, the EAC looks forward to form a political federation which will enable member countries to benefit from common foreign and security policies, good governance and ensure effective implementation of the prior stages of regional integration.

The EAC positive achievements during these last years include a deeper regional integration and increased intra-regional trade within member countries. With regard to the intra-regional trade flows, compared to other African regional integrations, the EAC is among those which possess higher rates of intraregional trade averaging 11.3% after SADC which counted for 18.3%, WAEMU with 12.2% and SACU with 11.4% over the period from 2001 to 2016 (ITC8, 2017). The use of a single currency would help to maximize the trade potential and to boost the growth momentum across the region and, at a large extent the East African trade with the rest of the world. The regional integration has also helped the East African economy to develop strong resilience to shocks and therefore to realize strong and sustainable growth rate. End 2016, the EAC economic growth was estimated at 5.4% and this was a strong achievement since Sub-Saharan Africa region has recorded the worst performance in more than two decades (1.4% in 2016 from an average of 5.5% over the period from 2000 to 2015).

[8] *International Trade Center, a joint agency of the World Trade Organization and the United Nations.*

Fig.1: Real GDP growth in selected Sub-Saharan regional integrations (%)

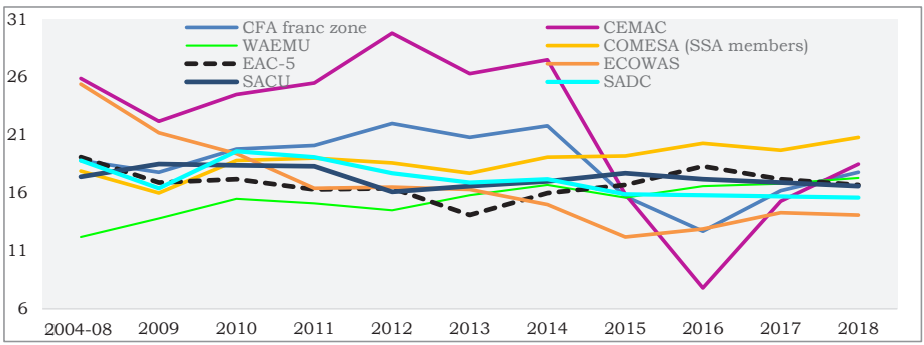


Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

On average, over the period from 2004 to 2016, apart from COMESA which real GDP growth averaged 6.3%, the EAC, was the best performer among the remaining Sub-Saharan regional integrations in terms of economic growth. EAC real GDP growth averaged 6.0% over this period higher than 5.5% for ECOWAS, 4.9% for WAEMU, 4.2% for CFA franc zone, 4% in CEMAC, 3.5% for SADC and 2.6% for SACU. The same applies for the per capita GDP growth whereby COMESA growth averaged 3.8%, EAC 3.2% similar to ECOWAS, 2.4% for WAEMU, 2.2% for SADC and CEMAC, 1.9% and 1.8% respectively for CFA franc zone and SACU over the period 2004 to 2016.

However, in terms of savings, before the year 2014, the EAC member countries were poorly performing compared to other sub-Saharan African regional integrations though the situation has been improving over time.

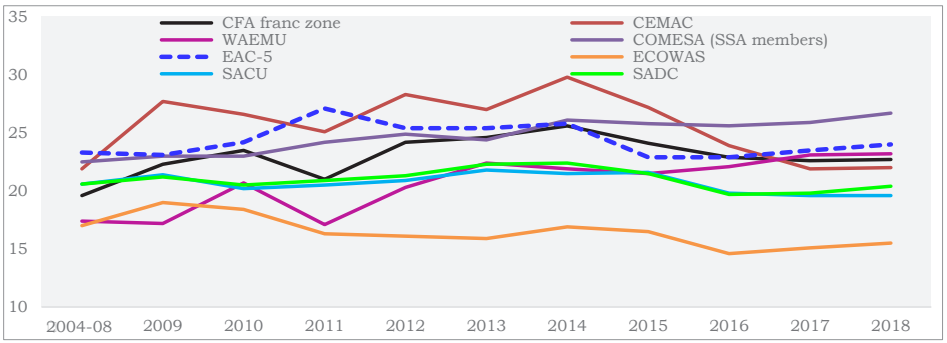
Fig.2: Gross National Savings in % of GDP



Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

On average over 2004-2016, CEMAC gross national saving amounted to 22.8% of GDP, CFA franc zone 18.8%, COMESA 18.5%, SADC and SACU had both 17.5%, ECOWAS 17.3%, EAC 16.8% and WAEMU accounted for 15.1% of GDP. But in terms of investments, the EAC upbeat almost all the Sub-Saharan regional integrations. The EAC investment averaged 24.3% of GDP and came after the CEMAC with 26.4% and the COMESA with 25.5% over the period 2004-2016.

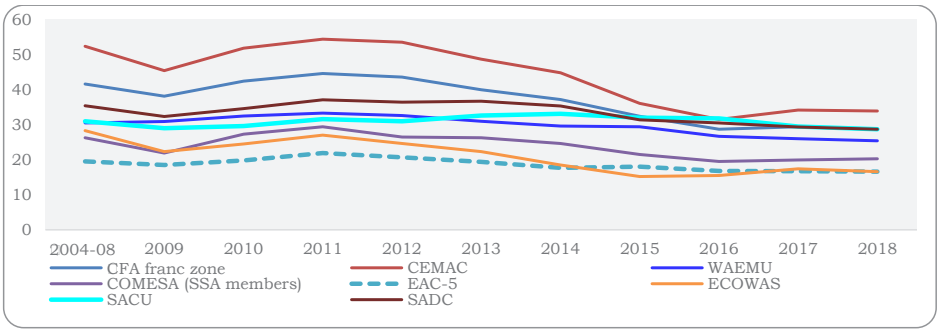
Fig.3: Total investments in % of GDP



Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

In terms of exports, the EAC countries have a narrowest exports base that are mainly dependent on agriculture commodities and some minerals while other regional integrations possess a large range of export commodities including oil and some manufacturing industries like textiles and agro-industries. The ratio of exports of goods and services averaged 19.1% of GDP over the period 2004-2016 in EAC.

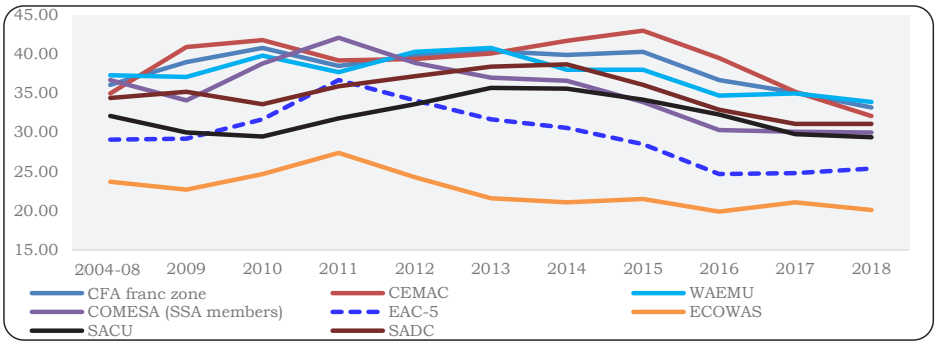
Fig 4: Exports of Goods and Services in % of GDP



Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

CEMAC has the highest exports to GDP ratio (46.5%) followed by CFA franc zone (38.7%), SADC (34.4%), SACU (31.3%), WAEMU (30.7%) and ECOWAS (22.0%). On imports side, in terms of imports of goods and services ratio of GDP, all regional blocs in Africa have a ratio above 30% except ECOWAS (23.0%).

Graph 5: Imports Goods and services % of GDP

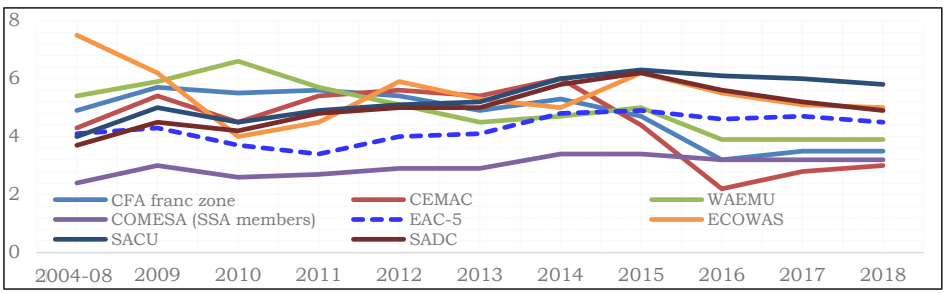


Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

On external point of view, Sub-Saharan African regional communities are very vulnerable to external shocks as the level of reserves buffers are low. High level of international reserves together with sound macroeconomic policies are perceived to protect countries against external payment defaults, the balance of payments shocks and ensure macroeconomic and financial stability.

The highest coverage of reserves in terms of months of imports was 6.1 in 2016 in SACU and the lowest was 2.2 months of imports in CEMAC while EAC countries have 4.6 months of imports on average.

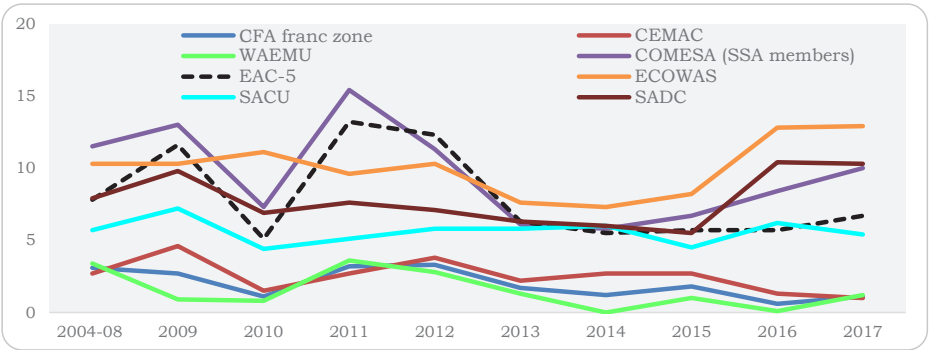
Fig.6: International reserves in months of imports of goods and services



Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

In terms of inflation, Sub-Saharan countries are vulnerable to commodity price shocks and adverse weather conditions. Inflation was high over the period from 2015 to 2016 reflecting the pass-through of high exchange rate pressures stemming from declines in export receipts in resource-rich countries together with the effect of drought in most Sub-Saharan countries.

Fig.7: Annual Average inflation in %



Source: IMF, REO: SSA Fiscal Adjustment and Economic Diversification, Oct.2017

In EAC countries, inflation remained moderate over this period thanks to efficient monetary and exchange rate policies and following good performance of the agriculture sector. But with the year 2016 and beginning 2017, inflation went slightly up on persistent effect of the above mentioned factors but remained moderate thanks to the second half 2017 recovery in agriculture production, the ease in exchange rate pressures following a recovery in commodity prices.

Overall, the regional integration here presented differ markedly, in terms of both economic structure and social development indicators. The EAC recent development indicators are below summarized.

Table 1. EAC community selected indicators, Average 2000-2016, except otherwise indicated

	2004-08	2009	2010	2011	2012	2013	2014	2015	2016
Economic indicators									
Nominal GDP (in bios USD)	79.13	92.86	99.39	106.75	111.92	118.36	125.43	132.93	140.74
GDP growth (% change)	6.2	5.2	7.4	6.9	4.6	5.8	6.0	6.0	5.8
Per capita income (USD,	543	590	612	637	652	668	688	708	726
Per capita income growth	3.3	2.3	4.7	4.2	1.6	3.1	3.3	3.3	3.2
Gross national saving in	19.3	16.9	17.2	16.3	16.7	14.1	16.3	17.7	17.2
Total investment (in % of	23.3	23.1	24.2	27.1	25.7	25.4	25.8	24.3	24.1
Inflation (Annual	7.8	11.6	5.1	13.2	12.3	6.3	5.5	5.7	5.7
Fiscal deficit including	-1.9	-3.7	-4.5	-3.4	-4.2	-4.5	-4.9	-5.3	-5.3
Total Government debt	42.1	29.8	33.2	32.8	33.0	35.4	39.0	43.0	45.6
Current account balance	-4.1	-5.9	-7.1	-9.9	-9.4	-9.2	-9.9	-7.8	-6.6
International reserve in	4.0	4.3	3.7	3.5	4.0	4.1	4.8	4.6	4.3
Exports of G&S (% of	19.5	18.5	19.8	21.9	20.6	19.4	17.7	18.0	17.6
Imports of G&S (% of	29.2	29.3	31.7	36.7	34.0	31.6	30.4	28.7	26.6
Terms of trade (index,	76.7	93.6	93.9	87.6	88.2	88.1	96.4	98.1	97.4
Net FDI (% of GDP)	2.3	2.2	2.0	3.7	3.4	3.2	2.9	2.3	2.2
Broad money (% of GDP)	26.3	26.7	29.6	29.2	28.8	29.0	29.9	30.3	28.9
Social indicators									
Population (millions)	124.3	136.1	140.4	144.7	149.1	153.7	158.3	163.1	168.0
Life expectancy at birth	56	58.8	59.7	60.5	61.2	61.9	62.4	62.9	-
Mortality rate of infants (per 1,000 live births)	7829	69	71	64	63	63	55	55	-
HIV/AIDS prevalence	5.5	4.9	4.8	4.7	4.6	4.5	4.4	4.3	4.2
Literacy rate (% of population aged 15 and	64	66	68	-	71	69	69	66	-

Source: World Development Indicators, national authorities, and IMF staff estimates.

In view of the achieved progress and going forward, the EAC plans to make a step ahead towards a monetary union in line with the Protocol on the Establishment of the East African Community Monetary Union (EAMU) signed on 30 November 2013 with the objective of introducing a common currency by 2024.

This paper tries to assess the readiness of East African community to become an optimum currency area as to adopt a single currency by 2024 as agreed in the EAC monetary union protocol. The objective of this paper is to analyze convergence criteria as a pre-condition for economic and monetary integration within member countries and investigate whether EAC member countries are prepared enough to form a monetary union. It will discuss the recent economic developments in EAC member countries, assess the impact of

recent shocks on member countries and the subsequent policy adjustments. These trends and policy responses will help us to appreciate the level of symmetry or asymmetry of shocks to member states, the structural similarity of member countries and hence to see whether the EAC is ready to form a monetary union.

There exist some papers on EAMU by Albert Mafusire and Zuzana Brixiova (2012), Buigut and Valev (2006), Kigabo and Masson (2012), Mkenda (2001) and Paulo Drummond et.al (2015) which concluded that member countries didn't fulfil macroeconomic convergence criteria which is crucial for MU to be sustainable. Lack of convergence and the presence of asymmetric shocks make unique monetary policy ineffective. Countries won't be equally affected by the policy adjustments and this may result in economic conflicts and source of important transfers. In this paper, we reexamine the readiness of EAC countries towards a monetary union, mainly focusing on the recent period since some progress was achieved in terms of policy coordination and implementation of the common market protocol.

The remainder of the paper is organized as follows. Section 2 discusses the OCA concept in the area of regional and monetary integration, section 3 describes the economic background of EAC member countries and Section 4 presents the methodology and variables definition. Section 5 discusses the results of estimation and interpretations. The paper ends with the conclusion and the policy recommendations which will help to further improve the readiness of the EAC toward an optimum currency area.

II. LITERATURE REVIEW

The step ahead for a regional integration to form a monetary union raises a number of questions about the advantages and costs for member countries. There is clearly many implications for a regional integration to form a monetary union of which the establishment of a unique regional central Bank and the use of unique currency across the region among others. The concept of optimum currency area was introduced in this context to guide the debate over the relative benefits and costs to adopt a monetary union.

Robert Mundell (1961) is considered as the father of optimum currency union (OCA) theory but later developments were attributed to authors like Abba Lerner, Kenen (1969) and Mckinnon (1963). While early authors considered characteristics that countries need to satisfy ex-ante in order to suitably form in an OCA, Julius Horvath (2003) believed that the OCA is a process that helps to choose exchange rate regime for a given economy, describes the role

of the exchange rate adjustment in the presence of the disequilibrium in the balance of payments in addition to its role in the designing of monetary unions. In this context, a currency area is a geographical region where the exchange rate is either fixed or in which a single currency has a legal tender.

In terms of regional integration, the monetary union is for most of time the ultimate objective of the process of integration but not always, as in rare cases, regional integration ended with political federation. Regional integration is defined as the gradual elimination of economic frontiers between independent states or different parts of a state, leading to the economies functioning as one entity and with objective to improve the economic welfare. It has as merits to foster economic development by eliminating trade barriers and obstacles to labor and capital mobility between constituent countries. The regional integration is not a new phenomenon, it dated probably in the ancient times, before the World War I; but the pattern and the pace of the integration has been changing over time, (Michael Mussa, 2000).

The technology advancement in both transportation and communication has reduced the transportation costs of goods, services and factors of production which were the biggest barriers to international trade. Economically useful knowledge and technology are shared across regional blocs and globally, timely and at reduced costs. At the other hand, with declining cost of transport and communication, people and regions took advantages of large range of opportunities through growing integration process. Public policies are playing a big role in shaping and stepping up the process although not always in the direction of increasing economic integration. In order to establish the distribution channels, neighboring economies agreed to unite one to another depending on some considerations like the proximity, tastes and the willingness to work together in order to improve the welfare of all member states.

The regional integration involves five different stages of integration conditional to fulfilment of a number of criteria (Balassa, 1961). (i) The free trade zone responds to high exchange of goods and services, reduced or fully removal of tariffs between member states while each country remains with its tariff versus the third parties. This stage aims to develop economies of scale and the comparative advantages as to promote the economic efficiency. (ii) Additionally to the free trade zone, countries in the custom union applies the same trade regime imposing a common tariff to third parties. (iii) The common market supposes the mobility of factors of production including labor and capital, the freedom of movement, as well as the convergence of policy. (iv)The economic Union implies the removal of all tariffs between member states, a

high degree of capital and labor mobility, effective coordination and harmonization of monetary and fiscal policies as well as the payment system. A further step in an economic union is the monetary Union where countries adopt unique currency. The monetary union is very crucial and very costly and needs to be undertaken conscientiously. (v) The most advanced form of integration is the political union with a common government and reduced individual country's sovereignty. The European Union is currently the most advanced form of regional integration.

This part describes the process toward a monetary union. Emphasis is put on preconditions, convergence criteria as well as the costs and benefits of a monetary union.

2.1 Monetary Union: Preconditions, Convergence Criteria, Costs and Benefits

2.1.1 Preconditions

The entry in a monetary union is challenged by the existence of asymmetric shocks that affect member countries. This issue has retained attention of several economists who sought to investigate on how countries manage to handle the problem. This point is of particular importance that different writers proposed a stand point for discussion about conditions to form a monetary union. The theory of optimum currency area has helped to predict conditions for countries to be suitable candidates to a monetary union. The concept of the optimum currency area itself refers to various issues in the area of international macroeconomics and not easy at all to put in practice.

First, the optimum currency area refers, according to McKinnon (1963) to, a geographical area which fulfils three conditions notably the full employment, the price stability, both two conditional to internal equilibrium and external equilibrium which implies a balanced external account. Similar definition was provided by Kenen (1969) who describes the optimum currency area as an area which has either a fixed exchange rate regime or a flexible one that allows for the external balance without creating unemployment. On his side, Grubel (1970) advanced that optimality of the currency union points to a capacity for a monetary union to improve the welfare of population inside the union at a level which is higher than one member countries can enjoy once they are outside of the union.

Referring to the external equilibrium, Allen and Kenen (1980) believed that the optimum currency area is a kind of minimization of the costs related to adjustment of the balance of payments. Roland Vaubel (1990) contends that there exists no operational scientific method of defining optimum currency areas and therefore no operational scientific method to measure and compare

the costs and benefits of currency unification for a given group of countries. For Thomas Willett (1994), the optimum currency area denotes various but relevant considerations which level of operational precision is not clear enough to lead to similar conclusions. Implicitly, the theory of optimum currency area doesn't clarify, according to Willem Buiter (1995) the nature and the level of behavior changes that are appropriate to fully compensate for the forgone nominal exchange rate as policy instrument.

On his side, Melitz (1995), contests the optimality of geographical area as far as the size of the regional integration (or the country) it refers to is given, and believes instead that this optimality refers to improving welfare within the region or country. On the contrary that, Kenen (1969) replicated that the optimality should apply for both region and for individual country. In view of these disparate considerations, the Eurozone experience is of important interest. Member countries abandoned the interest rates and exchange rate adjustment tools and remained only with fiscal policy to deal with macroeconomic shocks.

Overall, most of empirical studies considered the optimum as an approach to assess the preparedness of a region to adopt a single currency. This involves the standpoint or the basis for criteria that should be used to define an OCA. Classical theories such as the Mundellian theory of stationary expectations, predicts conditions to be satisfied for countries to be suitable candidates to adopt a single currency. Countries need to be characterized by absence or low level of asymmetric shocks, high flexibility of systems to adapt to changes and high credibility of the institutions.

In practice, preconditions include also, nominal convergence which points to convergence of interest rates, inflation, and exchange rates necessary to avoid large real exchange rate changes once nominal rates were locked under the Currency Union, convergence of the fiscal deficit and debt criteria to insure that countries are willing to bring their public finances onto a sustainable path. Monetary authority independence helps to enhance the efficiency of monetary union. Gradual adoption of stable macroeconomic policies and the integration of capital and labor markets among member countries. The optimum currency area approach, defines the conditions necessary for the good functioning of the integration and translates these in terms of criteria for membership. Lack of macroeconomic convergence would be devastating to economic integration in line with Mundell's model.
This part describes the process toward a monetary union emphasizing on preconditions, convergence criteria as well as the costs and benefits of a monetary union.

2.1.2 Convergence Criteria

The theory of optimum currency area provides criteria that are crucial for investigating circumstances in which it is economically optimal and beneficial to use a single currency. These features include the synchronization of real business cycles, the mobility of factor of production, including capital and labor mobility, price and wage flexibility across the region, correlation of monetary shocks, and a risk sharing system such as automatic fiscal transfers. Additionally, the openness (McKinnon) and the diversification process are supposed to prevail for the success of the OCA. Therefore, according to McKinnon, area where there are stability of price level, full employment and where external balance is in equilibrium fits into OCA.

According to Mundell's model of optimum currency area, member countries are expected to fulfil these criteria to form a monetary union. Convergence criteria are given and help member countries in their assessment of whether or not the advantages of union offset the costs. Here asymmetric shocks are assumed to undermine the real economy and unique monetary policy is found inefficient. Similarly, fixed exchange rate (single currency) doesn't work and floating exchange rate better serve to fix the imbalances. Most cited criteria for the success of the currency union are herewith discussed.

i. Labor mobility and labor cost flexibility

High labor mobility reduces the need for exchange rate flexibility. Kenen (1963), contended that labor mobility can support the use of the fixed exchange rate regime and is felt to bring the necessary adjustment to demand shocks. Mundell (1961) believed that in case of asymmetric shocks, fixed exchange rate or the peg would better help for adjustments if there is sufficient mobility of labor. This is consistent with empirical findings by Fidrmuc and Horvath (1998) in the case of 76 Czech economies faced by the challenges to select an exchange rate regime. The study which showed that asymmetric disturbances were mitigated by the labor mobility but at a lesser extent pointing to the need for a flexible exchange rate. Blanchard and Katz (1992) evidenced the important adjustment role played by the labor mobility in the United States replacing to a large extent the price flexibility.

Michael Mussa (2000) argued that human mobility has remained the main mechanism of interaction and integration of different societies. It has been perceived as one of the key factors for the success of a monetary union. Different factors have contributed to labor mobility including technologies, changes in tastes, favorable public policies and available opportunities across

regions. In reality, while the labor mobility is easy within the national boarders, it is very difficult outside the boundaries mostly due to difference in culture, language, legislation and welfare benefits and skills. Kenen (1969) stated that perfect interregional labor mobility requires perfect occupational mobility and, in return, the need for homogeneity of labor which is a utopia. He argued that countries which have similar but narrow production structures are suitable candidates for a monetary union given that they are likely to be affected symmetrically by a shock in terms of trade. However, Giersch (1973), advanced a bit pessimistic view point showing that labor mobility seems to be the worst alternative to disequilibrium in the balance of payments since migration is unlikely reversible. De Grauwe (1994), brought additional challenge that the devaluation should not have expansionary impact on output but rather a contractionary one. Similarly, Bofinger (1994) thought there was no evidence of reliable reaction of flexible exchange rate to real shocks disturbances. Today, Mundell's view remains valid to appreciate the optimum currency area, countries affected by asymmetric shocks need substantial flexibility in their labor markets (Julius Horvath, 2003).

ii. Capital mobility

Ingram (1992) advanced that financial integration can help to adjust for temporary asymmetric shocks allowing for easy capital inflows, reducing long-term interest rates while fostering efficient allocation of resources. For Helpman and Razin (1982), the incompleteness of financial markets, a floating exchange rate regime is found more helpful for nominal variables to affect real variables. This is however conditional to some facilitative channels. In reality, financial capital can easily move inside national borders but very difficult even impossible for physical capital to move outside national borders. Financial integration is all about free capital mobility. Domestic financial markets are linked with those of other countries or those of the rest of the world. Robson (1987) highlights the need for financial integration to harmonize rules and regulations amongst member countries. Its merits are economic efficiency by increasing competition and expanding markets, lowering cost of intermediation and allowing for more efficient allocation of capital and therefore potential of increased economic growth. McKinnon (2004) commenting on the role of financial integration in Mundellian model, found that countries sharing a single currency can mitigate the effects of asymmetric shocks by diversifying their income sources. Empirically, there are free capital movement areas (FCMA), capital market union (CMU) and integration of capital markets.

iii. Openness & Production Diversification

The more an economy is opened to the rest of the world (McKinnon) and the more diversified is its production (Peter Kenen, 1969), the higher the benefits it can achieve from monetary union. McKinnon (1963) ascertained that open economies are better off with fixed exchange rate regime since exchange volatilities in such economies are not necessarily accompanied by significant effects on real competitiveness. Trade in goods and services were pointed out as the key devices for integrating economic activities across countries and as critical channels for transmitting disturbances between different economies. In case of similarity of structure, risks for asymmetric chocks are limited. According to Hecksher-Ohlin-Samuelson, trade in goods is seen as a substitute for mobility of factors of production. Full economic efficiency could be achieved exclusively through trading outputs. A focus on natural and artificial barriers to trade is still important in assessing the extent to which international economic integration through trade achieves as much as possible through this channel. Mundell also observed that countries that have similar terms-of-trade shocks better fit into OCA than those facing asymmetric shocks given that this similarity of the shocks doesn't need the exchange-rate adjustments but allows for implementation of a common monetary policy. Specifically, if there were literally no natural or artificial barriers to trade in goods or services, then the relative prices of all goods and services would be equalized everywhere, and integration through the channel of trade would be perfect and complete.

iv. Solidarity

For a monetary union to be sustainable, potential candidates need to look in the same direction. Diversity may generate asymmetric disturbances which need exchange rate for policy adjustments. Cohen (1998), argues that political commitment is an important precondition to a monetary union. Inadequately planned monetary integration and /or without commitment on behalf of member units may damage the cause of regional integration (Masson and Pattillo, 2001, example of East African shilling broke down, the failure of Soviet Union). A monetary union will, from time to time, face asymmetric shocks that result into temporary conflicts of interests. Member states need to bear such economic costs in the name of a higher purpose.

v. Fiscal transfers or fiscal integration

It was felt that a fiscal tool may usefully substitute to an exchange rate flexibility or to migration. However, it's an imperfect substitution since the fiscal tool is not representing an adjustment tool rather a temporary financing

in a case of asymmetric shock (Luca A. Ricci, 1997). Countries may agree to form a monetary union with limited convergence. In this case, the success of the union will depend on the willingness for largest members to support smaller members until closer convergence will be achieved. Countries which are willing to compensate each other for adverse shocks form an OCA (Robert Mundell, 1973, p.358). Transfers act as an insurance that mitigates the costs of an asymmetric shock. Transfers stimulate demand curve shifts back. They exist within national borders, implicitly through the welfare system explicitly in some federations.

vi. Synchronization of the business cycles

Why do countries need to converge in integration? Integration and macroeconomic convergence are linked in two-way causality. On the one hand, convergence is an important issue for regional integration. With unique currency, monetary policy will be the same for all member countries. If there is no convergence, the unique monetary policy will affect unequally member countries. The absence of convergence will create divisions which in turn will affect the integration, increase demand for transfers which may be economically or politically not feasible and may lead to many economic problems. On the other hand, convergence is one of the goals of the integration. Once monetary integration has been created, tendencies toward both convergence and divergence will continue to work. Therefore convergence is never perfect and remains an issue that cannot be fixed once and for all. Grinberg (2004), indicated that extreme asymmetries between post-sovietic countries and strong differences in their economic policies, were considered as disintegrating forces for the region.

In reality, Mundell's idea of optimality is quite difficult to quantity with precision. Just some disparate views and suggestions about elements that play a role in the assessment and the solution of the problem. Roland Vaubel (1990) noted here that there is neither an operational scientific method of measuring and comparing the costs and benefits of currency unification for a given group of countries, nor an operational scientific method that defines the optimum currency areas. Similarly, according to Thomas Willett (1994), the theory of optimum currency areas refers to many different aspects, which have no clear operational precision that economists would come out with the same conclusions.

Willem Buiter (1995), considered that the "optimal currency area literature is woefully inadequate and confused on the issue about what policy institutional

or other behavioral changes are necessary in order to compensate for the loss of the nominal exchange rate instrument."

In line with these criticisms, other schools of thought considered that some convergence criteria are neither fixed nor given but they are outcome of the unification itself. Like the Eurozone, United States, some areas of these two unions don't satisfy the convergence criteria but taken together the union fit into an OCA status. This case reflects the endogeneity of the optimum currency area which suggests that economic and monetary integrations are interlinked and self-reinforcing processes.

From the beginning, the founders of the European Union were looking forward a monetary union in the late 1950s (Carlos Vieira and Isabel Vieira, 2010). It was a question of debate about either to form a monetary union without convergence or to wait for convergence criteria to be fulfilled. Following the endogeneity of the optimum currency area, peripheral countries entered the European monetary union with hope to reach the convergence criteria once in the union. Political will was on the forefront in the European integration and attracted earlier adherence of peripheral nations to the common currency. However, countries were required to satisfy a set of nominal conditions, known as Maastricht criteria10 for the project of the common currency to be sustainable. Nevertheless, irrespective to the specificity and mandatory status of such requirements, political motives outweighed the technical considerations.

While in 1999, 11 countries celebrated the Euro currency as the achievement of the project, it didn't wait so much that the global crisis in 2007 proved the diversity of the member states. Cross country structural problems were raised to day light. Criticisms mounted to proclaim the union as a bad idea and created doubts about the sustainability of the Euro and the validity of the endogeneity of the optimum currency area. For some countries the endogeneity hypothesis however hold.

Similar findings were made by Frankel and Rose (1997, 1998) who, by using ex ante assessments of endogeneity of the optimum currency area observed that the European Union should rather be justified ex-post. Divergences have remained significant between core countries and peripheral ones before and after the introduction of the Euro though positive developments were seen for

[10] Convergence criteria as defined by the Maastricht Treaty (1992) include low inflation, low interest rates, stable exchange rates and sound public finances as critical benchmarks for a successful economic and monetary integration in Europe.

countries like Slovenia, Hungary, Estonia and the Czech Republic. Empirical analyses are controversial on this endogeneity hypothesis with regard to European monetary union.

2.1.3 The Endogeneity of the Optimum Currency Area Criteria

Frankel and Wei (1998) propose two of the characteristics of the optimum currency areas as being fundamental in assessing the net benefits of a monetary union namely an economy's opening degree and the degree of correlation of the business cycles. On commercial side, Viner (1950) noted that the trade integration can either create or divert the trade. The two economic and commercial characteristics are key for investigating the convergence criteria. Traditional theories of optimum currency areas considered these characteristics as given and compulsory for selecting suitable candidates to a monetary. This was the Mundellian view where asymmetric shocks are felt to spoil the real economy. There is however a controversial view that these OCA criteria are not fixed and are rather dynamic and can be reached once in a monetary union. They are in this case the outcome of the monetary union itself. The endogenous approach suggests therefore that countries may enter a monetary union without fulfilling convergence criteria as mentioned in Mundell's theory of OCA and met them ex-post.

Krugman (1993) ascertained deeper trade integration may generate higher specialization. Countries benefit from higher trade integration and can achieve more effective allocation of resources. Findings by Frankel and Rose (1998a, 1998b), proved that higher trade integration leads to higher correlation of business cycles among countries. Fidrmuc (2001) showed also that the intensity of intra-industry trade is another variable, which has a positive impact on the synchronization of business cycles. Briefly, De Grauwe (2007) argues that the monetary union may create favorable conditions of well-functioning of the integration process that leads to convergence. Countries can therefore according to endogeneity of the optimum currency area form a monetary union without complying with the convergence criteria and this will ex-post lead to the increase of the trade integration and the degree of business cycle correlation and, hence to convergence.

2.1.4 Monetary Union Costs and Benefits

The most important benefits that member countries can obtain from a monetary union (MU) comprise, according to Obstfeld and Rogoff (1996), the elimination of the transaction costs arising from currencies exchange in order

to pay imports of goods and services, invest abroad or for acquisition of foreign securities and the suppression of volatility in exchange rate. The latter is proven to reduce cross-border trade and investment consistently to Robso (1987) and Tavlas (1993). The reduction of such costs actually increases the volume of trade and investment depending on the importance of intraregional transactions. The OCA prevents, for country constituents the need to keep foreign reserves for intraregional trade flows together with the need for reserves to cover the effects of speculative capital flows inside the area. However, financial institutions, banks and forex bureaus that deal with foreign exchange are likely to lose gains from currency transactions. Similar findings are obtained by Carney (2014), Stankovic (2013), Rusuhuzwa and Masson (2012).

The monetary union is also said to increase transparency in pricing and ensures equal bargaining power for consumers inside the monetary area. Unique currency allows for easy price discrimination and enhances firms' competitiveness, contributes to price stability inside the area therefore stimulating long-term allocation of resources by the public, and providing clearer economic signals to market participants. In other words, it allows for more predictable trade and investment conditions. Currency units in large, successful and stable monetary unions are likely to serve as international medium of exchange and counts as instrument of international reserves which makes it easier and cheaper for the union to sell its debt in foreign markets. With unique currency area, there is reduced need for trade protection and higher central bank independence.

On costs side, a single currency area results into the loss of the monetary and exchange rate policies as counter-cyclical instrument for individual countries to deal with internal shocks (recession and inflation). In the presence of asymmetric shocks, a single monetary policy becomes inefficient and countries are differently affected. The loss of seigniorage is another potential risk of the MU. Net losses or gains will depend on the structural characteristics of constituent countries. In the case of largely opened economies with important intraregional transactions flows, gains from MU will overweight the losses from the unification. Inversely, losses will be greater than gains in case of important non-tradable goods and/or in case of strong trade links outside the MU.

In actual policy making, players of integration come from diverse backgrounds. Some of them have clearly defined economic interests, others are motivated by political interests and constraints and the silent majority with undefined objectives. According to Eichengreen and Frieden (2000), "the decision to create a single currency and Central Bank is not made by a

beneficent social planner weighing the costs and benefits to the participating nations. Rather, it is the outcome of a political process of treaty negotiation, parliamentary ratification, and popular referenda. Interest groups support or oppose the initiative depending on how it is likely to affect their welfare, not that of the nation or of the Community as a whole. The pressures they bring to bear are amplified and dissipated by the political institutions through which those pressures are communicated".

Therefore, during the monetary integration process it is needed to look beyond criteria of the optimum currency area as political constraints and political economy are additional drivers of monetary integration. These latter imply inter-state bargaining and domestic distribution of benefits and costs of integration which may either lead to economic development and peace or to political shocks in case of unequal distribution. Monetary integration can also lead to structural reforms and growth with long-term benefits for member countries. However, it can also serve as vehicle of political shocks as member countries lose sovereignty particularly in monetary and fiscal policies. Indeed, the existence of fiscal spillovers point to the role for the coordination of member states coupled with fiscal rules. The rationale for fiscal rules in monetary integration is to improve policy coordination and promote time consistency avoiding therefore the deficit bias.

A word of caution, the currency union needs to be thought and decision needs to be optimal as an exit from a currency union would be difficult and costly. Reintroducing new currency would be difficult and, more seriously, all contracts in the common currency would be affected. Other countries that have tried to adopt exit strategies from a common currency area, such as "pesification" in Argentina and de-dollarization in Liberia, have resulted in economic crises.

Regardless of the efforts and good reasons behind Sub-Saharan African regional integrations, they failed to achieve their objectives. Gray (2012) noted "If we look at an organization's level of effectiveness along with its level of activity, we see that about a third of regional economic organizations are "alive" in any meaningful sense. About 10% are effectively dead, and the remainder are "zombies" with some minimal level of staffing and operation, but little actual output."

III. EMPIRICAL REVIEW

The theory of optimum currency area has stimulated intense debates around particularly the costs and benefits stemming from the adoption of a monetary union. The main emphasis was made on arguments pointed out as crucial in

investigating of whether member countries in a regional integration find it beneficial to adopt a single currency. Recent papers covered both real and monetary arguments for a currency union to be sustainably beneficial. The net gains countries can derive from a monetary union increase with the correlations of real shocks between member states, the degree of labor mobility, the degree of correlation of terms of trade or the real exchange rates across countries, the degree of adjustment provided by inflation differentials, the variability of domestic monetary shocks and the efficiency gains deriving from the use of a single currency.

This section makes a review of the main findings of recent researches. Studies presented here differ from the case studies, the methodologies used, as well as the period covered by the studies. Applied methodologies include a wide range of econometric techniques such analysis of correlations which apply for real income growth rates, exchange rates as well as for terms-of trade; the correlations of real shocks or the synchronization of business cycles, the Structural Vector Autoregression model as well as the cointegration VAR analysis.

Using a structural vector auto-regressive model and basing on data stemming from 1960 to1988, Bayoumi and Eichengreen (1992) investigated the prevalence of shocks in an effort to isolate supply and demand shocks prompting output fluctuations in European Community (EC) and some US regions.

Taking Germany and the Middle Atlantic as benchmarks for EC and the US respectively, Bayoumi and Eichengreen (1992) tried to assess how the supply and demand shocks of different countries in the EC and different regions of the US are related to benchmark regions. In European countries whose shocks are significantly correlated with German shocks are identified as core while those whose shocks don't display significant relationship with German are known as periphery. Core countries are France, Denmark, Belgium, and the Netherlands, while countries like England, Portugal, Ireland, Spain, Greece, and Italy are weakly linked to German. Findings showed low correlation of demand shocks between benchmark German and other EC countries and in US with benchmark Middle Atlantic. Bayoumi and Eichengreen tend to identify monetary Union on geographical basis.

Using auto regressive systems on the growth rates of output, prices, and money, Chamie, DeSerres and Lalonde (1994) split shocks to real supply, real demand, and nominal shocks. They get monetary shocks by imposing the restriction of long-term money neutrality. Their results showed that in Europe

only Germany and Switzerland are strongly related to the symmetrical component of shocks. Other countries including Greece, Italy, Norway, Portugal, and Sweden are found not statistically related to the common component of the shocks.
With regard to the US regional, these countries were facing highly asymmetric supply and real demand shocks. Conclusions pointed out that some European countries might face significant adjustment costs when joining a monetary union.
On his side, Whitt (1995), using monthly data on industrial production and price index analyzed demand and supply shocks and concluded that only France, Italy, and the Netherlands display significant positive relationship of shocks with Germany. He also showed that Canada and the United States had substantial positive supply and demand shocks with the core and therefore may easily join the monetary union.

Using data for 20 European market economies of European Community, Dibooglu and Horvath (1997), distinguished the supply, nominal, and real fiscal shocks. They try to tackle the case comparing original members of the European Community to new members and non-members. Results showed that for newer members and non-members, most of shocks are country specific, pointing to the need for alternative adjustment mechanisms other than national monetary policies after the introduction of a single currency.

Zhaoyong Zhang & Kiyotaka Sato (2005), in their work, tried to investigate whether Greater China including Mainland China, Hong Kong and Taiwan should make an OCA. Although, there were military strains in Taiwan Strait, the intense and increasing cross-border transactions flows both in terms of trade of goods and flows of FDI and of technologies, hastened the regional integration in the area. Considering the symmetry in shocks as one of the major preconditions of a currency union, the study investigated correlation of supply and demand shocks by applying time-varying and the Kalman filter technique. Findings showed a marginal correlation between geographical proximity and the grouping of countries into optimum currency areas. Hong Kong was found to display patterns in supply shocks which is similar to that of China while marginal signal of convergence for Taiwan was found only for the last years of the period under review. Very importantly, the evidence of two way causality between convergence and integration appeared here indicating an on-going process of convergence with the regional integration. It was observed that shocks in demand for Hong Kong and Taiwan were getting increasingly synchronized with the Mainland pointing to some extent, plausibility of the policy mix of the mainland Central Banks.

According to AHMED JASSIM B. (2015), the monetary union promotes trade which in turn enhances the economic growth. Using the panel Generalized Method of Moments (GMM) estimator, he assessed the effect of exchange rate volatility on bilateral trade between the GCC (Gulf Cooperation Council) countries. Findings showed that the elimination of exchange rate volatility would increase bilateral trade among GCC countries by about 6.2 up to 8.7%. He also analyzed the link between the trade and the economic growth and estimated the impact of trade on per capita growth rate for GCC member countries. He used the panel GMM estimator indicating that a one-standard deviation increase in the trade (or openness) ratio would increase the growth rate per capita by 2 up to 3%.

Lucio D'Aguanno (2016) investigated the welfare gains from a monetary union using a dynamic stochastic general equilibrium model with monetary barriers to trade, local currency pricing and incomplete markets. He estimated the model using standard Bayesian tools and data from Italy, France, Germany and Spain. Findings pointed out, that the tradeoff between monetary independence and monetary union was resolved in favor for the countries to form a monetary union. He noted also that the welfare ordering of alternative currency systems depends crucially on the international correlation of macroeconomic shocks and on the strength of the monetary barriers affecting trade with separate currencies.

In Africa, researchers working on the regional integration were challenged by the availability and reliability of data on optimum currency criteria (George S. Tavlas, 2008). It is hard to get time series on the labor mobility, degree of wages and prices flexibility, the uncovered and covered interest rates parity in the area of financial integration. Mostly, these studies focused on traditional OCA criteria due to above mentioned shortcoming of data. They looked at the nature of the shocks affecting members, assessed correlation between RER or terms of trade and the co-movement in cyclical real growth rates across the economies. Indeed, countries that are confronted to case of symmetry of shock, high correlation of real exchange rate or terms of trade, or the co-movement of cyclical real growth of output, don't need country-specific monetary or exchange rate policies to absorb the shocks. A single monetary policy or a fixed exchange rate is sufficient.

Assuming that changes in output result from shocks, Bayouni and Ostry (1997), assessed the bilateral correlation of output growth rates in the case of eleven Southern African countries using data from 1963 to 1989. They used residuals from autocorrelations of per capita growth to check for correlations

of shocks across countries. Findings revealed that correlations are slightly positive but minor and not statistically significant.

Using the three step regression methods to compute the cyclical component in PPP output growth and GDP adjusted real exchange rate at market prices, the differencing, HP and the Band-pass filter, Karras (2007) calculated bilateral correlations of nine SADC member countries over the periods 1960-2000 and 1980-2000. He came up with the conclusion that Malawi, Mozambique, South Africa, Zambia, and Zimbabwe can make a monetary union.

Basing on econometric approach and using three steps autoregression process, Bayoumi and Ostry (1997), Yehoue (2005), and Wang et al (2006) regressed the growth rate of per capita GDP on its first and second lags, generate the residuals of the regression and computed the correlations of disturbances among countries under review. Bayoumi and Ostry calculated the correlations of output disturbances for 11 countries over the period 1963-89. Yehoue got correlations for 15 countries over the period 1980-2000. Wang et al. appraised correlations for five countries over the period 1980-2005.

Wang, Masha, Shirono, Harris (2006) estimated correlations of the shocks for Botswana and the four CMA economies over the period, 1980-2005. They found that most of the shocks were negative between Botswana and CMA.
Masson and Patillon (2005), basing on 14 SADC member constituents, with three different approaches – correlation of percent change in terms of trade, simulation of cost and benefits of a monetary union using model calibration and the gravity model to investigate the trade creation effect, concluded on gradual and selective path to a monetary union.
Jefferis (2007) estimated, over the period from 1990 to 2002 correlations of bilateral exchange rate against the South African Rand, the inflation and interest rate differential reference made to South Africa and revealed that Botswana, Lesotho, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania form a converging group.

Based on more elaborated statistical methodology, Grandes (2003), Khamfula and Huizinga (2004), assessed the cointegration between bilateral real exchange rate for four CMA and Botswana. The study used monthly data covering the period from 1990 to 2001. The rand served as benchmark currency. Each of the four bilateral rates was tested for cointegration using a vector formed by the remaining vectors. The authors concluded that in the case the cointegration relationship between, the vectors of the bilateral exchange rates were moving together, and therefore correlated.

Taking Greece as a benchmark, Simionescu M. (2015) studied income convergence of six Central and Eastern European economies, member of European Union over the period 2003-2012. ADF test applied to income differentials toward the benchmark country, the author found that save the case of Romania and Bulgaria which are proven to converge toward Greek income, the remaining economies display wide income differences relative to Greece. The latter has the highest income compared to all those countries.

Mark J. Holmes (2002) studied the case of some OECD countries, using three different techniques namely univariate unit root test, panel data unit root test and the t-bar panel data unit root on quarterly GDP differentials over the period 1960-1998. Results from univariate ADF showed evidence of convergence for a few countries, T-bar found strong convergence using US or German as benchmark; while the panel data unit root showed convergence in a small number of countries where convergence was stronger using US as benchmark than when German is taken as base.

Fabio Busetti (2006) found, by applying ADF test on inflation differentials of some countries in European Union over the period 1980-2004, evidence of convergence on the sub-sample period from 1980 to 1997 while the second sub-sample (after the adoption of the euro) was characterized by divergences in inflation. Two separate groups of inflation convergence emerged; the first with lower inflation (German, France, Belgium, Austria and Finland) and the other with higher inflation (Spain, Netherlands, Greece, Portugal and Ireland). Italy didn't find place in the two groups and was in between. Additional researches applied ADF tests to pairwise differentials in income including Yin-Wong Cheung* and Antonio Garcia Pascualy, 2004 and Sabine Herrmann and Axel Jochem, 2003.

On the endogeneity side of the OCA, the gravity model reflecting the effect of the monetary union on the trade within member constituents has been used by different authors including Rose (2000) and Masson and Pattillo (2005). The model includes the GDPs of two economies, in level and per-capita specifications, the distance separating the two economies, the area of the economies as independent variables. Additional variables include dummies which may reflect the possible effects of common features of the economies such as membership in a free-trade area or currency union and a common language etc.

It is expressed in logarithm:

$$\ln(Xij) = \beta_0 + \beta_1 \ln(YiYj) + \beta_2 \ln(\frac{Y_i}{Pop_i}\frac{Y_j}{Pop_j}) + \beta_3 \ln(Dist_{ij}) + \beta_4 \ln(Area_i Area_j) + \sum_{k=1}^{n} \beta_{4+k} Dk$$

X_{ij} stands for bilateral trade between I and j countries; Y_i and Y_j represent the real GDP;

POP_i and POP_j denote population of country i and country j, $Dist_{ij}$ stands for the distance between the two economies; $Area$ is land area and; D_k denotes the dummies which reflect also the effect of monetary union on trade assuming that separate national currencies are considered as a barrier to trade.

For each CMA country other than South Africa, Masson and Pattillo (2005) found that the share of bilateral trade with South Africa over total trade was found to be 50 percent higher in a monetary union than the trade without a monetary union as evidenced by estimations from the gravity model. The union is therefore known to give a boost to the intra-regional trade.

Albert Mafusire and Zuzana Brixiova (2012), investigated whether the targeted speedy creation of the East African Monetary union by 2015 and the loss of the monetary policy as counter-cyclical policy tool would not be too costly for member countries. Their paper assessed the readiness of member countries to adopt a single currency. Using SVAR approach, they assessed the synchronization of shocks in EAC. For the structural similarity of the EAC countries, they used index of structural similarity of production and exports.

They came up with the conclusion that EAC community displays a low shock synchronization suggesting that the shift to EAMU would need an in-depth evaluation and preparation. More studies were conducted on readiness of EAC to form a monetary union including, Paulo Drummond, at al. (2015), Buigut (2011); Rusuhuzwa & Masson, (2012); Davoodi et al., (2013); Lepetit et al., (2014); Asongu (2014bc); Buigui & Valev (2005); Falagiarda (2010) Kishor & Ssozi (2011) as well as Sheik et al. (2011).

IV. METHODOLOGY

In this paper, we used the ADF test applied to differentials in both real and nominal variables and the correlation method on growth rates, shocks using the three step autoregressive method. The latter been applied to investigate

the existence of correlation of shocks to real output as to pinpoint the presence or absence of asymmetric shocks.

4.1. The Univariate Unit root test

Convergence can be tested using the properties of time series of concerned variables where convergence is taken as a dynamic stochastic process. Under this procedure, ADF test is applied to differentials in income growth rates, inflation, exchange rate and interest rates. The variable differentials are obtained as the difference between the growth rate of country j $(j = 1,\ldots n-1)$ and the reference country i which is Kenya in our case.

Kenya was chosen as reference since it has the highest per capita income. The remaining countries are expected to converge toward Kenyan per capita income. The rationale behind this methodology stems from the original neoclassical growth model by Solow (1956) which believes that countries should converge to a balanced growth path with poorer countries growing faster than the richer ones. At the end, the theory assumes that differences in per capita income are going to disappear over time.

Using annual per capita income data at power purchasing parity in US dollars from IMF database, we computed the annual growth rates over the period from 1980 to 2017 included for the five EAC member countries. The series of growth rate began in 1981. Individual growth rate differentials from Kenyan per capita income growth are computed and tested for unit root. The weakness of this methodology is the low power which needs to be supplemented by another test. The rejection of unit root hypothesis doesn't necessarily point to convergence. Unit root tests show that two or more variables are in the process of converging, with large part of the gap between them depending on the initial conditions.

The long run prediction of output gap is not likely to trend toward zero, but the relative convergence appear in the pairwise countries. Poor countries are making effort to catch up the reference country, Kenya in our case. The same methodology has been used for nominal convergence tests. The univariate unit root has been used by researchers like Mark J. Holmes (2002), Simionescu M.* (2015), Yin-Wong Cheung* and Antonio Garcia Pascualy (2004) and Sabine Herrmann and Axel Jochem (2003), and Fabio Busetti et al. (2006) among others.

4.2. Correlation of output growth

Using the same procedure as George s. Tavlas (2008) interpreting Bayoumi and Ostry (1997), our study computed the correlation of bilateral growth rates of per capita income at power purchasing parity. The rationale behind this procedure is that the difference in income between countries result not only from the trend effect but also from the impact of shocks. This methodology help to measure the extent to which shocks to income (inflation, interest rates, exchange rates, etc) are correlated among member states. Positive and statistically significant correlations point to symmetric shocks between countries while non-significant and negative ones indicate asymmetric shocks. It is applied on income per capita, inflation, exchange rate depreciation and interest rates, case by case.

On income side, data on per capita growth rate are generated from nominal income in levels. Annual average growth rates were computed and tested for correlations. Such correlation are helpful to investigate the degree of synchronization of economic shocks between the EAC countries. Similarly for the case of per capita income, this study employed also the three step autoregressive methodology. Correlation of shocks obtained from regression of the growth of per capita income on its first and second lags are calculated at the one hand and, at the other hand we computed the correlation of the cyclical components obtained from the data series by using HP filter and the Band Pass Filter.

If correlations are positive and significant, then there are positive correlations of business cycles and countries are found to converge. Otherwise (if non-significant or negative) countries are not converging and likely to be affected asymmetrically by shocks. The same procedure was used by authors like Bayoumi and Ostry (1997), Yehoue (2005), and Wang et al (2006) and Jian-Ye Wang et al. (2007).

The correlation methodology has limits. It doesn't make clear separation between shocks to output and the policy impact on disturbances. Indeed, a shock can combine the impact of policies to shocks and the shocks themselves. Similarly, a shock may affect differently countries depending on individual country's initial positions and differences in behavioral parameters with regard to fundamentals such as wage and price, price stability, tax structure (George S. Tavlas, 2008 citing Mélitz, 1991, p. 321; Tobin, 1993). Again, the autoregressive methodology doesn't distinguish the demand shock and the supply shocks which can affect simultaneously the economy. To address these shortcomings, writers Buigut and Valev (2006) employed the

Blanchard-Quah decomposition to split shock into demand and supply shocks, which is beyond this paper.

Data

Apart from the per capita income, the study utilized other time series in this analysis namely inflation, nominal and real exchange rate as well as interest rates (deposit rates, 91 day T-bill rate and the lending rates). Monthly consumer price data are extracted from respective country bureau of statistics and cover the period from January 2005 up to September 2017. Annual percent changes are computed and resulting inflation series started from January 2006 ending September 2017. Nominal exchange rate series started generally from January 2000 up to June 2017 except for Burundi and Tanzania. Burundi data started with January 2011 while for Tanzania series started with January 2001. Data on exchange rate and interest rates are from the Central Banks websites. Real exchange rate data are extracted from Darvas, Zsolt (2012a).

We utilized annual data for the real exchange rate since the monthly and quarterly data were missing for Tanzania. The series on interest rates cover the period from January 2000 to June 2017 for both lending, deposit and the T-bill rates with exception of Burundi which deposit and T-bill rates ran from January 2002 and January 2007 respectively and Rwanda which T-bill rates are available from April 2004.

Before we proceeded with the results of the estimation, we discussed the current economic performance indicators toward achieving the convergence criteria as set by EAC Treaty.

V. Empirical Results

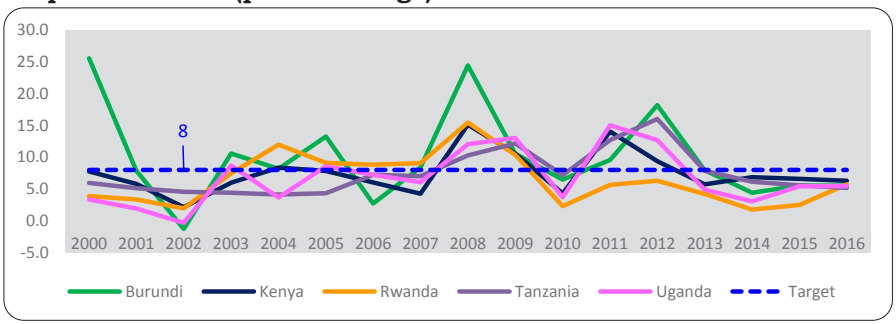
5.1. Assessment of convergence criteria

For the sake of sustainability of the integration, member states agreed on convergence criteria and fixed the benchmark for each of the criteria. This section discussed recent macroeconomic indicators toward observance of the convergence criteria. The indicative targets to be achieved in terms of these indicators include core inflation of less than 5%; fiscal deficit excluding grants at most 6% of gross domestic product and tax revenues as ratio of GDP at least 25%. On macroeconomic level, convergence should be analyzed referring to headline inflation ceiling of 8%; fiscal deficit including grants ceiling of 3% of GDP; gross public debt ceiling of 50% of GDP in net present value terms; and reserve cover of 4.5 months of imports.

a) Inflation convergence

In EAC, countries have been recording common episodes of high/low inflation pressures. Countries are facing almost the same shocks such as fluctuations in commodity prices which affect terms of trade in the region or the adverse weather conditions that affect food crops. In response to the deteriorating terms of trade, regional currencies depreciated to absorb the external pressures adding to the effect of adverse weather conditions and fluctuating oil prices on the domestic inflation.

Graph 8: Inflation (period average)



Source: IMF, World Economic Outlook, October 2017, database

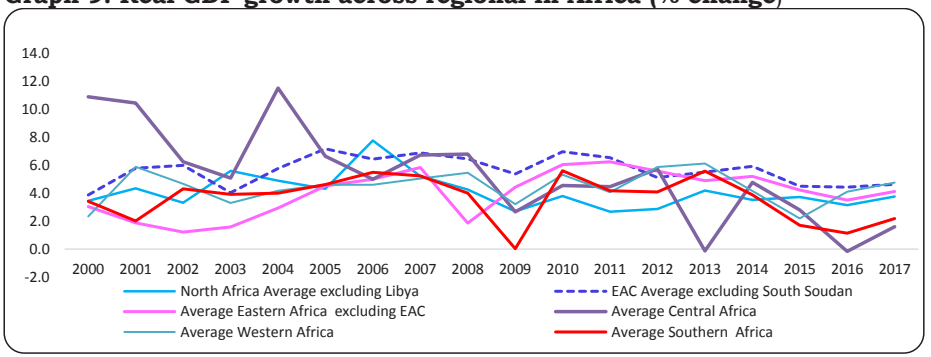
High inflationary pressures were recorded in the period before 1990 and temporally in 2007-2008 due to commodity prices shocks subsequent to the global financial crisis. From 2012 up to date inflation in EAC was downward trending reflecting efficient monetary and fiscal policies together with positive agriculture performances despite some upward pressures from oil prices and exchange rate pressures as well as adverse weather conditions in some points of time. Overall, since 2013, average inflation has been lower than 8% target. Visual inspection of graph on inflation shows a co-movement of trends therefore limited presences of asymmetric shocks. For the year 2016, EAC average inflation stood at 5.7 percent but trends were heterogeneous across countries. Inflationary pressures are seen easing in 2017 as weather conditions improved and agriculture output recovered from 2016 slowdown. This simple visual inspection will be supplemented by some econometric estimations to conclude with absence/presence of inflation convergence.

b) Per capita income convergence

While not explicitly announced in EAC convergence criteria, the efficiency of a monetary union depends a lot to correlation of real and nominal shocks. Policy adjustments in countries that are facing asymmetric shocks imply costs in case of MU. Globally, the EAC countries realized remarkable progress

in terms of economic performance before and after the global financial crisis helped by strong public investment, foreign capital inflows together with ease of financial conditions.

Graph 9: Real GDP growth across regional in Africa (% change)



Source: Authors' calculations using data from IMF, World Economic Outlook, October 2017, database.

Regional integration has played a big role in sustaining these macroeconomic performances creating strong regional resilience to shocks. End 2016, the EAC economic growth was estimated at 5.8% while large African economies like Nigeria, South Africa, Angola were faced with the recession. Sub-Saharan Africa region in general has touched the bottom in more than two decades with a real GDP growth of 1.4 percent only in 2016 from an average of 5.5 percent over the period from 2000 to 2015.

EAC additional support factors include macroeconomic stability, favorable business climate and government stability as well as sound macroeconomic policies. Average GDP growth was 5.9% over 2000-2010 and decelerated to 5.3% over 2011-2016 undermined by the last commodity prices shocks, the drought in most of EAC countries together with the political strains in some countries in the region. Individually, countries were however differently affected and economic performances scattered within the region.

Graph 10: EAC Real GDP Growth (%)

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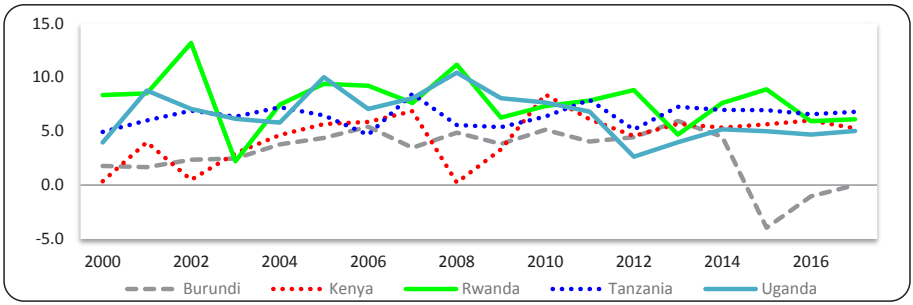
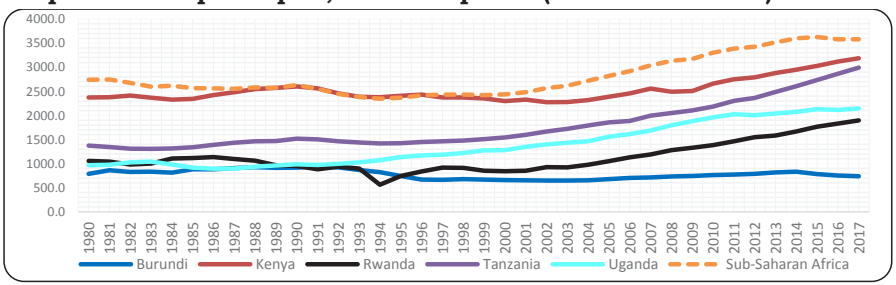


Source: IMF, World Economic Outlook, October 2017, database.

Rwanda, Tanzania and Uganda remained the engine of the strong EAC economic performance. Kenya was undermined by post-election concerns in 2007-2008 and by the drought in 2016 and Burundi is hit by domestic insecurity. Overall growth remained strong in EAC but lower than the average of the last years. Per capita income as measured by per capita GDP at power purchasing parity, has been gradually improving for EAC countries. Kenya has been and stays the best performer in terms of per capita income but has been poor performing compared to average income for the Sub-Saharan Africa since 1998.

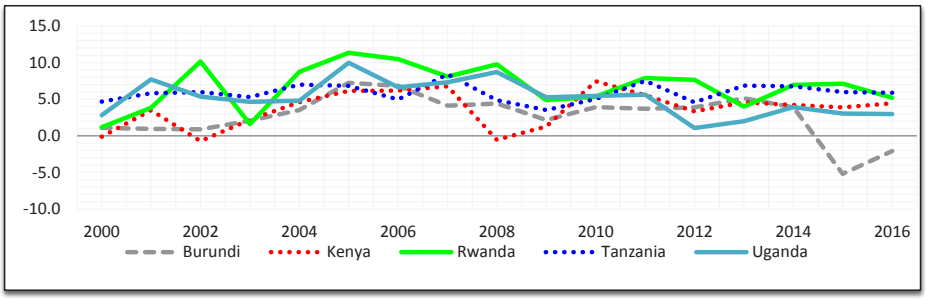
Graph 11: GDP per Capita, constant prices (PPP in US dollars)



Source: IMF, World Economic Outlook, October 2017, database.

While Tanzanian per capita income is visually converging to Kenyan, income differences are growing between Kenya and the remaining EAC members with Rwanda gradually trending to catch up. The case of Burundi has deteriorated with the recent political instability.

Graph 12: Per capita growth rate (%)



Source: IMF, WEO, October 2017, database

Still in the area of real convergence, Kenen (1969) proposed for the monetary union to be efficient, member constituents need to display similar, and widely diversified production and exports structure. Indeed, in that case, there are few asymmetric shocks and each of them is likely to be of small concern.

On production side, EAC economies are characterized by the predominance of agriculture sector in the years before 2000 and by the service sector later on. On average, over the period from 2012 up to 2016, regional GDP structure displayed a profound transformation compared to the prevailing status two decades before. The service sector is taking the lion's share followed by the agriculture while the industry sector remains embryonic in EAC countries.

Tab.2: EAC countries GDP structure (% share of total GDP)

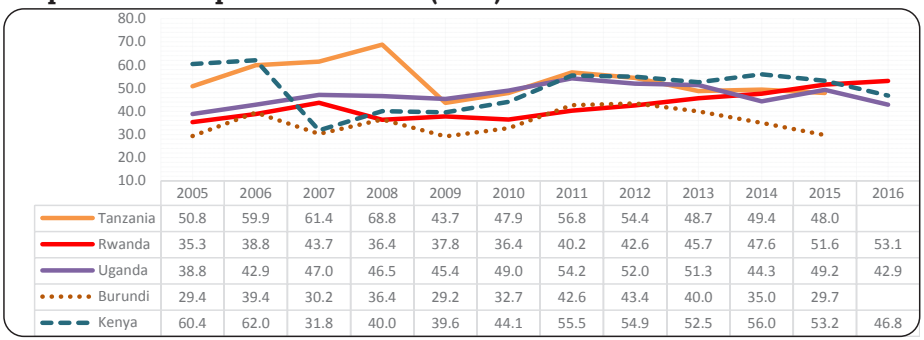
		1990-1995	1996-2001	2002-2006	2006-2012	2012-2016
Agriculture	Burundi	50.8	46.4	38.8	36.1	36.1
	Kenya	30.1	31.7	27.9	23.0	22.3
	Rwanda	42.7	43.6	42.0	31.4	28.4
	Tanzania	44.8	44.1	44.3	25.3	24.6
	Uganda	50.1	38.6	32.0	24.6	22.9
Industry	Burundi	20.7	17.4	19.2	16.0	15.6
	Kenya	20.3	17.6	17.9	16.3	19.0
	Rwanda	21.2	19.0	20.0	15.1	16.9
	Tanzania	14.7	14.8	16.2	21.2	21.8
	Uganda	14.0	19.5	21.5	19.4	19.0
Services	Burundi	28.5	36.2	42.0	38.8	38.3
	Kenya	49.6	50.7	54.3	48.3	49.3
	Rwanda	36.1	37.4	38.0	45.1	47.6
	Tanzania	40.5	41.1	39.5	44.4	44.0
	Uganda	35.9	42.0	46.5	43.8	50.0

Source: Author's calculations based on data from Country Bureau of Statistics

The low level of diversification of the production sector increases the vulnerability of the EAC economies to shocks. According to Kenen's idea, in the presence of labor mobility, countries that have narrow but similar production structures fit into a monetary union since they are likely to be affected symmetrically by a terms-of-trade shock. While it is early to confirm the presence of asymmetric shocks in the case of EAC economies, this structure is likely to pre-expose EAC economies to adjustments costs once in a monetary union with limited or non-existing labor mobility.

Subsequent to the weakness of the industry sector, exports in EAC are predominantly composed by commodities therefore vulnerable to depreciation in terms of trade, currently impacting the level of openness to the rest of the world. According to McKinnon (1963), the level of openness play a big role in regional integration as countries which are largely open to trade and possess high level of intraregional trade can efficiently adopt an OCA. Although the EAC openness to the rest of the world remains low, it has improved during the last decade despite the effect of recent declines in commodity prices.

Graph 13: EAC Openness to trade (in %)

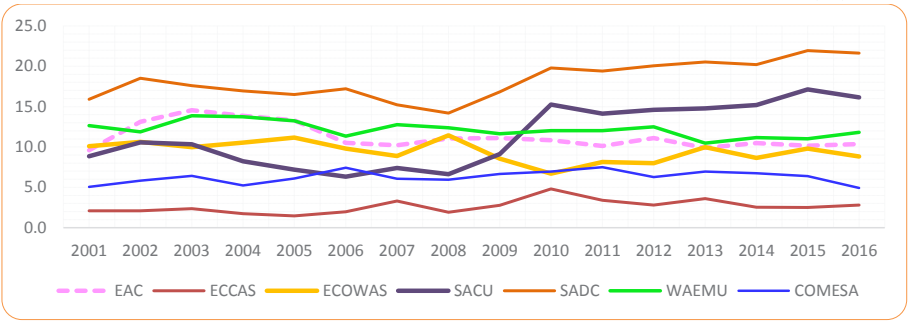


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tanzania	50.8	59.9	61.4	68.8	43.7	47.9	56.8	54.4	48.7	49.4	48.0	
Rwanda	35.3	38.8	43.7	36.4	37.8	36.4	40.2	42.6	45.7	47.6	51.6	53.1
Uganda	38.8	42.9	47.0	46.5	45.4	49.0	54.2	52.0	51.3	44.3	49.2	42.9
Burundi	29.4	39.4	30.2	36.4	29.2	32.7	42.6	43.4	40.0	35.0	29.7	
Kenya	60.4	62.0	31.8	40.0	39.6	44.1	55.5	54.9	52.5	56.0	53.2	46.8

Source: Country Bureaus of Statistics and Central Bank websites

Similarly, EAC intraregional trade of merchandises while still nascent represents 11.3% of the total EAC external trade placing the region at the fourth rank over seven selected large African regional integrations after SADC (18.3%), WAEMU (12.2%) and SACU (11.4%). A big part of regional trade passes through cross-border trade and very difficult to capture.

Graph 14: Intraregional merchandise trade to total merchandise trade (%)



Source: International Trade Center, 2017

Like in Africa in general, the reasons behind weak intraregional trade flows are the low level of income which limits the market size, infrastructure bottlenecks and the structure of the exports which are alike across the region. All EAC member countries are mostly exporting agriculture commodities, a few minerals and limited manufactured products which comprise mainly products of agro-industries with low value added. Exports from African regional integration remained subdue (refer to appendix 1.).

Tab.3: EAC exports structure (% share of the total exports)

		2010	2011	2012	2013	2014	2015	2016
Rwanda	Coffee	18.9	16.1	10.3	7.8	8.3	9.1	7.9
	Tea	18.7	13.8	11.1	7.9	7.2	10.6	8.5
	Pyrethrum	0.5	1.0	1.6	0.6	0.3	0.4	0.5
	Minerals	22.8	32.6	23.0	32.1	28.1	17.2	11.6
	Cassiterite	14.2	20.9	9.0	8.7	9.9	5.0	4.7
	Coltan	6.2	8.3	9.6	19.1	14.5	9.7	5.3
	Wolfram	2.4	3.5	4.4	4.3	3.7	2.5	1.6
	Hides and skins	1.3	1.6	2.4	2.3	2.0	1.5	1.0
	Other products	23.4	18.3	33.2	30.9	37.2	42.9	50.9
	Re-exportations	12.1	7.9	18.3	19.2	22.9	26.0	30.1
Kenya	Tea	23.9	21.2	21.1	22.7	20.6	24.7	24.5
	Horticulture	16.9	14.9	14.3	16.7	17.4	16.0	18.2
	Coffee	4.3	4.0	4.6	3.5	4.4	4.1	4.2
	Fish	1.3	1.0	1.1	0.7	0.9	0.7	0.4
	Chemicals	8.6	10.3	9.7	8.9	8.7	8.6	8.5
	Petroleum	1.8	2.1	1.4	0.9	1.3	1.4	1.0
	Cement	1.9	1.8	1.7	1.8	1.5	1.6	0.9
	Other	41.3	44.7	46.0	44.6	45.2	42.9	42.3
Uganda	**Coffee**	13.2	18.5	13.3	15.0	15.0	15.1	12.7
	Gold	1.4	0.3	0.3	0.1	0.0	1.3	11.6
	Fish & its prod.	6.2	5.7	4.3	3.8	4.9	4.4	4.2
	Oil re-exports	4.9	4.2	4.7	4.8	5.5	4.9	4.1
	Tea	3.2	2.9	2.6	3.0	3.1	2.6	2.5
	Maize	1.6	1.1	2.1	1.5	1.7	3.4	2.4
	Tobacco	3.2	2.2	2.2	4.1	2.4	2.7	2.1
	Hides & skins	0.8	1.3	1.5	2.3	2.7	2.4	1.8
	Flowers	2.2	2.1	1.9	2.0	2.1	1.9	1.8
	Beans	0.4	0.7	0.5	0.6	0.9	2.0	1.3

Tab.3 (con't): EAC exports structure (% share of the total exports)

		2010	2011	2012	2013	2014	2015	2016
Burundi	**Primary commodities**	97.3	92.4	89.6	71.4	67.6	69.6	-
	coffee	70.6	60.9	52.0	31.5	41.7	33.2	-
	Tea	18.0	17.2	18.9	26.4	18.4	27.8	-
	Hides &skins	3.3	4.9	4.9	2.8	3.0	4.2	-
	Minerals	0.0	0.0	1.1	3.0	2.3	2.1	-
	Manufactured products	2.7	7.6	10.4	28.6	32.4	30.4	-
	Soap	1.3	3.3	4.1	8.7	6.0	5.6	-
	Bear	1.8	1.8	2.0	3.0	4.4	5.4	-
	Wheat flour	0.0	0.0	0.0	3.2	4.0	5.3	-
	Tobacco	1.4	1.1	2.1	4.5	3.0	4.9	-
Tanzania	**Traditional exports, US$**	56.0	50.1	39.9	27.1	21.0	-	
	Tobacco, value	8.7	7.2	5.2	4.2	5.7	-	-
	Cashewnuts, value	16.9	16.8	11.5	6.6	4.8	-	-
	Coffee, value	17.1	12.7	11.4	6.7	3.6	-	-
	Tea, value	4.8	4.1	4.5	3.4	3.0	-	-
	Cotton, value	7.5	4.7	5.2	4.0	2.9	-	-
	Non-traditional exports, US$	44.0	49.9	60.1	72.9	79.0	-	-
	Minerals	4.1	12.2	24.3	35.5	39.2	-	-
	Gold	0.5	5.8	15.4	29.8	34.8	-	-
	Other Export Products	13.7	12.1	8.6	9.3	12.2	-	-
	Fish and Fish Products	11.7	9.4	10.4	11.4	11.9	-	-

Source: Central Banks websites

The similarity of production structure together with the similarity of export resources has been a key challenge against the intensification of intraregional trade flows but can be a potential that should be maximize with the integration trading with the rest of the world.

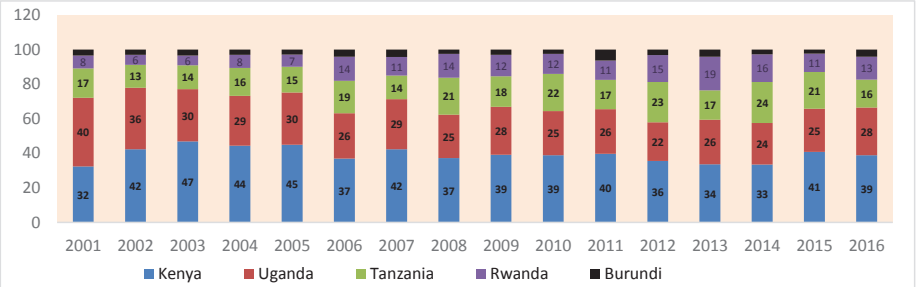
Tab.4: EAC intra-regional trade of merchandises (millions USD)

	Kenya	Uganda	Tanzania	Rwanda	Burundi	Total EAC
2001	305.3	375.6	159.6	70.9	32.7	944.2
2002	483.8	408.2	151.3	66.3	35.3	1144.9
2003	750	483.8	221.4	89.5	56.9	1601.7
2004	843.3	547.5	306.5	143.7	58.7	1899.8
2005	1037.5	696.2	343.1	160.3	69.2	2306.3
2006	821.5	583	415.6	312.6	91.8	2224.5
2007	1144.4	778.9	368.1	290.5	118.4	2700.3
2008	1402.9	948	804.1	523.1	94.2	3772.4
2009	1333.3	945.7	601.9	423	106.6	3410.6
2010	1535.8	1005.1	853.2	455	101.7	3950.8
2011	1848.3	1196.4	787.1	519.8	297.3	4648.9
2012	1964.5	1227.2	1291.9	855	179	5517.7
2013	1619.9	1244	818.6	934	201.1	4817.7
2014	1846.5	1326.9	1304.6	887	151.5	5516.5
2015	2300.8	1401.8	1203.6	592.5	137.5	5636.2
2016	1747.3	1241.4	731.1	595.2	187.1	4502.1

Source: Source: International Trade Center, 2017

Over the period from 2001 to 2016, EAC intraregional merchandise trade value is estimated to a total average of USD 3.412 billion of which Kenya counts USD 1.312 billion (39% of the total), Uganda with USD 0.901 billion (28%), Tanzania with USD 0.648 billion (18%), 0.432 billion pertaining to Rwanda (11%) while Burundi count for USD 0.120 billion (4%).

Graph 15: Share of total intraregional trade of merchandises (%)



Source: International Trade Center, 2017

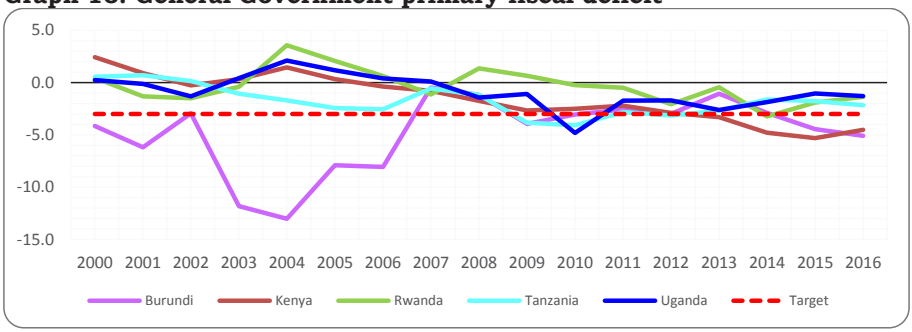
c) Reserve cover of 4.5 months of imports

Tight range of export products, mostly commodity based exports compared to important range of imported manufactured products and durable equipment result into persistent and increasing trade deficit across the region. The latter, together with slowing foreign inflows (aids, remittances, investments) and the resulting exchange rate pressures lead to a wide drop in foreign reserves. EAC countries decided to keep at least the equivalent of 4.5 months of imports in terms of international reserves to counteract the impact of unexpected external shock. A close look to performance in terms of international reserves showed Uganda complied with the minimum of 4.5 months of imports since 2012 and Kenya starting 2014. Rwanda used to have more than 4.5 months of imports in terms of reserves but missed the target since 2014. This was due to the poor performance of exports following the decline in commodity prices on international markets amid rising imports related to big construction projects during the period. Burundi and Tanzania never reached the target over the period from 2010 to 2016.

d) Government primary deficit and Gross domestic debt

Government in the EAC spends important amounts in terms of investments to support the economic growth. In terms of government primary deficit, EAC member states stay close to the benchmark level of 3%. Kenya and Burundi have, since recently missed the target. Rwanda stayed in accordance with this criteria since earlier 2007.

Graph 16: General Government primary fiscal deficit

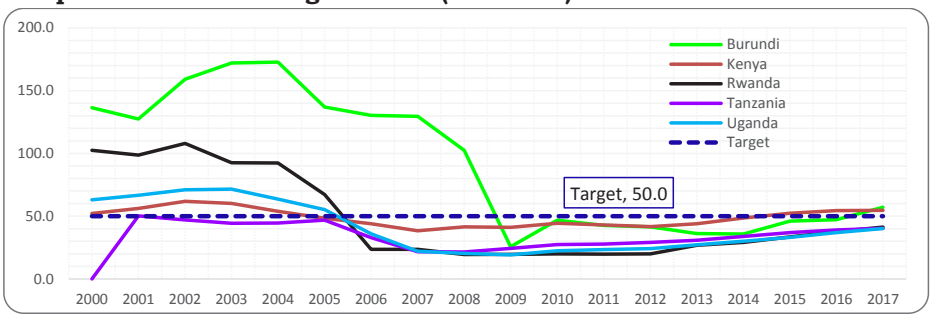


Source: IMF World Economic Outlook, October 2017, database.

The scaling up of public investment resulted into rising debt which need to be mitigated to bring it back to normal levels consistently to the convergence criteria in line with countries fiscal and external sustainability principles.

Already, between 2000 and 2007, most of EAC benefited from different debt relief initiatives under HIPC and MDRI. In 2016, EAC total government gross debt amounted at 45.6 percent of GDP against 29.8 percent in 2009.

Graph 17: Government gross debt (% of GDP)



Source: IMF, World Economic Outlook, October 2017.

The debt increased again significantly in the last four years due to the slowdown in export receipts, the decline in foreign inflows as well as the effect of depreciation of regional currencies.

Overall, on convergence criteria, countries succeeded to comply with the target on inflation. Two countries over 5 (Uganda and Kenya) achieved the target on international reserves, others like Rwanda and Tanzania are closer

to target while Burundi is far away from the target. Burundi and Kenya did not comply with the benchmark on fiscal deficit.

Tab.5: EAC performance criteria

	Indicator	Benchmarks	2010	2011	2012	2013	2014	2015	2016
Headline inflation	Burundi	8%	6.5	9.6	18.2	7.9	4.4	4.6	5.5
	Tanzania	8%	7.2	12.7	16.0	7.9	6.1	5.6	5.2
	Uganda	8%	3.7	15.0	12.7	4.9	3.1	5.4	5.5
	Kenya	8%	4.3	14.0	9.4	5.7	6.9	6.6	6.3
	Rwanda	8%	2.3	5.7	6.3	4.2	1.8	2.5	5.7
	South Sudan	8%			45.1	0.0	1.7	52.8	380.0
International Reserves (months of imports)	Burundi	4.5	4.1	3.2	3.4	3.4	3.5	4.2	1.9
	Tanzania	4.5	4.1	3.5	3.6	4.0	4.3	4.0	3.7
	Uganda	4.5	3.9	3.7	4.5	4.8	5.1	4.8	4.5
	Kenya	4.5	2.9	2.8	3.7	3.9	5.3	5.1	4.8
	Rwanda	4.5	5.2	6.5	5.6	4.8	3.9	3.5	4.0
	South Sudan	4.5		6.3	3.5	2.5	1.4	0.3	0.2
Fiscal deficit, including grants (in % of GDP)	Burundi	6	-3.6	-3.9	-3.7	-1.7	-3.4	-5.3	-6.2
	Tanzania	6	-4.8	-3.6	-4.1	-3.9	-3.0	-3.3	-3.8
	Uganda	6	-5.8	-2.6	-3.0	-3.9	-3.3	-2.7	-3.6
	Kenya	6	-4.4	-4.1	-5.0	-5.7	-7.4	-8.2	-7.3
	Rwanda	6	-0.7	-0.9	-2.5	-1.3	-4.0	-2.8	-2.4
	South Sudan	6		4.6	-14.8	-2.9	-7.0	-18.4	-20.0
Gross public debt (% of GDP)	Burundi	50	46.9	42.7	41.4	36.1	35.7	46.0	47.2
	Tanzania	50	27.5	28.0	29.2	31.4	33.2	36.9	39.0
	Uganda	50	23.6	23.3	24.6	27.4	30.1	33.2	36.9
	Kenya	50	44.4	43.0	40.8	42.2	48.6	52.4	54.4
	Rwanda	50	20.0	19.9	20.0	26.7	29.1	33.4	37.6
	South Sudan	50		0.0	8.9	17.6	34.8	65.7	33.0

Source: Central Banks websites

Achieving less than 3 percent target on primary deficit has been challenging as governments are doing a lot to address macroeconomic imbalances mostly through significant public investment and development spending. Countries are also experiencing significant deterioration in terms of trade; volatile agricultural productivity as result of weather conditions and volatilities in exchange and waning aid flows which make it difficult to comply with the target on international reserves.

The international reserves in terms of months of imports reduced across regional countries but remain close to the minimum required with Burundi and South Sudan as exception. Improvement in external reserves in most countries was on account of a deliberate policy to build reserves through efficient management of forex. While some member states missed again the target on the overall budget deficit mainly due to increasing capital expenditures associated with governments' effort to develop key

infrastructure, transport and energy, amid subdued revenue collections, there is a somewhat improvement. In the area of fiscal deficit there is a need to renew commitment in fiscal discipline and enhance fiscal surveillance.

5.2 Results of estimations

5.2.1. Per capita income convergence

a. Univariate ADF test method

Starting from IMF data on per capita income as measured at PPP terms over the period 1980-2017, the analysis assessed the convergence of the per capita income across EAC region. We checked for convergence of bilateral income difference with Kenya. Kenya was taken as benchmark as it has the highest per capita income. The question is to see if each economy is catching-up with Kenya income. Visual inspection of the graph on per capita income showed that bilateral income differences are still wide across countries but are getting closer and closer over time. Simple statistical calculations, applying ADF tests to the income differences confirmed the visual observation.

The null hypothesis of non-stationarity is taken as no convergence with respect to the benchmark country (Kenya). Over the period from 1980 to 2017, ADF test results showed non-stationary process of the income differences save for the Tanzanian economy. The latter is proven to be converging with Kenya at 5% level of significance. For the remaining countries, income differences are not stationary.

Tab.6: ADF test statistics over 1980-2017

Period 1980-2017				
	Burundi	Rwanda	Tanzania	Uganda
ADF Test	-2.095124	-2.014977	-2.158502	-2.095124
P-value	0.5310	0.5742	0.0315	0.5310
ADF result	Non-stationary	Nonstationary	Stationary	Nonstationary
Period 1990-2017				
ADF Test	-2.833214	-6.089864	-3.923218	-4.354370
P-value	0.0064	0.0000	0.0059	0.0097
ADF result	Stationary	Stationary	Stationary	Stationary
Period 2000-2017				
ADF Test	-2.448277	-6.110097	-2.321383	-3.684784
P-value	0.0179	0.0009	0.0235	0.0523
ADF result	Stationary	Stationary	Stationary	Stationary

The same test was conducted over the shortened periods of study from 1990 to 2017 and from 2000 to 2017 to ensure the integration is helping to improve the convergence process. Results showed that the null hypothesis of unit root is rejected at 5% for the four countries within the two time periods. For the period 2000-2017, the null hypothesis of unit root for Uganda is only rejected at 10%. We therefore have indirect evidence of convergence between EAC countries and Kenya which operates through convergence between each country with the benchmark Kenya. However, we said that this univariate ADF test has weak power and may be unable to reject the null hypothesis of non-stationarity. We therefore supplemented it with additional econometric tests.

b. Growth rate Correlation method

The absence of absolute or conditional convergence between member states doesn't exclude the adoption of monetary integration in case member countries are facing symmetric shocks. If countries present positive and significant correlation of business cycles they can usefully form a monetary union and convergence will follow the union. The presence of positive and significant correlation between countries is a proof that they are affected symmetrically by shocks and can use one policy measure to address the shocks. The shocks are asymmetric in case of negative or insignificant correlations (Wang, 2007).

Testing for the growth rate correlations, results reveal low and non-significant correlation coefficients with the only exception of Tanzania. The latter was significantly correlated with Kenya and Rwanda over the period 1983-2017 respectively at 5% and 10% level of significance. Considering that income convergence is a dynamic process, the study split the period under review into sub-sample periods and checked the nature of correlation of real shocks over the sub-periods.

Tab.7 Per capita GDP growth correlations over sample periods

Sample: 1981 2017					
Correlation					
Probability	PER_GR_BU	PER_GR_KE	PER_GR_RW	PER_GR_TZ	PER_GR_UG
PER_GR_BU	1.000				

PER_GR_KE	0.247	1.000			
	0.140	-----			
PER_GR_RW	-0.073	0.116	1.000		
	0.670	0.495	-----		
PER_GR_TZ	0.177	0.652	0.280	1.000	
	0.295	0.000	0.093	-----	
PER_GR_UG	-0.132	0.053	0.109	0.006	1.000
	0.437	0.754	0.520	0.971	-----

Sample: 1990 2000					
Correlation					
Probability	PER_GR_B	PER_GR_K	PER_GR_RW	PER_GR_TZ	PER_GR_UG
PER_GR_BU	1.000				

PER_GR_KE	-0.155	1.000			
	0.650	-----			
PER_GR_RW	-0.336	0.255	1.000		
	0.312	0.450	-----		
PER_GR_TZ	0.336	0.473	0.100	1.000	
	0.312	0.142	0.770	-----	
PER_GR_UG	-0.627	0.482	0.055	-0.082	1.000
	0.039	0.133	0.873	0.811	-----

Sample: 2000 2010					
Correlation					
Probability	PER_GR_BU	PER_GR_KE	PER_GR_RW	PER_GR_TZ	PER_GR_UG
PER_GR_BU	1.000				

PER_GR_KE	0.536	1.000			
	0.089	-----			
PER_GR_RW	0.527	0.091	1.000		
	0.096	0.790	-----		
PER_GR_TZ	-0.045	0.355	0.355	1.000	
	0.894	0.285	0.285	-----	
PER_GR_UG	0.373	0.036	0.382	0.091	1.000
	0.259	0.916	0.247	0.790	-----

Sample: 2010 2017					
Correlation					
Probability	PER_GR_B	PER_GR_K	PER_GR_RW	PER_GR_TZ	PER_GR_UG
PER_GR_BU	1.000				

PER_GR_KE	0.310	1.000			
	0.456	-----			
PER_GR_RW	-0.429	-0.071	1.000		
	0.289	0.867	-----		
PER_GR_TZ	0.071	0.405	0.071	1.000	
	0.867	0.320	0.867	-----	
PER_GR_UG	0.238	0.810	0.238	0.405	1.000
	0.570	0.015	0.570	0.320	-----

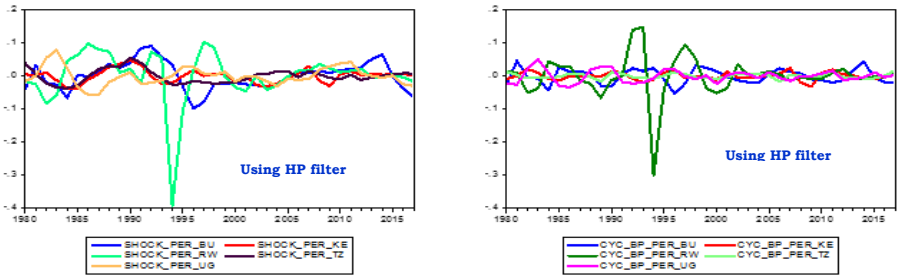
While most of correlations coefficients are positive, there are only three cases of significantly positive correlations: Kenya and Burundi and, Burundi and Rwanda over the period 2000-2010 at 10% level of significance but these links weakened during the recent period (2000-2017) and; one (Uganda and Kenya) over 2010-2017 at 5%.

c. Correlation of shocks/business cycles

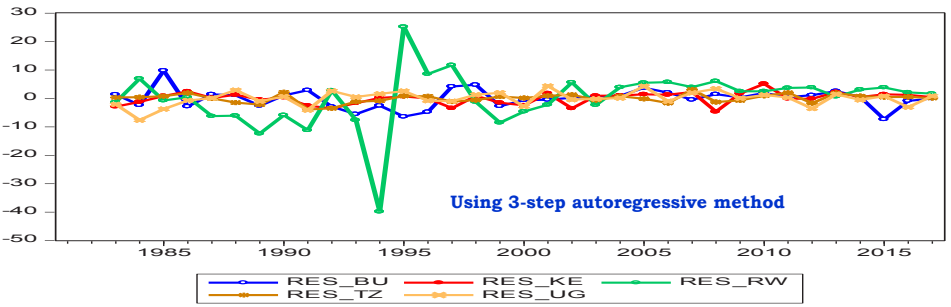
Business cycles or the cyclical components are here measured as deviations of actual per capita income from its long run trend. Shocks or the disturbances are obtained by the 3-step autoregressive method or by the difference between actual income and the potential income. Potential income itself is extracted from the data by using HP or the Band Pass filters. The following graphs plot the disturbances generated by the three methods. A close look at these graphs show a kind of co-movement which fluctuates around the zero line.

The statistical methods come here to complete this visual inspection and to show the level of correlation.

Graph 18: Business cycle synchronization



Graph 19: 3-step autoregressive residuals



Using HP and Band Pass filters, results conclude on mostly positive but not significant correlations of the shocks throughout the entire period of study (1980-2017) save Tanzanian which was significantly correlated with Kenya.

There are also presence of negative correlation pointing to asymmetry of shocks. Looking to the sub-periods, over the most recent period 2000-2017, cases of negative correlations were observed between Burundi & Tanzania and Tanzania & Rwanda. But as long as the integration is deepening, we expect member countries to get closer.

Tab.8 Business cycle correlations using HP filter

Correlation		Sample (adjusted): 1980 1990			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1				

SHOCK_KE	0.636	1.000			
	0.035	-----			
SHOCK_RW	0.227	-0.091	1.000		
	0.502	0.790	-----		
SHOCK_TZ	0.618	0.800	0.118	1.000	
	0.043	0.003	0.729	-----	
SHOCK_UG	-0.255	0.045	-0.827	-0.300	1.000
	0.450	0.894	0.002	0.370	-----

Correlation		Sample (adjusted): 1990 2000			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	-0.109	1.000			
	0.750	-----			
SHOCK_RW	-0.045	0.255	1.000		
	0.894	0.450	-----		
SHOCK_TZ	0.555	0.464	0.327	1.000	
	0.077	0.151	0.326	-----	
SHOCK_UG	-0.773	0.200	-0.073	-0.400	1.000
	0.005	0.555	0.832	0.223	-----

Correlation		Sample (adjusted): 2000 2010			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	0.545	1.000			
	0.083	-----			
SHOCK_RW	0.755	0.227	1.000		
	0.007	0.502	-----		
SHOCK_TZ	-0.209	0.045	0.164	1.000	
	0.537	0.894	0.631	-----	
SHOCK_UG	0.664	0.182	0.500	-0.282	1.000
	0.026	0.593	0.117	0.401	-----

Correlation		Sample (adjusted): 2010 2017			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	0.190	1.000			
	0.651	-----			
SHOCK_RW	0.310	0.119	1.000		
	0.456	0.779	-----		
SHOCK_TZ	-0.690	0.048	-0.571	1.000	
	0.058	0.911	0.139	-----	
SHOCK_UG	0.333	0.452	0.857	-0.595	1.000
	0.420	0.260	0.007	0.120	-----

Remarkable efforts in terms of harmonization of procedures led to positive though still non-significant correlation coefficients over 2000-2017 but still there is a need to strengthen the integration. For the most recent period 2010-2017, Tanzania was disconnected to other EAC member states displaying negative correlations with Burundi, Rwanda and lost the significant link with Kenya. Uganda and Rwanda are highly correlated over the period 2010-2017.

Using the Band Pass filter, results remained consistent with the HP filter approach. Correlations coefficients are low except for Tanzania versus Burundi and Tanzania versus Kenya. Rwanda and Uganda while negatively correlated over 1980-2000, become closer during the last 2 decades. The weak correlations of shocks facing EAC member countries reflect the disparities in macroeconomic performances.

Tab.9: Business cycle correlations using BP filter

Correlation		Sample: 1980 1990			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	-0.300	1.000			
	0.370	-----			
SHOCK_RW	0.009	-0.745	1.000		
	0.979	0.009	-----		
SHOCK_TZ	0.518	-0.318	0.455	1.000	
	0.103	0.340	0.160	-----	
SHOCK_UG	-0.536	0.736	-0.700	-0.400	1.000
	0.089	0.010	0.017	0.223	-----

Correlation		Sample: 1990 2000			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	-0.300	1.000			
	0.370	-----			
SHOCK_RW	-0.218	-0.109	1.000		
	0.519	0.750	-----		
SHOCK_TZ	-0.364	0.845	0.273	1.000	
	0.272	0.001	0.417	-----	
SHOCK_UG	0.073	0.736	-0.255	0.573	1.000
	0.832	0.010	0.450	0.066	-----

Correlation		Sample : 2000 2010			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	-0.282	1.000			
	0.401	-----			
SHOCK_RW	-0.091	-0.073	1.000		
	0.790	0.832	-----		
SHOCK_TZ	0.236	0.118	0.564	1.000	
	0.484	0.729	0.071	-----	
SHOCK_UG	0.491	0.027	0.545	0.400	1.000
	0.125	0.937	0.083	0.223	-----

Correlation		Sample : 2010 2017			
Probability	SHOCK_BU	SHOCK_KE	SHOCK_RW	SHOCK_TZ	SHOCK_UG
SHOCK_Bu	1.000				

SHOCK_KE	0.429	1.000			
	0.289	-----			
SHOCK_RW	0.286	0.357	1.000		
	0.493	0.385	-----		
SHOCK_TZ	0.833	0.714	0.381	1.000	
	0.010	0.047	0.352	-----	
SHOCK_UG	0.476	0.286	0.095	0.381	1.000
	0.233	0.493	0.823	0.352	-----

Similar findings were obtained with the 3-step autoregressive method, persistently weak and even negative correlation between member states. Tanzania real output shocks are linked significantly with Kenyan ones over 1983-2017 and over 1990-2000 but the link was lost in recent period consistently with the findings of the previous methods.

Tab.10: Business cycle correlations using the 3-step autoregressive regression

Sample: 1983 2017					
Correlation					
Probability	RES_BU	RES_KE	RES_RW	RES_TZ	RES_UG
RES_BU	1.000				

RES_KE	0.067	1.000			
	0.704	-----			
RES_RW	0.014	0.035	1.000		
	0.938	0.841	-----		
RES_TZ	-0.142	0.406	0.200	1.000	
	0.417	0.015	0.250	-----	
RES_UG	-0.120	0.278	-0.016	0.136	1.000
	0.494	0.105	0.926	0.435	-----

Sample: 1990 2000					
Correlation					
Probability	RES_BU	RES_KE	RES_RW	RES_TZ	RES_UG
RES_BU	1.000				

RES_KE	-0.045	1.000			
	0.894	-----			
RES_RW	-0.182	0.027	1.000		
	0.593	0.937	-----		
RES_TZ	-0.209	0.691	0.300	1.000	
	0.537	0.019	0.370	-----	
RES_UG	-0.445	0.309	0.145	0.218	1.000
	0.170	0.355	0.670	0.519	-----

Sample: 2000 2010					
Correlation					
Probability	RES_BU	RES_KE	RES_RW	RES_TZ	RES_UG
RES_BU	1.000				

RES_KE	0.045	1.000			
	0.894	-----			
RES_RW	0.500	-0.264	1.000		
	0.117	0.433	-----		
RES_TZ	-0.545	0.355	-0.245	1.000	
	0.083	0.285	0.467	-----	
RES_UG	0.200	0.418	0.155	0.236	1.000
	0.555	0.201	0.650	0.484	-----

Sample: 2000 2017					
Correlation					
Probability	RES_BU	RES_KE	RES_RW	RES_TZ	RES_UG
RES_BU	1.000				

RES_KE	0.069	1.000			
	0.785	-----			
RES_RW	0.304	-0.172	1.000		
	0.219	0.494	-----		
RES_TZ	-0.265	0.329	-0.150	1.000	
	0.288	0.182	0.553	-----	
RES_UG	0.191	0.447	0.106	0.335	1.000
	0.448	0.063	0.675	0.174	-----

Still taking Kenya as benchmark, correlations with EAC member countries using both HP and Band Pass filters are here below summarized.

Tab.11: Business cycles correlations

	1980-2017	1980-1990	1990-2000	2000-2010	2010-2017
HP Filter					
Burundi	0.28**	0.64*	-0.11	0.44**	0.55**
Rwanda	0.08	-0.09	0.25	0.28	0.23
Tanzania	0.43*	0.80**	0.46	0.02	0.05
Uganda	0.10	0.05	0.20	0.20	0.18
Band Pass Filter					
Burundi	-0.14	-0.30	-0.30	-0.28	0.43
Rwanda	-0.24	-0.75*	-0.11	-0.07	0.36
Tanzania	0.28	-0.32	0.85*	0.12	0.71*
Uganda	0.42*	0.74*	0.74*	0.03	0.29
3-step autoregressive method					
Burundi	0.07	-0.12	-0.05	0.05	0.07
Rwanda	0.04	0.07	0.03	-0.26	-0.17
Tanzania	0.41	0.31	0.69	0.35	0.33
Uganda	0.28	0.52	0.31	0.42	0.45**

(*): significant at 5%, (**) significant at 10%

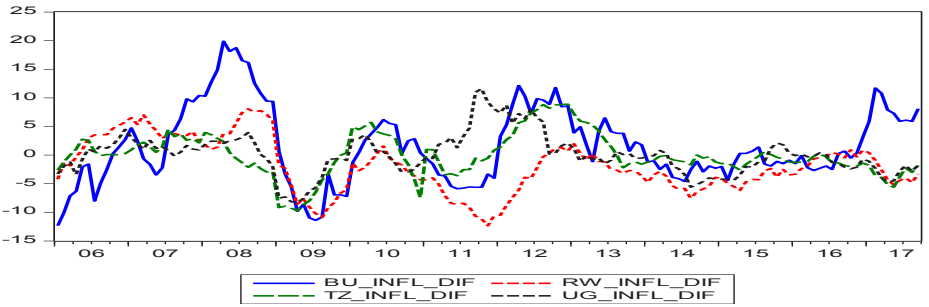
In summary, despite some similarities in the structures of EAC economies, countries are persistently subject to asymmetric shocks even in the most recent decades. ADF test concludes on the convergence of income per capita but we cannot base only on these ADF results to conclude on convergence.

They provide at least useful piece of information about per capita growth dynamics.

5.2.2. Inflation convergence

Fleming (1971) believed that the convergence of inflation across countries that intend to form a monetary union is critical. Differences in inflation are likely to undermine the potential of the monetary union by imposing costs related to asymmetric shocks. In addition, significant inflation differentials can lead to diverging real exchange rates asymmetrically affecting competitiveness across member states. Differences in inflation create disparities in real interest rates causing distortions in investment decisions across the region.

Graph 20: EAC countries Inflation differentials with Kenya



For EAC, both visual inspection and results of estimations attest that inflation differentials converge between Kenya and the remaining EAC countries except Burundi which case may be temporary and likely to be fixed once the internal problems solved. Inflation differences follow a stationary process according to ADF test results indicating absolute convergence of inflation differentials.

Tab.12: ADF test for inflation differences from Kenya

	Burundi	Rwanda	Tanzania	Uganda
ADF test stat	-2.685962	-3.118358	-2.351556	-2.473822
P-value	0.2441	0.0020	0.0186	0.0134
ADF result	Non-stationary	Stationary	Stationary	Stationary

Similar findings are obtained by the inflation correlation method. Though still low, the Spearman correlation coefficients are significantly positive across the region, even for the case of Burundi. Uganda is the only country with higher than 50% correlation coefficients. Important message to note is the symmetry of shock to inflation in the region allowing the unique monetary policy to have similar effect across member countries.

Tab.13: Correlations of inflation

Covariance Analysis: Spearman rank-order
Sample: 2006M01 2017M09
Included observations: 141

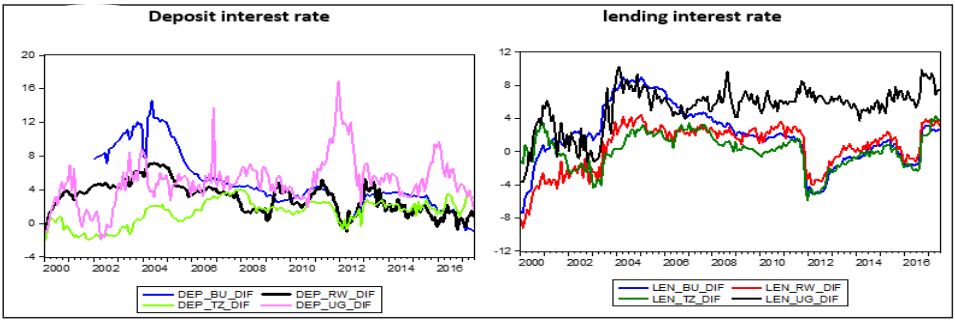
Correlation					
Probability	BU_INFL	KEN_INFL	RW_INFL	TZ_INFL	UG_INFL
BU_INFL	1.000				

KEN_INFL	0.377	1.000			
	0.000	-----			
RW_INFL	0.455	0.384	1.000		
	0.000	0.000	-----		
TZ_INFL	0.501	0.430	0.444	1.000	
	0.000	0.000	0.000	-----	
UG_INFL	0.475	0.727	0.611	0.660	1.000
	0.000	0.000	0.000	0.000	-----

5.2.3. Interest rates convergence

Data on lending, deposit as well as the T-bill rates are provided by the central banks.

Graph 21: Interest rate differentials



Visual inspection shows that interest rates differentials are reducing for EAC countries in general but deposit rates in Uganda and Tanzania remain large compared to Kenyan deposit rate. Applied on the interest differentials, ADF test revealed a stationary process between Kenya, Uganda and Rwanda deposit rates.

Tab.14: Interest rate differentials toward Kenya

	Burundi	Rwanda	Tanzania	Uganda
Deposit rate				
ADF test	-2.4813	-4.080827	-1.198284	-3.521376
P-value	0.3371	0.0078	0.2110	0.0083
ADF result	Non-stationary	Stationary	Non-stationary	Stationary
Lending rates				
ADF test	-3.547635	-3.433485	-2.248725	-4.747737
P-value	0.0370	0.0109	0.0240	0.0008
ADF result	Stationary	Stationary	Stationary	Stationary
T-bill rate (91 days)				
ADF test	-3.147044	-2.710522	-2.911708	-4.326044
P-value	0.0019	0.0069	0.0037	0.0005
ADF result	Stationary	Stationary	Stationary	Stationary

However, considering lending interest rates, differences with Kenyan interest rates follow a stationary process meaning that all lending rates in the regional follow a converging process. Similarly, T-bill rates are converging toward Kenyan levels. Using the correlation method, interest rates are proven positively and significantly correlated for most of the cases. However, on deposit rates side, over January 2002 to June 2017, interest rates are diverging between Rwanda and Tanzania and between Rwanda and Uganda and most particularly between Burundi and all regional economies except Rwanda. The links between EAC deposit rates improved and were significantly correlated over 2010M1 to June 2017 with Uganda and Burundi displaying statistically non-significant coefficient.

Tab.15: Level of Correlations between Interest rates in EAC countries

Sample: 2002M01 2017M06					
Correlation					
Probability	DEP_BU	DEP_KEN	DEP_RW	DEP_TZ	DEP_UG
DEP_BU	1.000				

DEP_KEN	-0.268	1.000			
	0.000	-----			
DEP_RW	0.625	-0.028	1.000		
	0.000	0.702	-----		
DEP_TZ	-0.443	0.716	-0.236	1.000	
	0.000	0.000	0.001	-----	
DEP_UG	-0.298	0.597	-0.141	0.657	1.000
	0.000	0.000	0.056	0.000	-----

Sample: 2000M01 2017M06					
Correlation					
Probability	LEN_BU	LEN_KEN	LEN_RW	LEN_TZ	LEN_UG
LEN_BU	1.000				

LEN_KEN	-0.187	1.000			
	0.007	-----			
LEN_RW	-0.550	0.279	1.000		
	0.000	0.000	-----		
LEN_TZ	0.031	0.496	0.164	1.000	
	0.650	0.000	0.017	-----	
LEN_UG	-0.464	0.490	0.475	0.242	1.000
	0.000	0.000	0.000	0.000	-----

Sample: 2010M01 2017M06					
Correlation					
Probability	DEP_BU	DEP_KEN	DEP_RW	DEP_TZ	DEP_UG
DEP_BU	1.000				

DEP_KEN	0.179	1.000			
	0.091	-----			
DEP_RW	0.587	0.257	1.000		
	0.000	0.015	-----		
DEP_TZ	0.299	0.537	0.419	1.000	
	0.004	0.000	0.000	-----	
DEP_UG	0.169	0.556	0.320	0.339	1.000
	0.111	0.000	0.002	0.001	-----

Sample: 2007M01 2017M04					
Correlation					
Probability	TB_BU	TB_KEN	TB_RW	TB_TZ	TB_UG
TB_BU	1.000				

TB_KEN	0.389	1.000			
	0.000	-----			
TB_RW	0.101	-0.154	1.000		
	0.268	0.089	-----		
TB_TZ	0.287	0.426	0.028	1.000	
	0.001	0.000	0.759	-----	
TB_UG	0.198	0.707	-0.207	0.292	1.000
	0.028	0.000	0.021	0.001	-----

On lending rate side, all regional countries lending rates are significantly correlated at 5% level of significance apart from Burundi which is found to significantly diverge from the remaining economies over the period from January 2007 to June 2017. Rwanda is diverging from Uganda and Kenya with regard to 91-T-bill rates while interlinks are positive and significant for the rest of EAC economies.

5.2.4. Exchange rate convergence

Following the same procedure, exchange rate differentials were computed as the difference between country exchange rate depreciation and Kenyan one. ADF test was applied to the differentials. Results showed that the Burundian franc and the Tanzanian shilling don't converge toward Kenyan exchange rate while the Rwandan franc and Ugandan shilling converge toward Kenyan exchange rate.

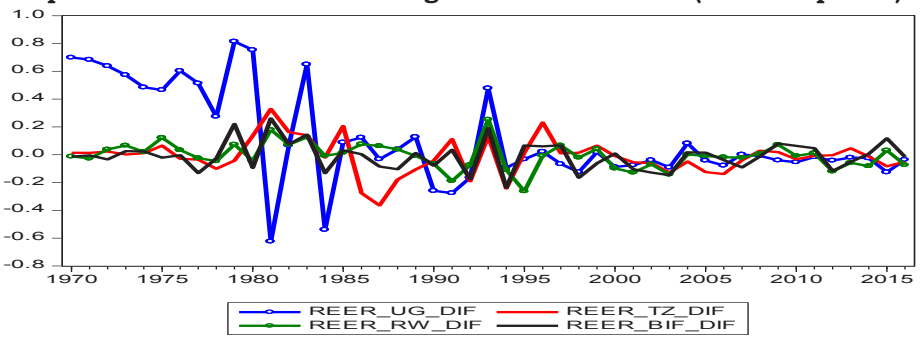
Tab.16: Nominal Exchange Rate Convergence, ADF test results

	Burundi (BIF)	Rwanda (FRW)	Tanzania (TZS)	Uganda (UGS)
ADF test	-1.597761	-2.825446	-3.053800	-3.857142
P-value	0.7850	0.0564	0.1206	0.0156
ADF result	Non-stationary	Stationary	Non-stationary	Stationary

Spearman correlation coefficients showed negative relationship between the Burundian exchange rate and the remaining EAC currencies. This negative link is proven to be strong between the BIF and the two shillings (KES and TZS) and the Rwandan franc. The latter is almost not correlated with the regional currencies (spearman correlation not significant and too low around 0.10% or even negative.

However, in a monetary union, for sustainability of membership, it is important that the real effective exchange rates do not diverge systematically. Visual inspection of the trends in REER differentials together with the ADF test suggest a kind of convergence.

Graph 22: Real effective exchange rate differentials (in basis points)



In order to explore whether competitive positions have not deviated substantially between Kenya and the remaining EAC economies, we conducted statistics tests including ADF and correlation tests to supplement the observation on the graph. The ADF tests results show absolute convergence for all EAC countries over the period 1970-2016.

Table.17: REER convergence, ADF test results

	Burundi (BIF)	Rwanda (FRW)	Tanzania (TZS)	Uganda (UGS)
ADF test	-8.133381	-5.589472	-4.955549	-2.629630
P-value	0.0000	0.0000	0.0000	0.0097
ADF result	Stationary	Stationary	Stationary	Stationary

ADF tests revealed absolute convergences though theoretically it is possible that real exchange rates converge toward a constant different from zero.

Applying correlation test on bilateral REER depreciation, results showed positive and significant relationship across member states for the most recent past (sample periods 1990-2016 and 2000-2016) which was not the case in 1980-1990.

Tab.18: Bilateral real exchange rate correlations

Correlation	Sample: 1970 2016				
Probability	REER_BI	REER_KE	REER_RW	REER_TZ	REER_UG
REER_BI	1.000				

REER_KE	0.366	1.000			
	0.011	-----			
REER_RW	0.554	0.390	1.000		
	0.000	0.007	-----		
REER_TZ	0.508	0.409	0.409	1.000	
	0.000	0.004	0.004	-----	
REER_UG	0.222	0.086	0.323	0.176	1.000
	0.133	0.565	0.027	0.237	-----

Correlation	Sample: 1980 1990				
Probability	REER_BI	REER_KE	REER_RW	REER_TZ	REER_UG
REER_BI	1.000				

REER_KE	0.136	1.000			
	0.689	-----			
REER_RW	0.755	0.236	1.000		
	0.007	0.484	-----		
REER_TZ	0.818	0.327	0.609	1.000	
	0.002	0.326	0.047	-----	
REER_UG	0.173	0.173	-0.182	0.091	1.000
	0.612	0.612	0.593	0.790	-----

Correlation	Sample: 1990 2016				
Probability	REER_BI	REER_KE	REER_RW	REER_TZ	REER_UG
REER_BI	1.000				

REER_KE	0.506	1.000			
	0.007	-----			
REER_RW	0.556	0.538	1.000		
	0.003	0.004	-----		
REER_TZ	0.540	0.493	0.404	1.000	
	0.004	0.009	0.037	-----	
REER_UG	0.506	0.476	0.648	0.452	1.000
	0.007	0.012	0.000	0.018	-----

Correlation	Sample: 2000 2016				
Probability	REER_BI	REER_KE	REER_RW	REER_TZ	REER_UG
REER_BI	1.000				

REER_KE	0.564	1.000			
	0.018	-----			
REER_RW	0.743	0.468	1.000		
	0.001	0.058	-----		
REER_TZ	0.473	0.551	0.456	1.000	
	0.055	0.022	0.066	-----	
REER_UG	0.267	0.539	0.434	0.515	1.000
	0.300	0.026	0.082	0.035	-----

VI. CONCLUSION AND POLICY RECOMMENDATIONS

The objective of this paper was to assess the readiness of the EAC toward forming a monetary union. This study considered five EAC member states which are Burundi, Kenya, Rwanda, Tanzania and Uganda. South Sudan was not taken into account due to lack of data. Various technics were utilized including both visual inspection and quantitative assessment of convergence criteria. Simple econometric and statistic calculations were performed to supplement the previous methods.

It is worth to note that EAC countries share many structural characteristics but also diverge on some points in terms of economic developments, social indicators and institutional developments. On income side, Kenya remains the best performer in the region and that's the reason why it has been taken as the benchmark for our analysis. It also predominates the regional trade. Trade and exchange rates flows have been fluctuating in the same directions though with different magnitude. With regard to the production sector, EAC countries have similar production structure and similar structure of export products. Primary commodities take a lion share in EAC exports. They are composed mainly by coffee, tea and minerals and few manufactured products which are products of agro industries and have very low add values.

In the area of integration process, the EAC passed successively through different stages which impact has been positive in terms of achievements (free movement of people, increasing intraregional trade and improving macroeconomic performances among others). The next step is now to shift to the monetary union. To this end, some targets were set up to be achieved before moving toward a currency union.

Countries succeeded to harmonize regulation and implementation policies in the area of monetary and exchange rate, payments systems as well as the alignment of financial system stability and development policies. There is however need for rules and enforcement mechanism to guarantee the implementation process.

The study reviewed the EAC quantitative criteria to assess the compliance by member countries. Following rising energy prices, pressures on exchange rates and partly due to adverse weather conditions, countries had challenges to meet inflation target but taking the annual average, they generally observed the target since 2013. Two countries over five (Burundi and Tanzania) missed the target on international reserves; Burundi and Kenya didn't comply with fiscal deficit benchmark. In terms of international reserves, countries made

significant effort thanks to deliberate policies to build reserves. Although some member states missed the target on the overall budget deficit there is a somewhat improvement compared to previous levels.

Using available data, this paper investigates if EAC member countries shall move to the next step and form a monetary union. Tests (ADF and correlation tests) reveal general nominal convergence toward Kenya which is taken as benchmark. On real sector side, income differences with Kenya remained large over time. Only Tanzanian per capita income was found to converge with Kenya over the period 1981 to 2017. Bearing in mind that convergence is never perfect but an issue that takes time to be achieved, we check for real business cycles correlations over sub-sample periods to investigate gradual progress toward convergence or return back to divergence over time.

Overall, there are positive perspectives for a monetary union such as increasing share of informal cross-border trade, positive pair-wise correlation of real GDP growth though still low, and more generally nominal convergence. Yet, convergence can never be or remain perfect. Both economic, social, political and institutional factors can break it for a time but tends to be reestablished after shock. It cannot be easily solved once for all. Countries need to keep eyes on the criteria. Additionally, research works assessing OCA properties are backward-looking and cannot reflect a change in policy preferences and the theory of stationary expectations seems to be more or less a utopia. There is need to supplement this theory by the endogeneity theory of OCA which suggests that convergence can be completed once in a monetary union. This will be subject to a forthcoming research paper.

As recommendation, the move toward a monetary union has to be well thought as it may pose serious challenges without macroeconomic convergence. While countries continue to work on the plan for a MU, there is a need to work furthermore on infrastructure and institutions to mitigate the bottlenecks between member countries. In addition, countries need to align policies to sustain nominal convergence and to further boost growth perspectives in all member countries. Join infrastructure projects are in pipeline and there is need to implement them, but also productive projects are welcome to align macroeconomic performances. Fiscal discipline is highly needed to ensure compliance with the target but also economic stability.

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Appendix 1

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
World	10343.3	11953.4	13777.5	15972.7	12317.2	15064.9	18073.1	18459.2	18957.1	18969.8	16508.5	15862.4
COMESA												
Total COMESA EXPORTS	30.4	42.6	71.4	104.9	82.4	104.4	97.9	129.2	113.4	90.7	69.1	60.6
COMESA exports to Africa	6.4	11.7	10.4	12.2	12.1	15.8	18.8	18.8	19.9	17.6	14.7	12.0
COMESA to COMESA	3.0	6.4	4.4	6.8	6.8	8.6	9.3	8.7	9.2	8.2	7.0	4.7
EAC												
EAC TOTAL EXPORTS	6.2	6.7	7.9	10.4	9.4	11.2	13.3	14.8	13.2	14.9	14.5	12.4
EAC exports to Africa	2.6	2.6	3.2	4.4	3.8	4.8	5.7	6.2	5.5	6.1	5.5	4.1
EAC to EAC	1.3	1.2	1.6	2.1	2.0	2.3	2.6	3.1	2.8	3.1	2.8	2.1
ECCAS												
ECCAS total exports	13.4	16.5	25.1	35.7	24.7	29.6	41.0	38.8	41.9	37.3	27.3	18.4
ECCAS exports to Africa	0.9	0.9	2.0	2.5	3.1	4.7	5.3	4.4	6.0	4.9	2.5	1.2
ECCAS exports to ECCAS	0.2	0.3	0.7	0.4	0.6	1.2	1.1	0.9	1.3	0.8	0.6	0.6
ECOWAS												
ECOWAS total exports	16.7	77.4	72.5	104.8	72.9	112.4	168.0	184.0	129.3	127.8	74.2	66.2
ECOWAS exports to Africa	9.3	12.5	11.1	18.4	17.0	20.7	30.3	29.2	23.9	21.0	13.9	10.5
ECOWAS exports to	6.1	7.5	6.1	10.8	7.2	7.0	14.5	12.9	12.8	11.3	8.7	6.8
SACU												
SACU total exports	55.4	61.9	74.4	83.9	63.8	93.7	122.1	112.6	111.2	107.2	83.3	88.8
SACU to Africa	9.5	10.8	12.9	16.4	14.9	28.4	31.9	32.7	33.8	33.8	27.9	27.0
SACU exports to SACU	1.7	1.6	2.7	2.7	2.9	14.8	16.1	16.0	16.8	16.9	15.0	14.2
SADC												
SADC total exports	68.5	84.4	137.6	105.5	123.0	173.0	222.3	218.3	215.4	204.3	147.7	142.5
SADC to Africa	12.6	17.9	20.6	24.6	21.8	37.8	44.2	46.9	48.0	47.1	38.9	35.2
SADC to SADC	10.0	14.6	16.7	19.4	17.3	32.9	38.7	41.8	43.0	41.7	34.0	31.3
WAEMU												
WAEMU total exports	11.3	11.9	12.8	16.5	14.9	17.5	21.0	21.1	23.6	24.7	22.7	18.9
WAEMU to Africa	4.0	4.9	5.0	6.8	5.1	6.6	7.5	8.2	8.5	7.4	5.8	3.6
WAEMU to WAEMU	1.7	1.7	1.9	2.5	2.1	2.1	2.6	2.9	3.0	3.3	3.1	2.1

Source: ITC ,2017

SECOND ROUND EFFECT OF FOOD AND ENERGY PRICES TO INFLATION IN RWANDA

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ABSTRACT

This paper assesses the existence second round effect from food and energy prices and evaluates the time span of the shock of these prices on headline and core inflation. Using gap-model and VAR based impulse response function, findings showed no significant evidence of second round effect from food and energy inflation and that shocks from energy and food price are transitory. Hence, keeping other factors constant, monetary policy should not respond to food and energy shocks.

Keywords: Inflation and Monetary policy

JEL Classification: E31, E52

I. INTRODUCTION

The key mandate of central bank is price stability and monetary policy is conducted to attain this mission. Central bank uses inflation to gauge the evolution of prices in the economy. However, some components of the general price index such as, food and energy items are beyond the control of the central bank. These articles' prices are influenced by supply factors such as weather condition and production quotas and have high volatility. Hence, for efficient monetary policy action, central bank refers to core inflation which excludes these items.

There is a wide consensus in economic literature that central bank should not react to changes in food and energy prices as these prices are highly volatile and their changes are assumed to reverse quickly (Alper et al. 2016). In addition, monetary policy instruments cannot address efficiently the inflationary pressures resulting from food and energy prices shocks. Therefore, monetary policy decision would be based on core inflation which excludes food and energy prices and on which monetary policy can have efficient results.

However, there is growing concerns that ignoring food and energy inflation may lead to misguided monetary policy decisions mainly in economies with higher shares of food and energy items in the consumer basket (Dureval et al. 2013). In this regards, shocks in food and energy prices should be taken into account by monetary authorities in formulating adequate policy response, since they can influence future inflation. Hence, recent research agenda have shifted to examine the role of food and energy prices not only in headline inflation but also in core inflation, such as Cecchetti and Moessner, 2008; Šoškić, 2015; Ruch and Du Plessis, 2015.

Monetary policy reaction to these shocks would depend however on whether or not there exists second round effect from food and energy shocks. If the shock is transitory, with upward spikes quickly reversing and leaving the medium-term inflation path unchanged, the monetary policy is supposed to not react. In the alternative case, not only headline inflation would be affected but also core inflation and will lead to a second round effect on inflation. Hlédik (2003) states that though monetary policy cannot eliminate the effect of supply-side shocks on inflation; it should, however, curb any second-round effects of these shocks on inflation.

The main goal of this paper is to test the existence second round effect from food and energy prices and evaluate the time span of the shock of these prices on headline and core inflation. Previous studies that assessed inflation in Rwanda (Rusuhuzwa, 2008; Gichondo and Kimenyi, 2012; Kayisire, 2014)

have focused on role of macroeconomic factors (GDP, exchange rate, money supply, output gap) but have not examined the issue of second round effect. The knowledge of this phenomenon is very important for the analysis and forecast of inflation as well as for monetary policy decision making as NBR is moving forward to adopt inflation targeting framework.

The paper is organized as follows. Section 2 analyzes trends of inflation, food and energy prices. Section 3 will review the relevant literature and section 4 would discuss the methodology. The 5th section will presents the results and section 6 will conclude.

II. FOOD AND ENERGY PRICES AND INFLATION TRENDS IN RWANDA

Inflation in Rwanda, which stood on average to 6.5% between 2006 and 2017, has been mainly driven by food inflation. Food items hold the biggest share (27.4%) of the consumer basket and their prices increased by 8.6% on average during this period. Therefore food inflation contributed 2.4 percentage points to the overall average inflation of 2006-2017, the highest contribution compared to other items.

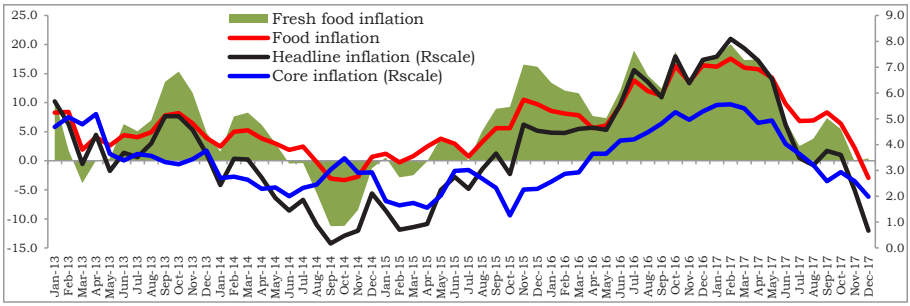
Table 1: Inflation by CPI components

		Weights	Average inflation (2006-2017)	Contribution
	GENERAL INDEX (CPI)	100	6.5	6.5
1	Food and non-alcoholic beverages	**27.4**	**8.6**	**2.4**
2	**Alcoholic beverages and tobacco**	4.9	8.2	0.2
3	**Clothing and footwear**	5.3	3	0.1
4	**Housing, water, electricity, gas and other fuels**	20.8	6.7	1.5
5	**Furnishing, household equipment and routine household maintenance**	3.8	3.8	0.2
6	**Health**	1.3	4	0
7	**Transport**	12.5	5.4	1
8	**Communication**	3.1	0.7	0
9	**Recreation and culture**	3.1	1.8	0
10	**Education**	2.7	11.2	0.7
11	**Restaurants and hotels**	8.8	5.8	0.2
12	**Miscellaneous goods and services**	6.4	2.8	0.1
	Energy index	**6.8**	**7.5**	**0.5**
	General Index excluding fresh Products and energy	**77.5**	**5.7**	**4.4**

Source: NISR

The high influence of food inflation also portrayed by chart 1, where both trends of overall inflation and food inflation track each other; stems from fresh food prices. Fresh food inflation was 10.1% over the period of study and contributed 1.6 percentage points to overall inflation.

Figure 1: Food inflation dynamics

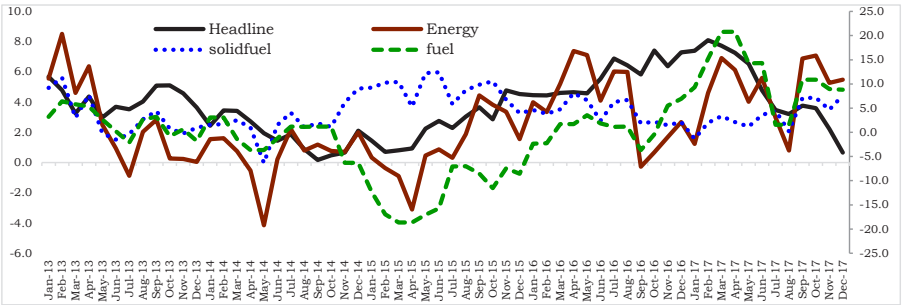


Source: NISR

The production of fresh food products is highly dependent on weather condition, hence it is erratic. This induces high volatility in their prices, which is also confirmed by the standard deviation of fresh food prices of 10.0 over the studied period. This high volatility pass directly to food inflation as well as to overall inflation since the weight of fresh food products is 57.6% and 15.8% in the food basket and general consumer basket respectively. The standard deviation for food prices was 7.4 and 4.7 for overall inflation. Therefore, these characteristics justify the exclusion fresh food inflation in the computation of Rwandan core inflation. In addition core inflation excludes energy inflation.

Energy inflation stood at 7.5% on average between 2006 and 2017 but contributed little to overall inflation (0.5 percentage points) due to a lower weight in CPI (6.8%). This is highlighted further by figure two, showing a weak co-movement between headline and energy inflation. Nonetheless, energy inflation has been volatile as evidenced by its standard deviation of 9.7 between 2006 and 2017. This is highlighted further by figure two, showing a weak co-movement between headline and energy inflation. The energy index is dominated by solid fuel with a share of 51.5% of the basket of energy items and fuels and lubricants for personal transport equipment, representing 25.7% of energy products basket. Looking at the trend of these two components, figure two indicates that fuels and lubricants inflation is the main driver of energy inflation.

Figure 2: Energy inflation



Source: NISR

III. LITERATURE REVIEW

Second-round effects are the reactions of market participants to first-round effects, that is, a specific earlier increase or decrease in the prices of individual goods or services. These reactions result from the ability of price-setting firms and wage-setting labour to increase prices through increasing mark-ups or marginal cost and wages. Therefore prices of other goods and services increase in response to a relative price shock such as food or energy prices.
Second-round effects occur through two channels: costs and expectations. The cost channel refers to the direct impact of changes to a firms marginal cost, for instance when energy is used in the production process of other goods and services. The second channel "expectations" invokes the response of wage-setting labour to a relative price shock. If labour perceives this shock to be permanent, or has the bargaining power to raise wages, then labour's higher inflation expectations will fuel demand for higher nominal wages. Therefore price of other goods and services increases either through the price adjustment by firms as their marginal cost increases or through increasing consumption. It ends with the increase of core inflation due to the combined impacts of the cost and expectations channels (Ruch and Du Plessis, 2015).
Core inflation is considered as a more important indicator for the conduct of monetary policy since it reflect the most accurate trend of inflation after excluding temporary price volatility. Fluctuations in the prices of food and energy are regarded as a transitory component of overall movements in inflation and also being caused by temporal or sector specific shocks which are beyond the control of central bank. Therefore, they are excluded in the computation of core inflation.

In economic literature, there is a school of economic thought advocating for no reaction of monetary policy in the presence of food and energy price shocks. The absence of monetary policy response is justified by the transitory

and volatility nature of those shocks and inefficient monetary policy reaction (Aoki, 2001, Motley, 1997; Mishkin, 2007; Kiley, 2008). Šoškić (2015) states that if the central bank would want to eliminate this short term impact on inflation, it would be very hard to achieve this effectively as monetary policy produces results with a time lag. The restrictive monetary policy reaction with ambition to decrease the price shock coming from food and energy prices, would most probably have cause a substantial overall drop in economic output and employment.

On another hand, some authors, for example Dureval et al. (2013), Alper et al. 2016, suggest the response of monetary policy to food and energy prices shocks due to possible second round effect and mainly for countries with high share of food as well as energy products in their consumer basket. Therefore, this raises the issue of knowledge about the existence of second round effect from food and energy prices in a particular economy.

A number of studies on the impact of food and energy prices on inflation have been conducted for developed, emerging market and developing countries. However, empirical literature on this topic in Rwanda is very scarce. To examine the presence of second round effects, econometric models were applied especially using the gap model, Phillips curve and VAR model.
The gap model applied by Šoškić (2015), Cecchetti and Moessner (2008), Misati and Munene (2015) and Rhee and Lee (2012); helps to test whether the headline inflation reverts to core inflation, that is, whether a supply shock is temporary leading to no necessity of intervention of monetary policy.

Rhee and Lee (2012) state that the reversion of headline inflation towards core inflation implies that changes in food and energy prices are temporary and do not lead to persistent changes in core inflation while the convergence of core inflation towards headline inflation is consistent with second-round effect as higher food and energy prices cause higher inflation expectation and thus higher core inflation.

Using the gap model, Cecchetti and Moessner (2008) found that that core inflation has generally not tended to return to headline inflation in a majority of countries considered but not all. Šoškić (2015) also found no significant second round effects on headline inflation in Serbia over the period of 20010 to 2015. Therefore, the central bank of Serbia has treated the food price shocks as transitory since the headline inflation soon reverted to core inflation. However, Rhee and Lee (2013) found the headline not reverting to core inflation, yet the core inflation tended to converge to headline inflation in some south-Asian countries. This implied second-round effects and it emerged through inflation expectations. Misati and Munene (2015) got the same finding in the case of Kenya: presence of second round effects from food

prices to inflation. In addition, they estimated a Phillips curve looking for the pass-through of food prices changes to inflation. Their results showed a domestic food price pass-through of 0.49 to overall inflation and 0.38 to non-food non-fuel inflation. The international food prices pass-through to overall inflation and non-food non-fuel inflation were estimated at 0.09 and 0.08, respectively.

In respect of VAR model, Mija et al. (2013) used it and found the impact of changes in oil and food prices on core inflation in Republic of Moldova. Jalil and Zea (2011) applied the VAR model in studying the pass-through of international food prices to domestic inflation in Brazil, Chile, Colombia, Mexico, and Peru. The impulse response analysis revealed positive and significant response of core prices to shocks in food prices. However, the study could not identify exactly what part of core prices actually was caused by international food prices shock.

Ruch and DuPlessis (2015), measured second round effects in South Africa by applying a structural Bayesian VAR. They found that changes in food, petrol and energy prices were accommodated and led to strong second-round effects through both the cost and expectations channel. A shock to relative food and energy prices increase wages by 0.3% a year and the core inflation rose by a maximum of 0.3% three quarters after the shock.

IV. METHODOLOGY

To inspect the existence of second round effects of food and energy prices to inflation, we borrow the gap model used by Ceccetti and Moessner, 2008; Šoškić, 2015 and Misati and Munene; 2015.
The gap model helps to investigate whether the headline inflation return to core inflation or vice versa. If headline inflation reverts to core, it would mean food or energy inflation is temporary and do not lead to persistently rising headline inflation that could arise from persistent upside shocks to commodity prices or from second round effects due to higher inflation expectations and accelerating wages (Cecchetti & Moessner, 2008).

In this respect, we estimate equation 1, specified as follows:

$$\pi_t^{headline} - \pi_{t-i}^{headline} = \alpha + \beta\left(\pi_{t-i}^{headline} - \pi_{t-i}^{core}\right) + \varepsilon_t \quad (1);$$

Where $\pi_t^{headline}$ is the headline inflation in period t, π_t^{core} stands for core inflation in period t and i represent lags in months.
This equation helps to estimate the reaction of headline inflation to non-core inflation. The left side part represents the change of the headline inflation during a certain period while the right hand side major component is the

difference between headline and core inflation or non-core inflation. β is the coefficient which determine whether or not headline and non-core inflation have a relationship.

If headline inflation turn back to core inflation after a shock from food or energy prices, the sign of the coefficient β is negative. Therefore, the food or energy price shock would be temporal. If α is 0 and β1 coefficient equals -1, it implies that headline inflation would completely return back to core inflation.

To investigate the possibility of core inflation reverting to headline, we estimate equation 2.

$$\pi_t^{core} - \pi_{t-1}^{core} = \alpha + \delta\left(\pi_{t-1}^{core} - \pi_{t-1}^{headline}\right) + \varepsilon_t \quad (2);$$

This equation tests the reaction of core inflation to non-core inflation. The left hand side is the change in core inflation during a certain period and on the right hand side, the non-core inflation influence on core inflation is shown by the coefficient δ.

If δ becomes significant with negative sign, it would be indicating the presence of second round effect from food and energy prices shocks. Therefore, core inflation would be catching up with headline inflation, which monetary policymakers would need to resist (Ceccetti & Moessner, 2008).

Furthermore, following Mija et al. (2013) we specify a VAR model for evaluating length of time of the shock from food or energy price.

The VAR model is specified as was follows:

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

Where $\mathbf{Y_t}$ represents the vector of all contemporaneous values in the model, **A** the matrix of all the coefficient to be estimates, $\mathbf{Y_{t-1}}$ the vector of lagged values and $\mathbf{U_t}$ a vector of error terms. The model includes the headline, fresh food, solid fuel, fuel and lubricant as well as core inflation.

We used monthly inflation data from January 2009 to December 2017; sourced from National institute of statistics of Rwanda (NISR).

V. EMPIRICAL RESULTS

5.1. Unit root test

The empirical analysis begins with analyzing the order of integration of the variables using the Augmented Dickey Fuller unit root tests. As indicated in the table below, all variables are stationary.

Table 2. Unit root test results

Variables	ADF statistic	Critical values			P value	Order of integration
		1%	5%	10%		I
Headline inflation	-7.740	-3.494	-2.889	-2.582	0.000	0
Core inflation	-3.168	-3.494	-2.889	-2.582	0.000	0
Fresh food inflation	-8.540	-3.494	-2.889	-2.582	0.000	0
Fuel inflation	-12.376	-3.494	-2.889	-2.582	0.000	0
Solid fuel	-8.112	-3.494	-2.889	-2.582	0.000	0

Source: Author's estimation

Therefore, all variables are stationary and we proceed by estimating the specified equations.

5.2. Testing the transitory nature of food and energy price change

Applying equation (1), we respond to whether the headline inflation revert to core inflation or not.

Table 3. Equation 1 results

Dependent Variable: ΔHEADLINE		
Variable	β Coefficient	P-value[12]
DHDCORE(-12)	-1.049*	0.000
DHDCORE(-3)	-0.427*	0.000
DHDCORE(-1)	-0.122*	0.011

Source: Author's estimation

[12] * indicates that the variable is significant based on 5% significance level.

These results show that the β coefficient of equation (1) has a negative sign and is significant as the p-value is less than 5%. The results suggests that after initial food or energy price shock, headline inflation return back to core inflation, implying that food or energy price shock are transitory.

5.3. Testing the presence of second round effect

Is there a second-round effect of food inflation on headline inflation? We estimated equation two, which results are presented table 4. We found that the coefficient δ is not significant. The result implies that the core inflation do not converge to headline inflation after a shock of food and energy prices. Thus, there is no evidence of second round effect from food and energy inflation.

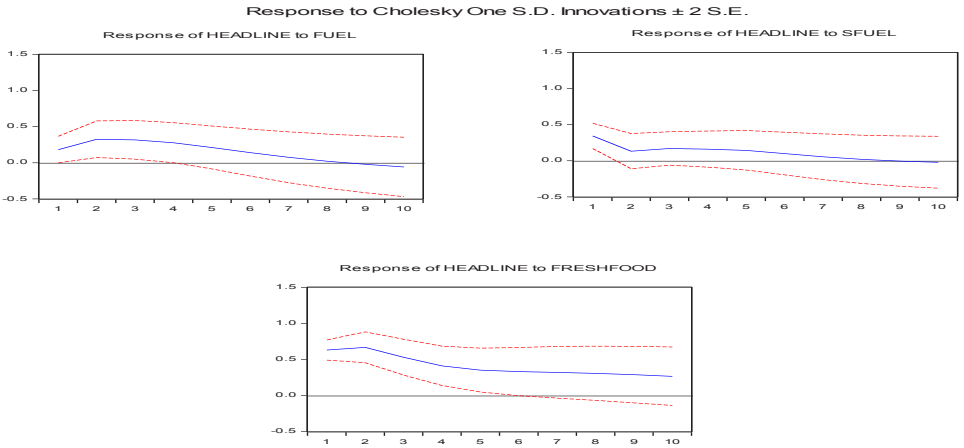
Table 4. Equation 2 results

Dependent Variable: ΔCORE		
Variable	δ Coefficient	P-value
DCOREHD(-12)	-0.234	0.363
DCOREHD(-3)	0.101	0.286
DCOREHD(-1)	0.036	0.366

Source: Author's estimation

Given these results, we sought the length of time of the shock from food or energy price on the headline inflation since the impact on core is not significant. To derive the duration of the shock on the headline inflation, we used the impulse response function based on cholesky decomposition after the estimation of the VAR model (see appendix).

Figure 3: impact of fuel and food prices in on headline inflation



Source: Author's estimation

The impulse response function confirms the results of the first equation, that the shocks from energy and food prices are temporal. The first graph, on upper left hand side, shows the response of headline inflation on the fuel and lubricant price shock. The shock increases the headline inflation during the first month and this effect start to decline in the second month and die at the end of the third month. It implies that the shock from fuel and lubricant price last for three months only.

The second graph (upper right hand side) shows that the effect of solid fuel price shock on headline inflation directly decline and ends in one month. In respect of fresh food prices, the shock pushes higher the headline inflation for a period of one month and half then slid gradually and disappear ending the fifth month. Therefore the impulse response function demonstrates that the transitory periodicity of fresh food price shock is five months while being one and three months for solid fuel and fuel and lubricants prices respectively.

VI. CONCLUSION

This study tested the existence of second round effect from food and energy prices in case of Rwanda and evaluated the time span of the effect of those shocks on the headline inflation. The use of gap model helped to find out that there is no significant evidence of second round effect from food and energy inflation and that shocks from energy and food price have a temporary nature. Furthermore, the impulse response function show that shocks from non-core components of headline inflation, namely fresh food, fuel and lubricants as well as solid fuel, are transitory; spanning five months, three months and one month respectively. Therefore, monetary policy should not react to food and energy shocks, ceteris paribus.

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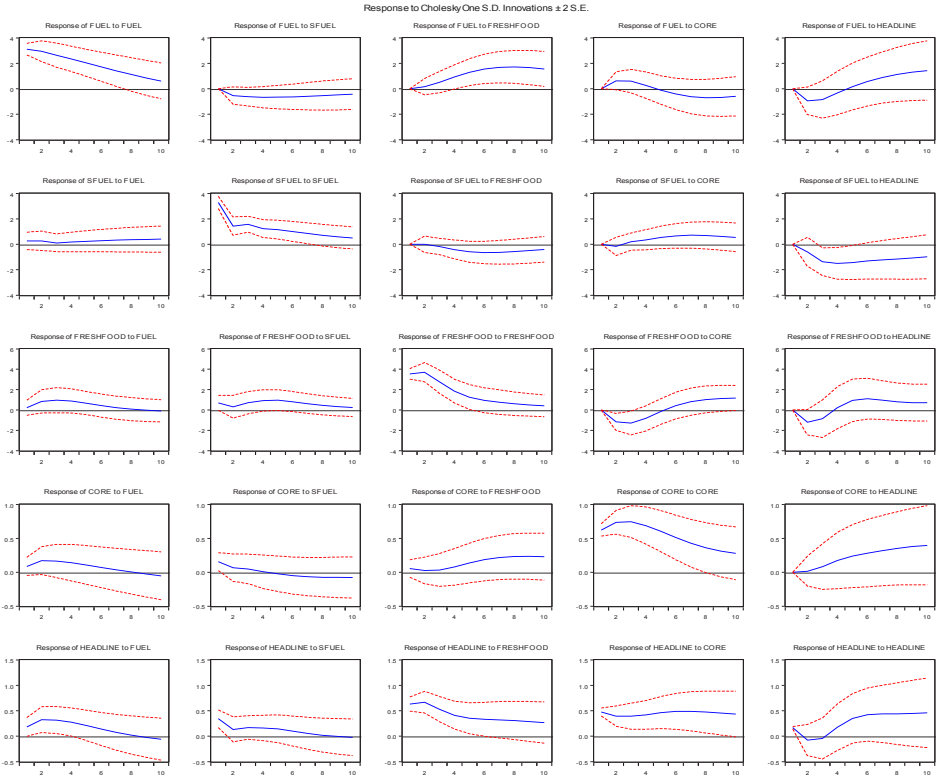
Appendix

1. VAR Estimation results

Vector Autoregression Estimates					
Standard errors in ( ) & t-statistics in [ ]					
	FUEL	SFUEL	FRESHFOOD	CORE	HEADLINE
	1.066427	0.139539	0.414395	0.023597	0.087274
	-0.13316	-0.14151	-0.15442	-0.02778	-0.03837
FUEL(-1)	[8.00864]	[0.98605]	[2.68361]	[0.84931]	[2.27482]
	-0.21986	-0.0432	-0.45817	-0.03105	-0.09915
	-0.12836	-0.13642	-0.14886	-0.02678	-0.03698
FUEL(-2)	[-1.71279]	[-0.31671]	[-3.07792]	[-1.15936]	[-2.68091]
SFUEL(-1)	-0.02603	0.567082	0.19913	-0.0361	-0.01211
	-0.15552	-0.16527	-0.18034	-0.03245	-0.04481
	[-0.16740]	[3.43116]	[1.10417]	[-1.11238]	[-0.27017]
	-0.12126	0.357269	-0.1954	0.01102	-0.01011
	-0.15909	-0.16907	-0.18449	-0.03319	-0.04584
SFUEL(-2)	[-0.76221]	[2.11310]	[-1.05911]	[0.33198]	[-0.22066]
	0.981965	0.605355	2.282915	-0.02491	0.254532
	-0.5301	-0.56336	-0.61473	-0.11061	-0.15273
FRESHFOOD(-1)	[1.85240]	[1.07454]	[3.71368]	[-0.22518]	[1.66654]
	-0.70772	0.442439	-2.12525	-0.02992	-0.33467
	-0.541	-0.57494	-0.62737	-0.11288	-0.15587
FRESHFOOD(-2)	[-1.30816]	[0.76953]	[-3.38756]	[-0.26504]	[-2.14712]
	5.371868	2.499353	3.659711	1.114565	0.978198
	-2.40844	-2.55954	-2.79292	-0.50252	-0.6939
CORE(-1)	[2.23044]	[0.97649]	[1.31035]	[2.21794]	[1.40970]
	-4.79327	3.040885	-6.16399	-0.453	-1.18166
	-2.44867	-2.60229	-2.83958	-0.51092	-0.70549
CORE(-2)	[-1.95750]	[1.16854]	[-2.17074]	[-0.88664]	[-1.67493]
	-5.70072	-3.61645	-7.228	0.088091	-0.45109
	-3.19441	-3.39483	-3.70437	-0.66652	-0.92035
HEADLINE(-1)	[-1.78459]	[-1.06528]	[-1.95121]	[0.13217]	[-0.49012]
	4.94066	-2.90438	10.77834	0.258062	1.733488
	-3.24585	-3.44949	-3.76402	-0.67725	-0.93517
HEADLINE(-2)	[1.52215]	[-0.84197]	[2.86352]	[0.38104]	[1.85365]
	0.191041	0.21659	0.538012	0.333493	0.313583
	-0.75118	-0.79831	-0.8711	-0.15673	-0.21642
C	[0.25432]	[0.27131]	[0.61763]	[2.12776]	[1.44893]
R-squared	0.890226	0.703934	0.816481	0.892462	0.863528
Adj. R-squared	0.876838	0.667828	0.7941	0.879348	0.846885
F-statistic	66.49863	19.49652	36.48193	68.05245	51.88538

2. Impulse responses



NOWCASTING GDP IN RWANDA

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ABSTRACT

This paper aims to test the forecast accuracy of different models via in-sample and out-of-sample tests and proposes a methodology for Nowcasting GDP in Rwanda, which is key for formulating monetary and fiscal policies. We test the forecast accuracy for the current quarter (nowcast) and the following quarter (forecast) of two sets of models: Bridge Equations (BE) using single variables (high-frequency indicators of economic activity) in Auto-Regressive Distributed Lags (ARDL) estimations and Multiple Linear Equations (MLE) using up to three variables in OLS estimation.

For both BE and MLE, we test five possible ways of combining forecast equations, each with different sets of weights. We find that the combination enhances the accuracy of nowcasts and forecasts, as measured by six different mea-sures of error. Moreover, combining again the combined BE estimate with the combined MLE estimate adds further to accuracy of both nowcasts and forecasts.

Keywords: Nowcasting, GDP, Bridge Equations, Forecast Combinations.

JEL Classification Numbers: E32, E37, C20, C30

1 INTRODUCTION

Monetary and fiscal policies depend on evaluations of current and future economic conditions. Unfortunately, one of the most recurrent issues encountered is data timeliness, making it difficult for forecasters and policymakers to have a reasonable perspective of the condition of the economy continuously. As in Rwanda, real gross domestic product is published quarterly by the National Institute of Statistics of Rwanda (NISR) with a delay of between two and three months. Therefore, the evaluation of current-quarter GDP, also called "nowcasting" and other key factors is a critical undertaking for Governments and Central Banks.

Nowcasting, as explained by Giannone, Reichlin, and Small (2006), is done in Central Banks and Government institutions utilizing both basic models and qualitative judgment on high frequency indicators to estimate current GDP before the data is made available. This requires careful examination of a lot of data and judgment on the relative weights to ascribe to different information. While nowcasting current-quarter GDP growth, subjective judgment is regularly joined with straightforward small-scale models called "bridge equations" (BE). The idea is to use small-models to "bridge" the information contained in a number of individual high frequency indicators (HFIs), using single equations, with the quarterly growth rate of GDP. Bridge equations are now widely used and have been proven effective (Baffigi, Golinelli, and Parigi, 2004; Angelini et al., 2011). We tested up to twenty-two HFIs, and retained seven. Another idea is to use multiple linear equations (MLE) associating two or three indicators, which make sense from an economic or statistical point of view and fit well the data (Angelini et al., 2011). We tested up to ten equations and kept three with three regressors each.

This paper's objective is to test the forecast accuracy of different models via in-sample and out-of-sample tests as explained by Tashman (2000) or Hyndman (2015) and propose a methodology for Nowcasting GDP in Rwanda. We test the accuracy for nowcasting and forecasting one quarter ahead GDP with different BE, and combinations of them; and different MLE, and combinations. We use six different measures of error to estimate forecast accuracy and test up to five different ways to combine nowcasts and forecasts from simple mean and simple median to more complex weighted averages. We find that the error is always minimal while combining nowcasts and forecasts from BE, likewise for MLE. Comparing the combined BE estimate, and the combined MLE with another set of combinations of the two, we find that the mixed BE/MLE combination is the most accurate.

The data is limited in terms of number of indicators available, most of them are also not available before 2007, making the nowcasting and forecasting exercise more difficult. However, as more and more data and indicators become available in Rwanda, the nowcasting and forecasting accuracy will certainly improve. With this paper, we try to evaluate the information available today and distinguish what is relevant for GDP.

The remainder of the paper is organized as follows: Section 2 describes the literature review. Section 3 explains the methodology used. Section 4 shows the data used and Section 5 explains the results. Section 6 concludes.

2. LITERATURE REVIEW

Bridge models or Bridge Equations (BE) have been used and tested a lot in the forecasting literature. It is now common to use simple BE with different indicators and average them with different weights from the simplest approach (simple average) to the more complex with weights based on errors computed comparing predicted to actual values. Baffigi, Golinelli, and Parigi (2004) compared the forecast accuracy of bridge models in the Euro area with univariate and multivariate statistical models as well as a structural model. They found that BE outperform the other models. In addition, Kitlinski and an de Meulen (2015) analyze different sizes of indicator sets with two edge algorithms to look at their impact on the forecasting performance of bridge models in forecasting Euro area GDP. They find that a selection of indicators improves the forecasting performance compared to a benchmark model, especially in times of weak economic activity. However, adding more indicators can have a negative effect on the forecasting performance, emphasizing that using bridge models, one should carefully choose the set of indicators to use. In the case of Rwanda, our paper helps at identifying those.

We follow the approach by Angelini et al. (2011) by examining both MLE and a pool of forecast based on a larger number of single BE with only one regressor. Several researches have proven that combining forecasts through simple or weighted average is often better (Clemen, 1989; Goodwin, 2009).

Out-of-sample tests hold part of the sample aside as a test period, reproducing real life forecasting (the forecaster having no access to future data) whereas in-sample tests focus on how well the models fit the data in the sample. There is convergence in the literature that forecast accuracy is best assessed through out-of-sample tests for different reasons.

'The nuances of past history are unlikely to persist into the future and the nuances of the future may not have revealed themselves in the past' (Tashman, 2000). The accuracy of forecasts can only be determined by

considering how well a model performs on new data that were not used when estimating the model' (Hyndman, 2015). Nevertheless, Inoue and Kilian (2002) question this: results of in-sample predictability tests are not necessarily less credible than out-of-sample. Another disadvantage of out-of-sample tests is that they require to put aside part of the data, a luxury when one considers the limited observations in the available data in Rwanda. Therefore, we present both in-sample and out-of-sample tests on a limited test period.

3. METHODOLOGY

3.1 Bridge Equations

A Bridge equation (BE) uses a High Frequency Indicator (HFI) as regressor in a single equations with GDP. We first seasonally adjust all HFIs in order to facilitate forecasting of real "economic" movements, not due to seasonal factors, in the short run (Bell and Sotiris, 2010). We then take the diff erence in log (dlog) to have only stationary variables. In everything that follows, we use the same dlog variables. We chose to use "Autoregressive-Distributed Lag" (ARDL) models rather than basic OLS, for which the fit was poor.

ARDL models are "autoregressive": GDP is explained by its lagged values. It

Additionally has "distributed lags" for the HFI. The thought is just to run ARDL regressions of GDP on each HFI. For every regression, we tried up to four lags for both GDP and the HFI. We chose the best model in light of the Adjusted R squared.

The general model can be composed:

$$dlog(GDP) = \alpha + \beta_1 dlog(GDP)_{t-1} + \cdots + \beta_i dlog(GDP)_{t-i} + \gamma_1 dlog(HFI)_t + \gamma_2 dlog(HFI)_{t-1} + \cdots + \gamma_{j+1} dlog(HFI)_{t-j} + \varepsilon \quad (1)$$

with i and j taking values between 0 and 4,ε being some error term

3.2 Multiple linear Equations

Following Angelini et al. (2011), we also used Multiple Linear Equations (MLE). We first tried up to 10 several instinctive models of the Rwandan economy with a couple of variables each. Finally, we retained three equations with three regressors each. The general model is then simply estimated by OLS. Unlike ARDL, no lag is used. The general model can be written:

$$dlog(GDP) = \beta_0 + \beta_1 dlog(HFI_1) + \beta_2 dlog(HFI_2) + \beta_3 dlog(HFI_3) \quad (2)$$

3.3 Combining forecasts

After estimating all BE, we test their forecast accuracy computing six well-known measures: the Root Mean Square Error (*RMSE*), mean Absolute Error (*MAE*), Mean Absolute Percent Error (*MAPE*), Symmetric mean Absolute Percent Error (*SMAPE*) and Theil Inequality Coefficients (*U1* and *U2*). Defining the error $e_i = y_i - \hat{y}_i$ as simply the difference between the actual value of GDP y_i and the forecast $\hat{y}_i$ for the period i, for all six measures of error, the lower is the value and the better the forecast is. They can be defined as:

$$RMSE = \sqrt{mean(e_i^2)} \tag{3}$$

$$MAE = mean(|e_i|) \tag{4}$$

$$MAPE = mean(|100e_i/y_i|) \tag{5}$$

$$SMAPE = mean(200|y_i - \hat{y}_i|/(y_i + \hat{y}_i)) \tag{6}$$

$$TheilU1 = \frac{\frac{1}{n}\sqrt{\sum_{i=1}^{n}(y_i-\hat{y}_i)^2}}{\sqrt{\sum_{i=1}^{n}(y_i)^2}+\sqrt{\sum_{i=1}^{n}(\hat{y}_i)^2}} \tag{7}$$

$$TheilU2 = \frac{\frac{1}{n}\sqrt{\sum_{i=1}^{n}(y_i-\hat{y}_i)^2}}{\sqrt{\sum_{i=1}^{n}(y_i)^2}} \tag{8}$$

These six measures of error are used to decide on the best BE forecast to use. We also use them to test five different combinations of forecast: the *simple mean*, *simple median*, one based on some *Least-Squares* coefficients, one based on *Mean Square Error* or MSE, and finally one based on the ranks of MSE (*MSE Ranks*). The two first combinations simple mean and simple median are straightforward.

For *Least-Squares*, the weights are calculated based on the coefficients of a regression of the forecasts against the actual values, see Elliott, Granger, and Timmermann (2006).

For the *Mean Square Error*, the weights used are the Mean Square Errors or square of *RMSE* described in equation (3), for more details see Stock and Watson (2001). For *MSE* Ranks, the idea is similar to MSE, but rather than calculating the weights based on MSE, they are calculated after ranking the forecasts by MSE. The ratio of the inverse of the ranks are then used for averaging (Aiolfi and Timmermann, 2006).

For Multiple Linear Equations, we adopt exactly the same procedure of estimation and testing combinations as described for BE. To summarize, we estimate equations BE and MLE, test forecast using five measures of errors, test different combinations to finally choose the best model.

3.4 Tests: In-Sample and Out-of-Sample

We follow the procedure described above to perform two types of tests: In-Sample (IS) and Out-of-Sample (OS). IS tests are done considering the whole sample available until the third quarter of 2017 (2017Q3). This means that all regressions are done using the full sample. Forecasts are in-sample because we know the actual values of GDP during this period.

For OS tests, what is important is not how well the model fit past data, but how well it performs using new data (Hyndman, 2015). For this, we choose a part of the data that is not used for regressions, but only for testing: it is called the "test data". The part of the sample used for estimation is called the "training data". We are only interested in how well nowcasting current quarter and forecasting the next quarter are performing.

This means that at each time, we need to add one observation to the sample, estimate the equations, forecast, add another one, re-estimate and forecast again. This procedure is known as "rolling forecasting origin' (Hyndman, 2015). Suppose that the training data goes from period 1 to *k*, the process can be summarized as follows:

1. We use observations at periods 1, 2, ...k to nowcast GDP at period k and forecast GDP at period k + 1
2. We repeat the first step for periods 1, 2, ...k + 1 to nowcast GDP at period k + 1 and forecast at period k + 2
3. We repeat the previous step until the end of the test data.

Table 1 shows an example of OS procedure for the BE GDP forecasts using the variable variable *cement*, one of the HFIs, which is the sum of the domestic production of cement and imports of cement. Actual values of GDP are repeated in the training data period. For each period, we obtain a nowcast for the current quarter and a forecast for the next quarter. For example using data until 2015Q1, we nowcast 2015Q1 GDP: 2.162 in gray and forecast 2015Q2 GDP: 3.670 in light gray. Then, we add one more observation : 2015Q2 and re-estimate again all equations to nowcast this time 2015Q2 GDP: 2.979 and forecast 2015Q3 GDP. We repeat this until 2017Q3, end of the sample, and extract nowcast and forecast values for accuracy tests.

The overall procedure of regressions and tests can be summarized as follows:

- **Step 1:** Obtain nowcasts and forecasts In-Sample or Out-of-Sample by using Bridge Equations and Multiple Linear Equations
- **Step 2:** Test accuracy of BE, MLE and diff erent combinations using *RMSE*, *MAE*, *MAPE*, *SMAPE*, *T heilU*1 and *T heilU*2. Retain the best models for Be and MLE.

Table 1: Out-of-Sample Test

	2015Q1	2015Q2	2015Q3-2016Q4	2017Q1	2017Q2	2017Q3	**Nowcast**	**Forecast**
2015Q1	2.162	3.181	…	3.181	3.181	3.181	2.162	
2015Q2	3.670	2.979	…	2.444	2.444	2.444	2.979	3.670
…	…	…	…	…	…	…	…	…
2016Q3	5.025	4.742	…	−0.194	−0.194	0.194	…	…
2016Q4	2.291	1.978	…	0.197	-0.197	-0.197	…	…
2017Q1	4.872		…	1.613	1.136	1.136	1.613	1.960
2017Q2	0.029	0.165	…	2.036	3.290	3.208	3.290	2.036
2017Q3	3.116	3.030	…	1.237	1.075	1.543	1.543	1.075

- **Step 3:** Test again the best MLE or combination, the best BE or combination and a combination of the two types of models.
- **Step 4:** Compare the best model obtained after Step 3 to actual GDP.

For both IS and OS, given the limited number of observations, we chose to test the forecast accuracy during the period starting from the first quarter of 2015 (2015Q1) until the third quarter of 2017 (2017Q3).

4. DATA

The 22 HFIs used and GDP are described in Table 2. All data is available until quarter 3 of 2017, and have been seasonally adjusted and transformed via dlog. The monthly variables have been averaged into quarterly as GDP is only available quarterly.

The monthly variables, available with minimum delay, are the CPI variables, then trade variables like exports and imports and finally the monetary variables like broad money M3 and credit to the private sector.

The variables available late are those obtained from an industrial production survey published every quarter even though the data is estimated for every month. These data are often made available a couple of weeks before GDP, allowing to revise an earlier nowcasting estimate. When the data is not yet available, one can forecast HFIs using ARMA methods to get preliminary nowcasting estimates. For the purpose of this paper, all data is available for the whole sample period allowing us to make diff erent tests.

Table 2: Variables Description

Indicator	Description	Frequency	Delay	Starting date
GDP	Rwandan Real GDP	Quarterly	Up to 3 months	Mar 2006
Ciea	BNR's Real Composite Index of Economic Activity	Monthly	25 days	Jan 2012
Cpi	Rwandan Consumer's Price index	Monthly	10 days	Jan 2004
cpifood	Rwandan Food CPI	Monthly	10 days	Jan 2004
Credit	Credit to the private sector	Monthly	25 days	Jan 2003
m3	Broad money	Monthly	25 days	Jan 2003
Mcif	Imports of goods in value (cif)	Monthly	20 days	1998
Mvol	Imports of goods in volume	Monthly	20 days	1998
Xval	Exports of goods in value	Monthly	20 days	1998
Xvol	Exports of goods in volume	Monthly	20 days	1998
Tind	Turnovers of Industry sector	Monthly	1 month	Jan 2012
Tserv	Turnovers of Services sector	Monthly	1 month	Jan 2012
Vat	VAT receipts	Monthly	20 days	Jan 2006
Usd	Nominal US Dollar to Rwandan Franc exchange rate	Monthly	1 day	Jan 2006
Ppi	Rwandan Producer Price Index	MDPQ	4-6 weeks	Jan 2005
cement	Cement industrial production + Imports	MDPQ	Up to 2 months	Jan 2006
Elec	Electricity production	MDPQ	Up to 2 months	Jan 2006
Flour	Flour industrial production	MDPQ	Up to 2 months	Jan 2006
Milk	Milk industrial production	MDPQ	Up to 2 months	Jan 2006
Rice	Rice industrial production	MDPQ	Up to 2 months	Jan 2006
Soda	Soft drinks industrial production	MDPQ	Up to 2 months	Jan 2006
Water	Water production	MDPQ	Up to 2 months	Jan 2006
Beer	Beer industrial production	MDPQ	Up to 2 months	Jan 2006

MDPQ = Monthly Data Published Quarterly

5. RESULTS

5.1 Bridge Equations

After testing individually 22 ARDL equations using 22 HFIs on the whole sample period going until quarter 3 of 2017, we decided to keep 14 and removed 6 for which no significance was found for the HFI or its lagged values once the lagged values of GDP have been controlled for. These 14 BE have then been tested following the procedure described in section 3. Based on the six types of errors measured, we decided to keep only 7 variables, thus 7 BE.

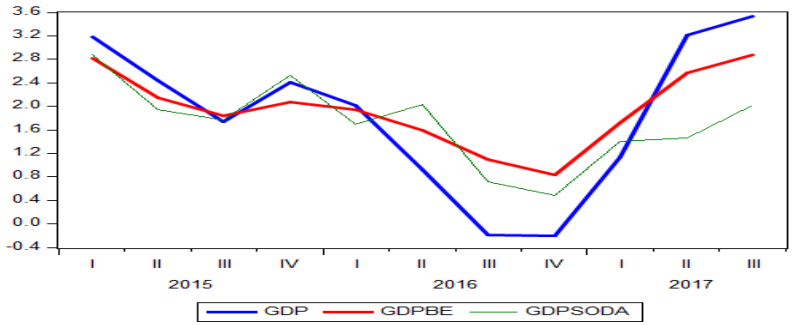
Table 3 shows results of in-sample (IS) accuracy tests for the nowcasts from all 7 BE and combinations. Variables start by *gdp* indicating that we refer to nowcasts: *gdpsoda* being the nowcast estimated from the BE using the variable *soda*.

Table 3: Bridge Equations In-Sample Tests

Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
Gdpsoda	0.77	0.58	63.39	55.13	0.19	0.29
Gdpcredit	0.95	0.71	139.67	58.87	0.23	0.72
Gdpciea	0.98	0.83	108.57	70.75	0.23	0.82
gdpm3	0.99	0.81	107.59	67.24	0.25	0.90
Gdptserv	1.00	0.87	102.58	74.78	0.24	1.36
Gdpmcif	1.01	0.90	129.51	71.59	0.25	0.98
Gdpelec	1.15	0.88	182.06	56.21	0.27	0.95
Simple mean	0.78	0.70	107.02	62.44	0.19	0.68
Simple median	0.73	0.62	100.45	57.80	0.18	0.84
Least-squares	0.65	0.55	126.86	53.31	0.15	0.88
Mean square error	0.77	0.69	103.17	62.29	0.19	0.65
MSE ranks	0.77	0.68	101.97	61.61	0.19	0.65

The final 7 HFIs with the lowest error, thus the 7 best predictors in-sample are: *soda*, *credit*, *ciea*, *m*3, *tserv*, *mcif* and *elec*. Table 3 shows that among the 7 HFIs, the best predictor, having the lowest *RMSE*, *MAE*, *MAPE*, *SMAPE*, *TheilU1* and *TheilU2* is *soda*, the industrial production of soft drinks for the test period. It seems that the production followed the demand for soft drinks, which in turn moved with the economic activity.

Figure 1: Bridge Equations In-Sample Tests



The best combination model is the average via *least-squares* weights, outperforming all other combinations and single nowcasts. Therefore, we retain this method to compute the variable *gdpbe*, combination of all BE nowcasts in-sample.

Figure 1 compares the nowcasts from using *soda* and the combined nowcasts using BE in-sample to the actual GDP series. We can see that except during the period quarters 3 *and* 4 of 2016 of slow down in economic activity with a GDP growth quarter-on-quarter

seasonally adjusted close to zero, the nowcast *gdpbe* seem to perform relatively well. In 2016Q3 and *2016Q4*, *gdpbe* predicted the slow down, but underestimated its magnitude.

Table 4 shows the same tests as Table 3 but for this time Out-of-Sample tests. With OS tests, we test *both* nowcasts (N) and forecasts (F) for the following quarter. Looking at nowcasts, the nowcast *gdpcredit* is the best single predictor considering *MAE*, *SMAPE* and *TheilU2*, while the combination using *simple median* is the best considering *RMSE*. It is not clear here that the combination is or is not better than just using *gdpcredit*. However, combining HFIs allows to take into account a larger set of information. Therefore, we combine nowcasts based on the *simple median* to generate the variable *gdpnbe*.

Looking at one quarter ahead forecasts, the best combination is the average using *least-squares* weights *computing* the variable *gdpf be*.

Table 4: Bridge Equations Out-of-sample Test

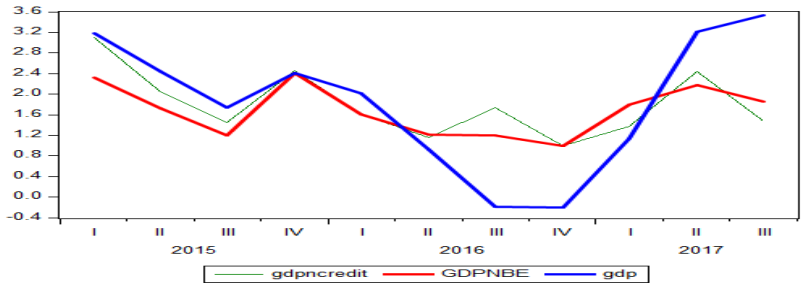
Forecast	RMSE		MAE		MAPE		SMAPE		Theil U1		Theil U2	
	N	F	N	F	N	F	N	F	N	F	N	F
Gdpcredit	0.98	1.07	0.69	0.81	162.04	167.42	55.67	64.42	0.24	0.28	0.93	0.79
Gdpsoda	1.03	1.30	0.85	1.03	139.35	143.23	67.85	93.50	0.25	0.33	0.79	1.03
Gdpcement	1.10	1.50	0.87	1.31	175.75	234.39	66.90	105.35	0.26	0.37	0.89	0.97
Gdpmcif	1.10	1.18	0.94	1.02	151.10	159.31	74.22	82.97	0.28	0.31	1.22	1.03
Gdpelec	1.15	1.62	0.83	1.03	171.36	285.25	64.12	57.16	0.27	0.36	0.70	1.08
Gdpmvol	1.15	1.28	0.99	1.11	184.68	228.47	70.65	78.19	0.29	0.34	1.62	1.54
gdpm3	1.16	1.23	1.01	1.02	189.55	143.29	74.87	80.38	0.29	0.33	1.46	0.96
Simple mean	0.97	1.06	0.83	0.84	164.34	174.36	63.25	66.62	0.24	0.28	1.02	0.81
Simple median	0.93	1.06	0.80	0.85	144.82	168.70	63.39	68.43	0.23	0.28	1.01	0.84
Least-squares	0.93	0.97	0.82	0.78	147.08	136.47	63.32	66.26	0.24	0.27	0.99	0.86
Mean square error	0.96	1.05	0.81	0.84	162.94	169.40	62.67	67.23	0.24	0.28	1.00	0.86
MSE ranks	0.94	1.05	0.77	0.85	157.46	165.36	60.40	68.19	0.23	0.28	0.91	0.92

N = Nowcast , F = Forecast

Figure 2 compares the nowcasts (left figure) and forecasts (right figure) from using credit to the private sector and the combined nowcasts and forecasts using BE out-of-sample to the actual GDP series.

As in Figure 1, we note that the combination of nowcasts and forecasts did not predict the magnitude of the reduction in GDP growth in 2016Q3 and 2016Q4. However, the information available in 2015 allowed to slightly reduce the gap with the actual GDP, the nowcast being better than the forecast during this period. Nevertheless, the nowcast in 2017Q3 is going the wrong direction. The forecast estimates using BE are in general quite poor.

Figure 2: Bridge Equations Out-of-Sample Tests



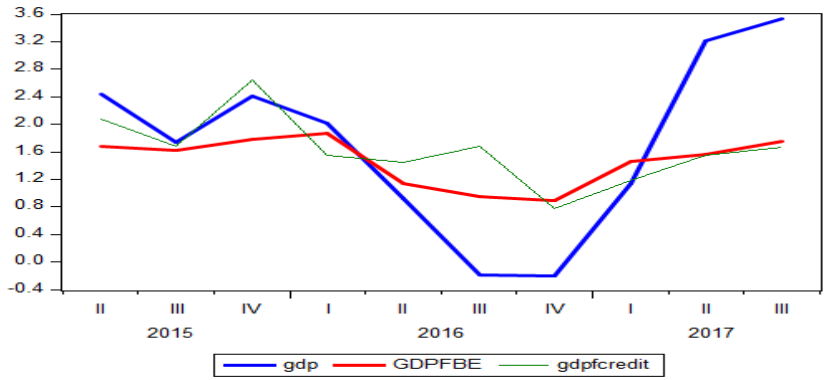


Table 5: Multiple Linear Equations In-Sample Tests

Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
gdpmle1	0.88	0.68	126.65	56.61	0.21	0.65
gdpmle2	1.07	0.90	68.38	80.01	0.27	0.86
gdpmle3	0.96	0.79	83.08	69.67	0.23	1.22
Simple mean	0.84	0.74	90.77	65.97	0.21	0.76
Simple median	0.84	0.72	78.15	66.54	0.21	0.85
Least-squares	0.80	0.67	103.10	59.43	0.20	0.55
Mean square error	0.82	0.72	94.17	64.20	0.20	0.73
MSE ranks	0.81	0.68	99.51	61.57	0.20	0.68

5.2 Multiple Linear Equations

In this subsection, we interpret similar results than for Bridge Equations but this time focusing on Multiple Linear Equations. After testing several equations, we retained 3 MLEs. The first one, *mle*1, is a linear regression of GDP on the variables: credit to the private sector, broad money M3 and the CPI, representing the "money" side of the economy. The second, *mle*2, is a regression of GDP on food CPI, turnovers of the industry sector and turnovers of the services sector, representing the three sectors of the economy: agriculture, industry and services. Finally, in the third and last equation, *mle*3, GDP is estimated by still three variables chosen among the best individual predictors: production of soft drinks, turnovers for the services sector, and imports in value (cif).

Table 5 shows the in-sample tests on the gdp nowcasts from the three MLE equations: *gdpmle*1, *gdpmle*2, and *gdpmle*3. The best predictor is from a combination of all three estimates via the *least-squares* method.

Figure 3: Multiple Linear Equations In-Sample Tests

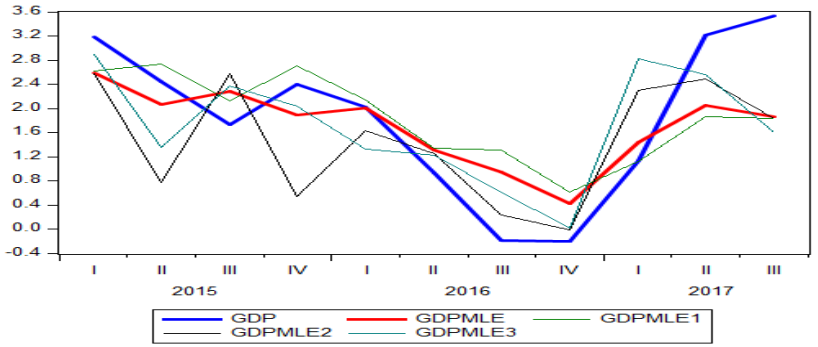


Table 6: Multiple Linear Equations Out-of-sample Tests

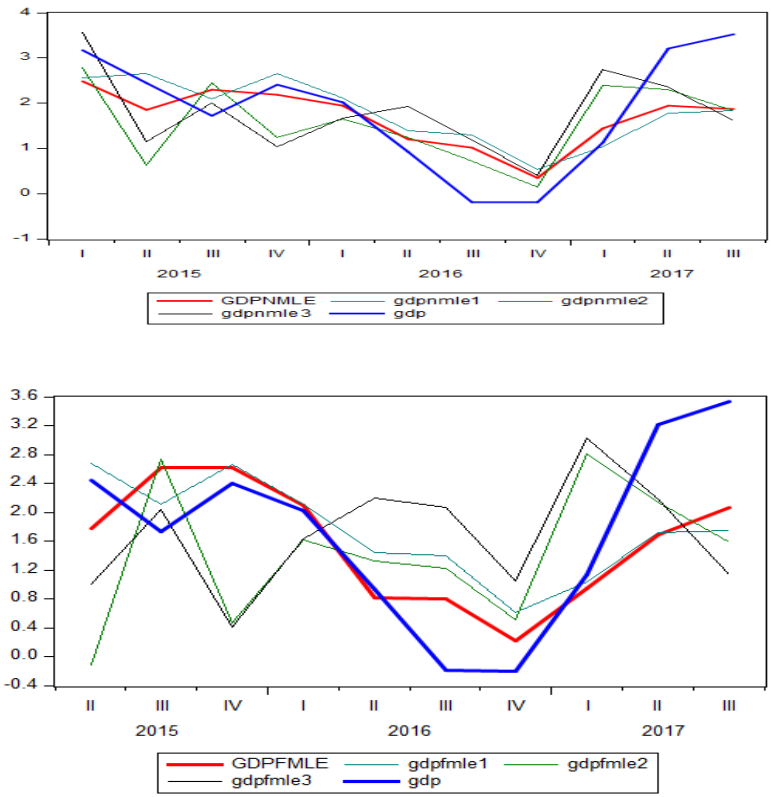
Forecast	RMSE		MAE		MAPE		SMAPE		Theil U1		Theil U2	
	N	F	N	F	N	F	N	F	N	F	N	F
mle1	0.88	0.96	0.68	0.73	122.89	143.80	57.48	62.46	0.21	0.24	0.61	0.67
mle2	1.04	1.48	0.90	1.31	96.85	162.54	76.91	103.69	0.26	0.39	0.95	1.33
mle3	1.14	1.58	1.00	1.42	136.49	237.53	77.81	97.61	0.27	0.40	1.25	1.67
Simple mean	0.91	1.22	0.80	1.11	116.04	179.02	67.32	82.82	0.23	0.32	0.81	1.10
Simple median	1.01	1.31	0.90	1.17	127.58	170.12	72.24	90.30	0.25	0.35	1.03	1.36
Least-squares	0.82	0.83	0.67	0.65	102.77	93.21	59.24	63.03	0.21	0.22	0.51	0.42
Mean square error	0.88	1.07	0.76	0.93	115.21	163.68	64.95	73.08	0.22	0.28	0.73	0.87
MSE ranks	0.86	1.09	0.73	0.97	113.17	162.27	63.26	75.61	0.21	0.29	0.67	0.90

N = Nowcast , F = Forecast

Figure 3 compares the nowcasts from using the three MLEs and the combined nowcasts in-sample to the actual GDP series. The combined variable seem to follow GDP movement except in 2015 Q2 and Q3 and 2017Q2. The magnitude of the slow down in 2016 Q3 and Q4 is a bit underestimated, but the fit for these periods is much better than in BE. Considering out-of-sample tests results (table 6), both the best nowcast and forecast is obtained by combining all 3 MLEs using the *least-squares* method, giving the variables *gdpnmle* and *gdpf mle* respectively for the nowcast and forecast combination.

Looking at Figure 4, the combined variable seem to predict well the GDP movements for both the nowcasts (left figure) and forecast (right figure).

Figure 4: Multiple Linear Equations Out-of-Sample Tests



5.3 Combining BE and MLE

After testing BE and MLE in-sample and out-of-sample, and obtaining the best combination of nowcasts and forecast, we are interested in this section in testing these combinations to see which approach performs better amongst BE and MLE and if combination of the two approaches is necessary.

Table 7 tests this in-sample. We can see that in-sample, the best method seems to be BE, except for the *MAPE*, where MLE is better. We opt for the best combination instead of just BE in order to include a larger set of information included in MLE, since one error measure still favors it and knowing that the weight will certainly favor BE. The best combination here is not clear but we choose *Least-squares* based on the *MAE*,*SMAPE* and *TheilU1*.

Figure 5 compares in-sample the combined BE prediction *gdpbe*, the combined MLE variable *gdpmle* and the combined BE/MLE variable *gdpcomb*. As expected, *gdpcomb* is much closer to BE estimate, and follows relatively well GDP movements. However, *gdpcomb* failed to predict the very low level of GDP growth in 2016 Q3 and Q4

Table 7: Combining BE and MLE: In-Sample Tests

Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
Gdpbe	0.65	0.55	126.86	53.31	0.15	0.88
Gdpmle	0.80	0.67	103.10	59.43	0.20	0.55
Simple mean	0.70	0.61	114.98	56.29	0.17	0.71
Simple median	0.70	0.61	114.98	56.29	0.17	0.71
Least-squares	0.66	0.56	124.89	53.79	0.15	0.85
Mean square error	0.69	0.60	117.43	55.66	0.16	0.74
MSE ranks	0.68	0.59	118.94	55.28	0.16	0.77

Figure 5: Combinations Be and MLE In-Sample Tests

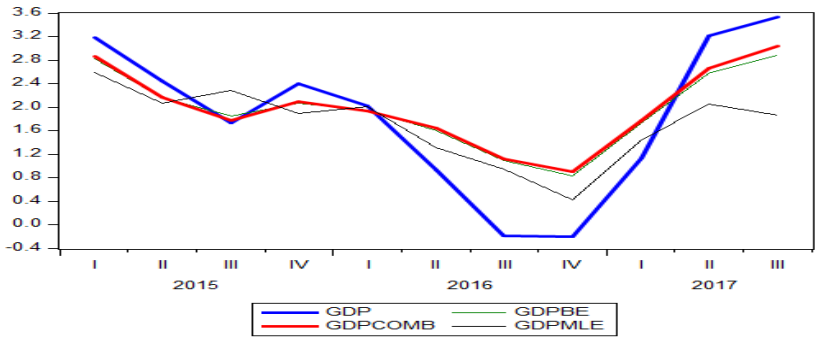


Table 8 tests out-of-sample accuracy of BE, MLE and the different combinations possible. For OS tests, the results are opposite to in-sample as the best model seems to be MLE this time compared to BE for both nowcasts and forecasts. Since there are some exceptions where BE predicts better GDP, again we go for the best combination instead of just MLE in order to include a broader set of information included in BE. The best combination is *MSE ranks* for the nowcasts and the forecasts.

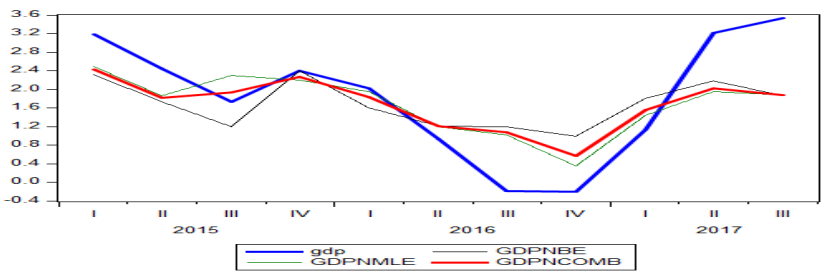
Figure 6 compares the combined BE and ME predictions in-sample and out-of-sample. Nowcast predictions perform relatively well, the combination allows to reduce the gap in 2016 Q3 and Q4 compared to BE. However the gap remains large in 2017Q3. The forecast curve is quite similar to the nowcast.

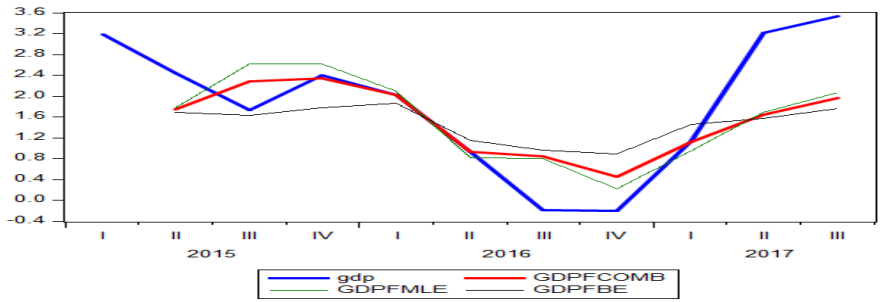
Table 8: Combining BE and MLE: Out-of-sample Tests

Forecast	RMSE		MAE		MAPE		SMAPE		Theil U1		Theil U2	
	N	F	N	F	N	F	N	F	N	F	N	F
Gdpbe	0.93	0.97	0.80	0.78	144.82	136.47	63.39	66.26	0.23	0.27	1.01	0.86
Gdpmle	0.82	0.83	0.67	0.65	102.77	93.21	59.24	63.03	0.21	0.22	0.51	0.42
Simple mean	0.85	0.87	0.68	0.65	120.97	110.08	58.44	60.14	0.21	0.23	0.75	0.60
Simple median	0.85	0.87	0.68	0.80	120.97	138.55	58.44	66.97	0.21	0.27	0.75	0.88
Least-squares	0.85	0.98	0.68	0.63	121.06	109.82	58.43	59.08	0.21	0.23	0.76	0.51
Mean square error	0.84	0.86	0.68	0.63	118.83	106.16	58.58	59.30	0.21	0.23	0.72	0.57
MSE ranks	0.83	0.85	0.68	0.62	114.90	102.07	58.79	58.71	0.21	0.23	0.67	0.53

N = Nowcast , F = Forecast

Figure 6: Combinations BE and MLE Out-of-Sample Tests





6. CONCLUSION

In this paper, we test the forecast accuracy of two sets of models: Bridge Equations (BE) using single variables in Auto-Regressive Distributed Lags (ARDL) estimations and Multiple Linear Equations (MLE). We find that for both BE and MLE, using in-sample and out-of-sample tests as well as six diff erent measures of error and five possible combinations, the combination is more accurate. After comparing the combined BE estimate with the combined MLE estimate again, we cannot reject the hypothesis that a combination of these two may add value to the nowcast and the forecast.

There is limitation in the data as well in terms of indicators available than in terms of observations, making the nowcasting and forecasting exercise more difficult. Nowcasting using the combined method allows to anticipate GDP movements, but the accuracy reduces in times of chocs like at the end of 2016 as the magnitude of the reduction in GDP growth could not be anticipated. The same occurs for the surprising recovery in 2017Q3. However, as more and more data (observations and indicators) become available in Rwanda, the nowcasting and forecasting accuracy will certainly improve. With this paper, we propose an approach which we think is the most accurate given the information available today. Another limitation is on the side of out-of-sample tests: splitting the already limited data may have made reduced the accuracy of the test. We recommend to run again out-of sample tests in a period of two to three years as more data will be available.

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