

MONETARY TRANSMISSION MECHANISM IN RWANDA

By Celestin Hakizamungu[1], Mbabazi Mbabazize[2], Charles Mulindabigwi Ruhara[3]

Abstract

The purpose of this study is to determine the effect of monetary policy on economic growth of Rwanda. The study uses quarterly data from 2000Q1 to 2015Q4 to estimate the dynamic influence of interest rate channel of monetary transmission mechanism, to estimate the effect of exchange rate channel of monetary transmission mechanism and the effect of credit channel of monetary transmission mechanism on economic growth. This study employed the co-integration techniques to determine if there exists a long-run relationship among variables. The results from the variance decomposition revealed that in long run the credit channel is more effective than other channels of monetary transmission mechanism by affecting RGDP with a shock of 52.15% in long- run at the 64th period followed by interest rate channel and exchange rate channel respectively. In the short- run interest rate channel affects the economic growth of Rwanda than other channels. Given the findings, there is need for constant revision of policy and instruments targeting framework and operating procedure to enhance monetary policy effectiveness particularly in stabilizing the exchange rate and keeping inflation levels at generally recommended rate. There is also a need for the Central bank to harmonize and combine the functionality of all channels to achieve optimum output goals of monetary transmission mechanism.

Key words: Monetary transmission, Interest rate channel, Exchange rate channel, Credit channel,

1. Introduction

All over the world, monetary policy has played significant role in repositioning economies because the instruments that eventually touch relevant macroeconomic variables such as output, resource utilization, assets prices, credits, inflation amongst others. The Central banks often have to act or react in response to actual, perceived or anticipated events. The monetary policy transmission mechanism (MTM) is the process through which monetary policy triggers changes in macroeconomic variables by certain transmission channels. In Rwanda , monetary policy really encompasses those rules and regulations designed by the monetary authority aimed at sufficient regulation and control of money supply, interest rate and credit availability with a view to attain the goals set up by the government. Nonetheless, the precise channels of transmission and their relative importance have remained a topic of debate. In particular, it is largely unclear whether there is a significant channel of transmission beyond the classical interest rate channel. A number of arguments have been proposed in particular or general, complementary or contradictory to explain how monetary policy decisions could be transmitted to prices and to the real sector (Robert, 1972) as well as to describe the intensity and efficiency of this transmission. The main issue on the debate

[1] Jomo Kenyatta University of Agriculture and Technology
[2] Jomo Kenyatta University of Agriculture and Technology
[3] University of Rwanda

regarding monetary transmission is its potential association to short-term real effects. Exchange rate channel during a monetary expansion leads to a decrease of domestic interest rates, relative to the foreign ones, followed by currency depreciation. We go on to analyze the transmission mechanisms of monetary policy and evaluate the empirical evidence on them to understand better the role of the channels of transmission mechanism on economic growth of Rwanda. By using tools the central bank can regulate the monetary base and reserves to aim for change money supply, which have an impact on macroeconomic process. Which are as final goal of monetary policy is price stability, intermediate target is monetary aggregate, and operating target is monetary base, also BNR has core tools of monetary policy. To find out the efficiency of monetary policy we will start from analyzing the link between monetary targets and price stability, (Mark Gertler, 1995). To our knowledge there are no studies in Rwanda that have been done to determine the effect of monetary transmission mechanism. For the case of Rwanda, BNR tried to reduce the key repo rate but the lending rate to private sector is still very high which reduce the investment to affect negatively the economic growth. In addition, the interest rate channel is weak and controlled by BNR instead of determined by the market, the value of national currency is stable while at market the prices of goods and services are increasing very high than the changes of local currency, the credit channel is very weak where banks are much financing the project of building houses and the agriculture sector which contributes 80% of GDP is lagging lastly, on side of asset price channel the taxes on fixed assets are increasing the value this research is going to show how effective monetary policy will help to analyze the effect of channels of monetary transmission mechanism on economic growth. This research is coming to fill the gap by determining the effectiveness of monetary transmission mechanism channels on economic growth of Rwanda from 2000 to 2015.

2. Literature review

Both the monetarist and Keynesians have come up with their theory of a monetary transmission. According to the monetarists they identified the monetary transmission mechanism influence the economy through the wealth channel and financial asset prices. With the contraction of monetary policies it leads to decline in stock prices through reduced demand and therefore an overall decrease in individual wealth since there are limited capital gains from stocks. Expectations in the market are that consumption declines and therefore leading to a fall in aggregate demand. A loose monetary policy will lead to an increase in demand for financial assets which in turn will lead to realization of greater wealth, boosting expenditure and aggregate demand. The relative asset price is best explained by Tobin q's theory on investment. It states that if q is greater than 1 then managers can raise the market values of their firms by increasing investments and if less than 1, then will choose not to invest in new capital. With a tight monetary policy, consumers demand will fall and therefore will reduce spending in more specifically one area i.e. stock markets which will lead to a fall in stock prices and therefore lower the value of the Tobin q, (Friedman, 1968). According to Keynesian theory, the key channel is the interest rate channel. With the adoption of a contractionary monetary policy, interest rates will shoot up leading to crowding out of local investments this increases unemployment and low aggregate demand due to low consumption levels. This is clearly illustrated by (Mishkin, 1996):$\uparrow$ Y =$\downarrow$ I =$\uparrow$ r =$\downarrow$M.

Another way in which the interest rate is effective is in the exchange rate channel when specifically using a floating exchange rate regime. With loosening (tightening monetary policy, interest rates fall (rises) this leads to capital flight (capital inflow) since domestic interest rates are lower (higher) than foreign interest rates and causing a depreciation of the local currency (appreciation).The depreciation (appreciation) makes local goods competitive (.uncompetitive) in the world market and so, leading to the appreciation of the exchange rate (depreciation of the exchange rate). The overall net effect of a rise (fall) in the net exports is projected by an increase (decrease in aggregate demand). The transmission mechanism of monetary policy refers to the various channels through which changes in the monetary policy stance influence aggregate demand and inflation. The range of channels can be grouped into five categories: Interest-rate channel, Exchange-rate channels, Credit channels, Expectations channel and Asset price channels. According to (Mishkin F. , 1995) there are 3 main channels of monetary transmission mechanism such are interest rate channel, exchange rate channel and credit channel. Interest rate channel is one of the basic and most well-known channels of the transmission mechanism of the traditional Keynesian model. Within this channel, monetary policy decisions affect short-term nominal interest rate and, through sticky prices and rational expectations, also the long-term nominal interest rate, at least temporarily. In case of a monetary restriction, short-term, and consequently, also long-term interest rates increase. Assuming temporary stickiness of prices this transmits into an increase of the real interest rates. Higher real interest rates, through the higher cost of funds, lead to a decline in investments (business fixed investments, residential housing investments and inventory investments) and consumption that transmits into a decline of aggregate output and, consequently, to the decline of inflation. Mishkin noted that real spending decisions are only affected by changes in the real interest rate, whereas the monetary policy authority has direct control only over the short-term nominal interest rate. The crucial factor linking the monetary base with the real interest rate and ultimately determining the effectiveness of the interest rate channel is the slow adjustment of the price level, (Mishkin F, 1995). The traditional Keynesian ISLM view of the monetary transmission mechanism can be characterized by the following schematic showing the effects of monetary expansion:

$$M \uparrow \rightarrow i \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

Where indicates an expansionary monetary policy leading to a fall in real interest rates (i,$\downarrow$) which in turn lowers the cost of capital, causing a rise in investment in spending (I$\uparrow$) ,thereby leading to an increase in aggregate demand and a rise in output (Y$\uparrow$).

Keynes originally emphasized this channel as operating businesses decision about investment spending, late research recognized that consumers' decisions about housing and consumer durable expenditure also are investment decisions. Thus, the interest rate channel of monetary transmission mechanism outlined in the systematic above applies equally to consumer spending in which I represents residential housing and consumer durable expenditure. Batini revealed that with growing internationalization of the economies throughout the world and flexible exchange rate regimes the importance of the exchange rate channel has gradually increased. This channel is particularly important for open economies, as discussed by Batini et al

(2001). Within this channel, in case the nominal interest rate rises relative to the foreign interest rate, equilibrium in the foreign exchange market requires that the domestic currency gradually depreciate. This channel involves interest rate effects because when domestic real interest fall, domestic dollar deposits become less attractive relative to deposits denominated in foreign currencies, leading to a fall in the value of a dollar denoted by ($E^{\downarrow}$). The lower value of domestic currency makes domestic goods cheaper than foreign goods, thereby causing a rise in net export ($NX^{\uparrow}$) and hence in aggregate output.

The schematic for the monetary transmission mechanism operating through the exchange rate is thus:

$$M \uparrow \rightarrow i, \downarrow \rightarrow E \rightarrow NX \uparrow \rightarrow Y \uparrow$$

This exchange rate channel plays an important role in how monetary policy affects the domestic economy as is evident in his research, (Tylor 1993). There are two ways in which monetary policy can maintain a degree of independence with the exchange rate channel present in the case of a fixed exchange rate regime. Specifically, the exchange rate might not be completely fixed but have a small variation and secondly, monetary policy can influence the real exchange rate by working through the price level, (BIS, 1998). According to Bernanke (2004) developed in the late 1980s; the main contribution of this view is that it incorporates bank loans into the IS/LM model. The main components of the credit channel, as described by (Bernanke, B.S., V.R. Reinhart, and B.P. Sack. , 2004) are the bank lending channel and the balance sheet channel. The bank lending channel emphasizes the important role of banks as financial intermediaries, as they are suited to deal with certain type of borrowers, like small and medium enterprises and households, where the problem of asymmetric information arises. According to this theory, an increase in interest rates that leads to a contraction in bank reserves and bank deposits transmits into a contraction of intermediated credit. Thus, the reduction in the supply of bank credit, relative to other forms of credit, should increase the external finance premium and contract real activity. The Bank lending channel emphasizes the role of banks in monetary policy transmission not only from their assets but also from their liabilities (Bernanke and Blinder (1988)).Bank lending channel based on the view that banks play a special role in the financial system because they are especially well suited to solve asymmetry information problems in credit markets. As long as there is no perfect substitutability of retail bank deposits with other sources of funds, then the bank lending channel of monetary transmission mechanism operates as follows: Expansionary monetary policy which increases bank reserves and bank deposits increases the quantity of bank loans available. Given bank's special role as lenders to classes of bank borrowers, this increase in loans will cause investment (and possibly consumer) spending to rise. Schematically, the monetary policy effect is:

$$M \uparrow \rightarrow \text{Bank deposits} \uparrow \rightarrow \text{Bank loans} \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

An important implication of the credit view is that monetary policy will have a greater effect on expenditure by smaller firms that are more dependent on bank loans that it will on large firms that can directly access the credit markets through stock and bonds markets without going through doubts about the bank lending channel have been raised in the literature. The previous studies revealed that the balance sheet channel works through the net worth of business firms and the present value of loan collateral. Contractionary monetary policy transmits into a decreasing net worth of firms, so the lenders have less

collateral for the loans. It means losses from the adverse selection are higher. Beyond the adverse selection problem, the falling net worth of firms lowers the owners' equity stake in their firms giving them more incentives to engage in risky investment projects. This increases the moral hazard problem. These problems cause a decrease in the loan supply and thus a decrease in aggregate output. Except the effect on the net worth of firms/collateral, increasing interest rates can transmit also into higher debt burden (in case of loans with floating interest rates). Higher debt burden or lower cash flow of firms and households is mirrored in decreasing investments and consumption and thus in aggregate output. Monetary policy can affect firms' balance sheets in several ways. Expansionary monetary policy ($M\uparrow$ **)** which causes a rise in equity prices ($Pe\uparrow$) along lines described ealier raises the net worth of a firms and so leads to higher investment spending (I↑) and aggregate demand ($Y\uparrow$) because of the decrease in adverse selection and moral hazard problems.

This leads to the following schematic for one balance sheet channel of monetary transmission:

$$M \uparrow \rightarrow Pe \uparrow \rightarrow Adverseselection \downarrow Moralhazard \downarrow \rightarrow Lending \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

There are several ways, how monetary policy affects the target variables through the asset price channel. A proper mechanism can be provided using Tobin's q theory. Tobin (1969) defines q as the market value of firms divided by the replacement cost of capital. In case of a monetary policy contraction, increasing interest rates imply falling bond prices. Lower prices of bonds make them more attractive compared to equities, thus causing their prices to fall also. (Mishikin, 1999) showed that other asset prices, and not just interest rates, are important elements of the monetary transmission mechanism. This provides a rationale for why monetary authorities pay a lot of attention to these other asset prices in the conduct of monetary policy. However, this paper has also argued that targeting other asset prices, whether they are exchange rates, real estate or stock market prices, is likely to worsen the performance of monetary policy. This is because the response of monetary policy to asset price fluctuations depends on the nature of the shocks to asset prices and the degree of permanence of the shocks. Furthermore, targeting asset prices is likely to erode support for the independence of central banks because control of these asset prices is beyond central banks' capabilities. By concluding, in the case of Rwanda before has not been done any study on transmission mechanism on economy taking together the interest channel, exchange rate channel and credit channel. My research has the aim of completing the gap to researches done on monetary transmission mechanism based on interest channel.

3. Data and Methodology

The data used in this paper was drawn from National Bank of Rwanda (BNR) from 2000Q1 to 2015Q4. The study modeled RGDP to be function of consumer price index, international oil prices, credit to private sector and monetary policy variables including money supply, interest rate and exchange rate as follows:

RGDP= f(CPIt, M3t, REPORATE, IRATE, ER, CPS, International Price Oil)

Econometrically, the regression model can be specified as:

$$RGDP = \beta_0 + \beta_1 CPI + \beta_2 M3 + \beta_3 REPORATE + \beta_4 OILPRICE + \beta_5 IRATE + \beta_6 ER + \beta_7 CPS + \boldsymbol{\mu}t \ldots.$$

Where

RGDP: Real Gross Domestic Product

CPI: Consumer price index

M3: Broad money/money supply

IRATE: Interest rate

ER: Exchange rate

CPS: Credit to private sector

OILPRICE: International Price oil

μt: Other variables intervening in the model

There are important differences between stationary and non-stationary time series (Enders W,John Wiley and Sons. Hamilton J., 1995) Shocks to a stationary time series are necessarily temporary; overtime, the effects of the shocks will dissipate and the series will revert to its long-run mean level. As such, long term forecasts of a stationary series will converge to the unconditional mean of the series. To identify the presence of a stationary test, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) are some properties deserved to be used. The distribution theory supporting the Dickey-Fuller tests is based on the assumption that the error terms are statistically independent and have a constant variance. So, the ADF assumes that the error terms are uncorrelated; however PP (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The test regression for the PP test is the AR (1) process:

$$\Delta y_{t-1} = \alpha_0 + \gamma y_{t-1} + \varepsilon_t.$$

.Meanwhile, the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-had side, the PP test makes a correction to the t-statistic of the coefficient from the AR (1) regression to account for the serial correlation in e. This study applied log transformation variables to remove the degree of heterogeneity and autocorrelation of error terms.

$\Delta yt = a_1 + \gamma yt - 1 + a_2 t + \sum_{i-1}^{K} \alpha i yt - 1 + \varepsilon_t$

Where: yt: represent anx1 vector of variables under study a1: is an intercept, t is linear time trend, k is the number of lagged first differences, and εt is error term. The null hypothesis is unit root and the alternative hypothesis is level stationarity. If the coefficient of $yt-1$ (i.eγ) is significantly different from zero, then the null hypothesis will be rejected.

4. Findings and discussion

The results on monetary transmission mechanism in Rwanda are presented in the following tables and interpreted to determine the effect of channels of monetary transmission mechanism on Economy. It is done by conducting unit root test on each variable to find the order of integration. If all the variables are integrated at the same order and stationary, then we can run the VAR model, if integrated of same order but not I(0), then the analysis will call for an Error Correction Model to be conducted.

Table 1: Unit Root Test

VARIABLES	ADF Test			PP Test		
	LEVEL	1st Difference	I(d)	Level	1st Difference	I(d)
CPI	-0.254982	-0.507829*	I(1)	-0.181857	-0.507829	I(1)
Log RGDP	-0.022641	-1.032823*	I(1)	-0.022641	-1.032823	I(1)
LOGM3	-0.457567	-1.348494*	I(1)	-0.001259	-1.346653	I(1)
REPO RATE	-0.049476	-1.154297*	I(1)	-0.049476	-1.154297	I(1)
LOGER	-0.012627	0.282761**	I(1)	-0.048357	-1.107419	I(1)
IRATE	-0.079964	-1.881306*	I(1)	-0.224121	-1.350033	I(1)
LOGOIL PRIC	-0.079964	-1.881306*	I(1)	-0.066343	-0.861712	I(1)
LOGCPS	0.002820	-0.837031*	I(1)	0.002820	-0.837031	I(1)

Source: author's compilation and values obtained from Eviews 7

Notes: ** means the rejection of the null hypothesis at 5%.or Note: *(**) denote significant at 1% and 5% level of significance respectively.

Based on the Augmented Dickey-Fuller and Phillips-Perronunit root test results, all the variables achieved stationarity after first difference, meaning that they are integrated of the order one, I (1). The p-values for the ADF and PP test statistic reveal that the results are 1% significant. Table 4.4 shows the unit root tests results computed using Eviews 7. Since all variables are I (1) processes, the pre-condition for the Johansen co-integration test is satisfied. However, before conducting the Johansen test, a lag order selection test was carried out to determine the optimal lag-length that is to be used, since this test is sensitive to the number of lags. Most lag selection criteria suggested the use of one lag in carrying out the Johansen test (not presented due to space).Having confirmed the existence of unit root, then we can run the test for co- integration between the series under this study.

Table 2: The Johansen co-integration test based on trace and maximal Eigen value –Interest rate channel

Hypothesized	Trace statistics	0.05 critical value	P-value	Maximum Eigen Statistic	0.05critical value	P-value
None *	96.16894*	95.75366	0.0468	48.10112*	40.07757	0.0051
At most 1	48.06782	69.81889	0.7191	22.06147	33.87687	0.6029
At most 2	26.00635	47.85613	0.8891	12.85000	27.58434	0.8930
At most 3	13.15635	29.79707	0.8844	7.812549	21.13162	0.9148
At most 4	5.343802	15.49471	0.7713	5.161868	14.26460	0.7213
At most 5	0.181934	3.841466	0.6697	0.181934	3.841466	0.6697

Trace test indicates 1 co integrating eqn(s) at the 0.05 level , denotes rejection of the hypothesis at the 0.05 level**

As shown in the table 2, both Trace statistic and Maximum Eigen Statistic identify one co-integrating equation at 5% level of significance. The Trace statistic and Maximum-Eigen statistic which are computed using the Eviews 7 software show the existence of one co-integrating equation at 5% level of significance. Therefore, the null hypothesis of no long run relationship between GDP, CPI, M3,REPORATE, EXCHANGE RATE,OIL PRICE, Credit to private sector and interest rate channel is not accepted. By implication, a long run relationship exists between the variables. The following table 3 shows the cointegrating equation which normalized the coefficient of log GDP shows that nearly all the explanatory variables are significant in influencing changes in Output between 2000 and 2015.

Table 3: Normalized Co-integration coefficients-Interest rate channel

RGDP	CPI	REPO RATE	M3	IRATE	OILPRICE
1.000000	-0.316297	0.405761	0.090992	2.789834	-0.117415
(SE)	(0.05004)	(0.14151)	(1.00324)	(0.87948)	(0.90864)
[t-stat]	[-6.334332]	[2.86736626]	[0.0969814]	[3.17214]	[0.12922059]

Source: Researcher's Estimation from E-views 7

Table 3 above shows the normalized cointegration coefficients of the variables in the study model. The results in the table are explained with respect to the signs and magnitude of the variables in the normalized cointegration result. The probability (P>|z|) statistic is used to determine whether or not a variable is significant at a 5% level. The null hypothesis states that the variable is not statistically different from zero and is thus insignificant while the alternative hypothesis states that the variable is statistically different from zero and is thus significant. With a P value less than 0.05, the null hypothesis cannot be accepted that the variable is statistically different from zero and is thus significant. The coefficient of the variables shows if the independent variable has a positive or negative relationship with the dependent variable.

The normalized co-integrating coefficients for the co-integrating equation normalized on GDP is following:

LOG (GDPPC)t = -0.316297LOG(CPI)t+0.405761LOG(REPORATE)t +0.090992LOG(M3)t -0.117415LOG(OILPRICE)t +2,789834IRATE **(1)**

The results represented by equation 4.6, show that, the coefficients of M3, REPORATE, EXCHANGE RATE, Credit to private sector to gross domestic product and interest rate channel have a positive and significant long run effect on economic growth in Rwanda. The coefficients of CPI and international price oil have and insignificant relationship with the output of Rwanda at 0.05 level of significance which deviates from a priori expectation. This normalized equation shows that the interest rate channel affected

positively the GDP of Rwanda in the period of the study from 2000 to 2015.

Table 4: The Johansen co-integration test based on trace and maximal Eigen value –Exchange rate channel

Hypothesized	**Trace statistics**	**0.05 critical value**	**P-value**	**Maximum Eigen Statistic**	**0.05 critical value**	**P-value**
None *	96.8134*	95.75366	0.0422	45.53392*	40.07757	0.0110
At most 1	51.27956	69.81889	0.5814	19.41617	33.87687	0.7958
At most 2	31.86339	47.85613	0.6197	16.10959	27.58434	0.6565
At most 3	15.75380	29.79707	0.7295	9.458854	21.13162	0.7938
At most 4	6.294943	15.49471	0.6607	6.294934	14.26460	0.5757
At most 5	8.21E-06	3.841466	0.9993	8.21E-06	3.841466	0.9993

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

Table 5 : Normalized Co integration coefficients Exchange rate channel

LGDP	CPI	M3	ER	REPO RATE	OILP RICE
1.000000	0.001077	0.418409	0.452384	0.025252	-0.056005
(SE)	(0.00263)	(0.09896)	(0.32902)	(0.01043)	(0.06964)
[t-stat]	[0.4095057]	[4.22806184]	[1.37494377]	[2.44678811]	[0.8420735]

Source: Researcher's Estimation from E-views 7

When adding the exchange rate to the basic model the generated normalized equation becomes as follows:

LOG (GDPPC)t =0.001077LOG(CPI)t+0.025252LOG(REPORATE)t +0.4184092LOG(M3)t -0.056005LOG(OILPRICE)t +0.452384ER **(2)**

The consumer price index, Money supply, Reporate and exchange rate affect positively the gross domestic products with a shock of 0.01% ,4.18% ,2.52% and 4.52% respectively while rate and oil price affect negatively the gross domestic products with a shock of 4 5.6% respectively. This normalized equation shows that the Exchange rate channel affected positively the GDP of Rwanda in the period of the study from 2000 to 2015.

Table 6: The Johansen co-integration test based on trace and maximal Eigen value – Credit channel

Hypothesized	**Trace statistics**	**0.05 critical value**	**P-value**	**Maximum Eigen Statistic**	**0.05 critical value**	**P-value**
None *	149.5439*	125.6154	0.0008	57.52634*	46.23142	0.0022
At most 1	92.01756	95.75366	0.0879	33.96908	40.07757	0.2074
At most 2	58.04848	69.81889	0.3001	24.40965	33.87687	0.4260
At most 3	33.63883	47.85613	0.5216	18.96050	27.58434	0.4176
At most 4	14.67833	29.79707	0.8005	8.683138	21.13162	0.8571
At most 5	5.995189	15.49471	0.6961	5.561631	14.26460	0.6699
At most 6	0.433557	3.841466	0.5102	0.433557	3.841466	0.5102

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

Since * denote rejection of the null hypothesis at 0.05% level both trace and max-Eigen values indicate one co integration equation at 0.05% of significance. From all the tables above indicating Johansen co integration test based on trace and maximal Eigen value in all macroeconomic variables. Both the trace and the Max-Eigen statistics indicate the presence of at least two co integrating equations at 5% level of significance. This implies that the channels of monetary transmission mechanism and other variables are co-integrated in long run, it shows that there is a long-run relationship between MTM channels and economic growth. Thus we reject the hypothesis of no co-integration and proceed with the investigation of the co-integrating relationship.

Table 7: Normalized Co integration coefficients -Credit channel

RGDP	CPI	M3	REPO RATE	OIL PRICE	IRATE	LCPS
1.000	0.075600	1.572630	0.136417	-0.272758	0.359177	1.984237
(SE)	(0.01510)	(1.74499)	(0.04561)	(0.27993)	(0.26656)	(1.44895)
[t-stat]	[5.00662252]	[0.90122579]	[2.99094497]	[0.97437931]	[1.34745273]	[1.36943097]

Source: Researcher's Estimation from E-views 7

After adding the credit to private sector to the basic model the normalized equation will be generated as follows:

LOG (GDPPC)t =0.075600LOG(CPI)t+0.136417LOG(REPORATE)t +1.572630LOG(M3)t

-0.272758LOG(OILPRICE)t +0.359177ER+1.984237LCPS (3)

The normalized equation showed that 1% increase in real gross domestic products is positively due to the changes of CPI,M3,Reporate, Interest rate and credit to private sector while international oil price is insignificant. This normalized equation shows that the Credit channel affected positively the GDP of Rwanda in the period of the study from 2000 to 2015. This section highlights the causality between variables under study after classifying them as co integrated and having also identified the Vector error correction model. This study uses the Granger causality method to detect how these variables drive each other. The results are presented in the table 8:

Table 8: The granger causality test of selected variables and interest rate channel

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause RGDP	58	0.58032	0.5632
RGDP does not Granger Cause CPI		0.39310	0.6769
M3 does not Granger Cause RGDP	58	1.86986	0.1642
RGDP does not Granger Cause M3		2.25783	0.1145
REPORATE does not Granger Cause RGDP	58	0.55571	0.5770
RGDP does not Granger Cause REPORATE		3.70538	0.0312
OILPRICE does not Granger Cause RGDP	58	0.16502	0.8483
RGDP does not Granger Cause OILPRICE		0.73905	0.4824
IRATE does not Granger Cause RGDP	58	3.53682	0.0362
RGDP does not Granger Cause IRATE		1.96069	0.1508

Source: Researcher's Estimation from E-views 7

Note: The table 8 illustrates the pair wise Granger Causality estimation.

The first column shows the Null hypothesis for possible rejection at different significance level while second and third columns indicate F statistic and probability respectively. Based on the probability values reported in table 8. The statement having a probability value less than or equal to 0.10 may be rejected as the null hypothesis. Based on probability value, the interest rate does not granger the RGDP is 0.03 we can reject null hypothesis, i.e. interest rate channel not Granger cause GDP, implying that IRATE enhances the GDP. Due to more the transmission of interest channel and effective management of interest rate by national Bank of Rwanda helps to improve the economic growth of Rwanda trough the improvement of GDP. There is bidirectional and the causal relationship between interest rate channel and GDP the interest rate lead to move the income, GDP of the country and hence more investment and capital stock improved due to stable of interest rate. The probability value of other variables are greater than 0.10 meaning that they have no granger causality with the GDP.

Table 9: The granger causality test of selected variables and exchange rate channel

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause RGDP	58	0.58032	0.5632
RGDP does not Granger Cause CPI		0.39310	0.6769
M3 does not Granger Cause RGDP	58	1.86986	0.1642
RGDP does not Granger Cause M3		2.25783	0.1145
OILPRICE does not Granger Cause RGDP	58	0.16502	0.8483
RGDP does not Granger Cause OILPRICE		0.73905	0.4824
REPORATE does not Granger Cause RGDP	58	0.55571	0.5770
RGDP does not Granger Cause REPORATE		3.70538	0.0312
ER does not Granger Cause RGDP	58	3.07441	0.0545
RGDP does not Granger Cause ER		1.32459	0.2746

Source: Researcher's Estimation from E-views 7

The probability value for the null hypothesis, i.e ER does not Granger cause RGDP is 0.054. It depicts that ER granger cause RGDP, but the RGDP does not granger cause ER. There is a unidirectional relationship between ER and gross domestic product. The Probability values of other variables are insignificant to Gross Domestic products.

Table 10: The granger causality test of selected variables and credit channel

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause RGDP	58	0.58032	0.5632
RGDP does not Granger Cause CPI		0.39310	0.6769
M3 does not Granger Cause RGDP	58	1.86986	0.1642
RGDP does not Granger Cause M3		2.25783	0.1145
OILPRICE does not Granger Cause RGDP	58	0.16502	0.8483
RGDP does not Granger Cause OILPRICE		0.73905	0.4824
REPORATE does not Granger Cause RGDP	58	0.55571	0.5770
RGDP does not Granger Cause REPORATE		3.70538	0.0312
CPS does not Granger Cause RGDP	58	2.08470	0.1344
RGDP does not Granger Cause CPS		1.57474	0.2166

Source: Researcher's Estimation from E-views 7

The results of grange causality showed that the credit channel has no effect in short run on RGDP, CPI, M3 and OIL price because the probabilities of null hypothesis are greater than 0.10 meaning that the null hypothesis is not rejected. On the other side the credit channel has an effect on Reporate because the Central Bank uses this rate to control and regulate the credit to private sector through the commercial banks. Having determined the variables as integrated of order I(1) i.e they are non-stationary at their levels but stationary after differencing once and once again having approved the existence of co-integration test, we can, then, formulate an error correction model. The intuition behind such a model is the need to recover the long-run information lost by differencing the variables by introducing an error correction term. This term is

derived from the long-run equation based on economic theory and enables us to estimate the speed of adjustment of Gross Domestic Product, consumer price index, broad money and hence price level to its long-run equilibrium. The error correction term gives the proportion of shocks accumulated in the previous period that are corrected in the current period. The results of VECM are presented below.

Table 11: Vector error correction model coefficients-Interest rate channel

	Coefficient	Std. Error	t-Statistic	Prob.
ECM	0.855351	0.134654	6.352213	0.0000
CPI	-0.000860	0.002941	-0.292436	0.7713
M3	0.260202	0.159287	1.633537	0.1093
OILPRICE	0.044715	0.045823	0.975805	0.3344
REPORATE	0.011204	0.007875	1.422703	0.1617
IRATE	0.031657	0.026897	1.176974	0.2454
C	1.088619	0.538836	2.020314	0.0493
R-squared	0.986401	Mean dependent var		6.578260
Adjusted R-squared	0.982775	S.D. dependent var		0.438135
F-statistic	272.0075	Durbin-Watson stat		1.875641
Prob(F-statistic)	0.000000			

Source: Researcher's Estimation from E-views 7

The ECM results in table 4.15 showed that the interest rate channel has a short run effect on Gross Domestic Products, Consumer price Index, money supply, international oil price, on repo rate because the R-squared is 98% while adjusted R-squared is 98%. The prob (F-statistic) in the model is also greater than 5%which shows the effect of interest rate channel on selected variables.

Table 12: Vector error correction model coefficients-Exchange rate channel

	Coefficient	Std. Error	t-Statistic	Prob.
ECM	0.711140	0.141461	5.027094	0.0000
CPI	-0.002090	0.002769	-0.754736	0.4543
M3	0.150367	0.169089	0.889274	0.3786
REPORATE	0.009293	0.008415	1.104280	0.2753
OILPRICE	0.050838	0.044550	1.141133	0.2599
ER	-1.434537	1.008061	-1.423066	0.1616
C	-1.287137	1.100148	-1.169967	0.2482
R-squared	0.986630	Mean dependent var		6.578260
Adjusted R-squared	0.983065	S.D. dependent var		0.438135
F-statistic	276.7360	Durbin-Watson stat		1.977460
Prob(F-statistic)	0.000000			

Source: Researcher's Estimation from E-views 7

The ECM results in table 4.16 showed that the exchange rate channel has a short run effect on Gross

Domestic Products, Consumer price Index, money supply, international oil price, on repo rate because the R-squared is 98.6% while the probability of all variable is also greater than 5%which shows the effect of exchange rate channel on selected variables. Lower interest rates lead to a depreciation of the exchange rate, an increase in competitiveness, an improved trade balance (due to higher net exports,) and increased demand, a larger output gap and finally higher inflation, (Ole Rummel, 2012).

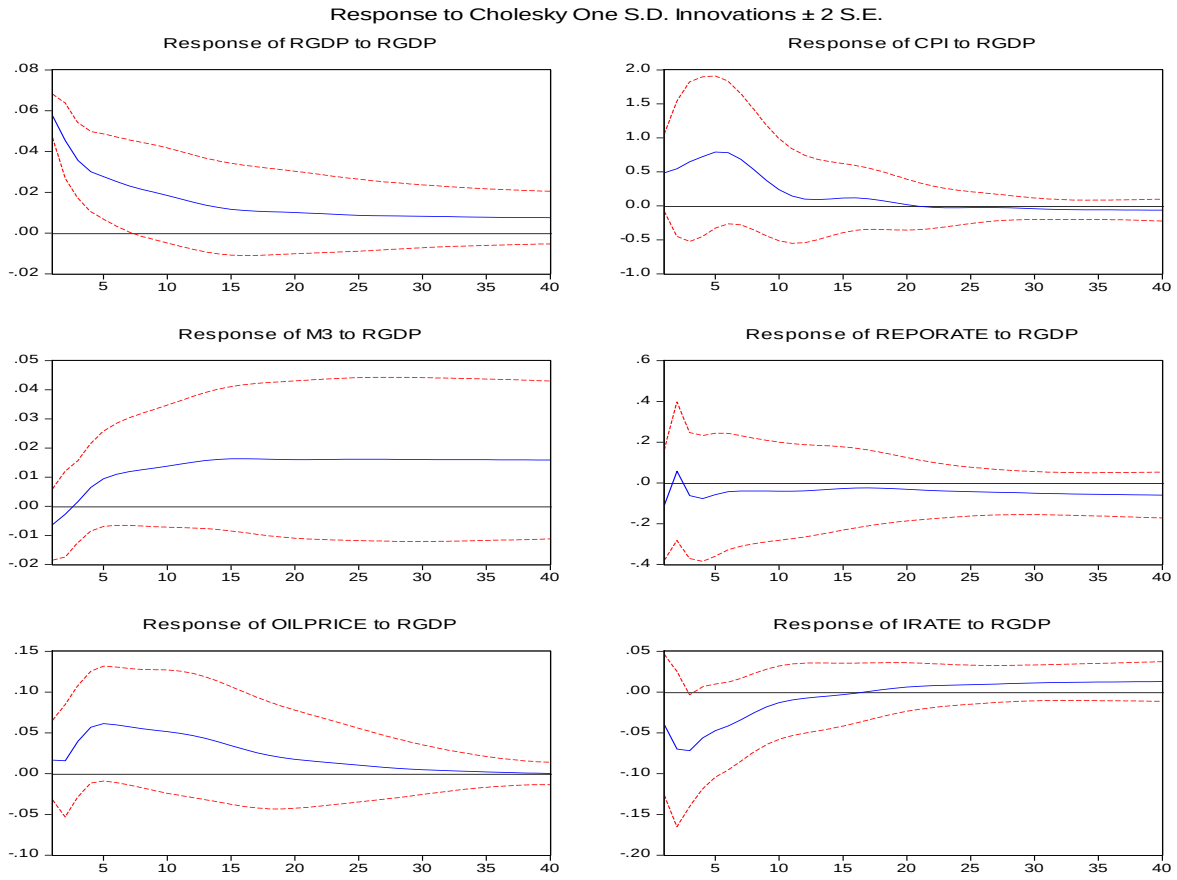
Table 13: Vector error correction model coefficients-credit channel

	Coefficient	Std. Error	t-Statistic	Prob.
ECM	0.792835	0.151594	5.229973	0.0000
CPI	-0.001467	0.003024	-0.485077	0.6300
M3	0.183899	0.204450	0.899485	0.3732
OILPRICE	0.055631	0.047618	1.168276	0.2488
REPORATE	0.011067	0.008393	1.318491	0.1940
CPS	-0.029047	0.295909	-0.098162	0.9222
C	0.901653	0.397006	2.271133	0.0280
R-squared	0.984772	Mean dependent var		6.578260
Adjusted R-squared	0.980711	S.D. dependent var		0.438135
F-statistic	242.5019	Durbin-Watson stat		2.041011
Prob(F-statistic)	0.000000			

Source: Researcher's Estimation from E-views 7

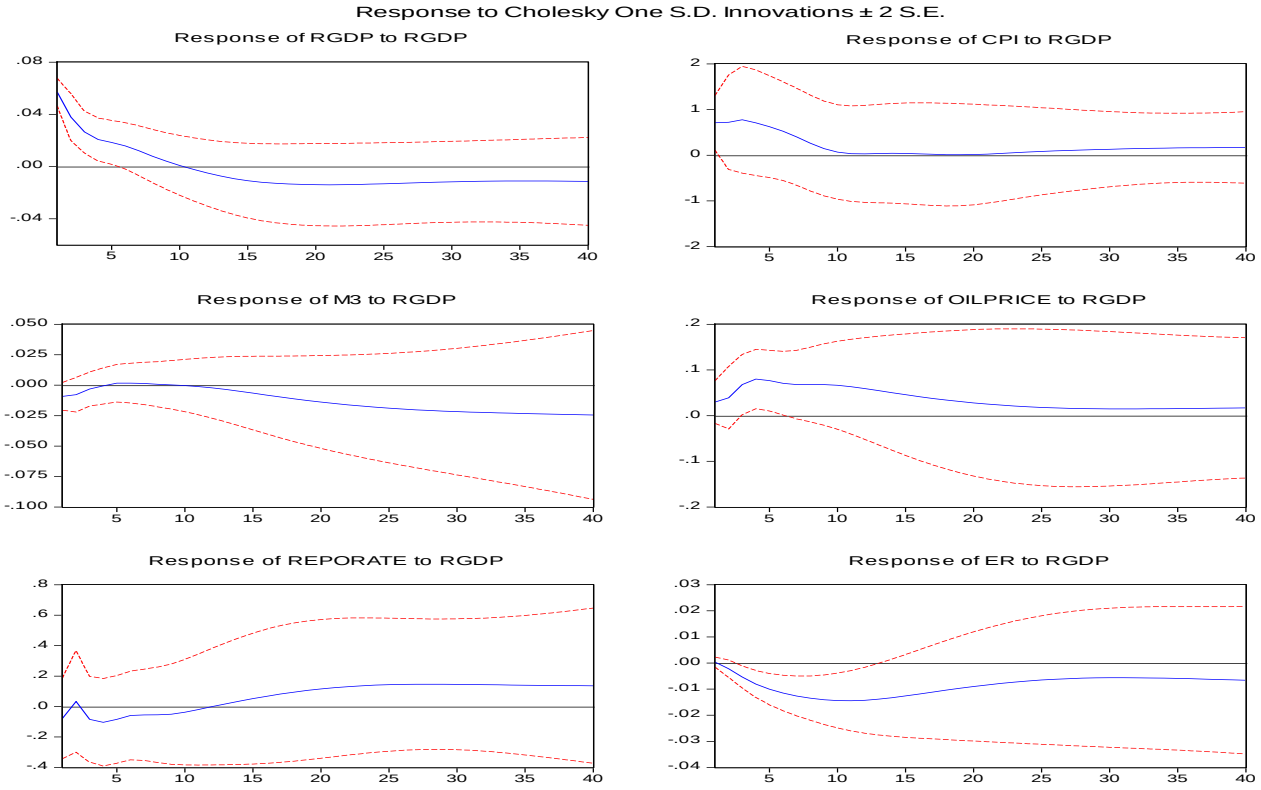
The ECM results in table 4.17showed that the credit channel has a short run effect on Gross Domestic Products, Consumer price Index, money supply, international oil price, on repo rate because the R-squared is 98.4% while the probability of all variable is also greater than 5%which shows the effect of credit channel on selected variables.

Figure 2: Impulse responses of Interest rate channel



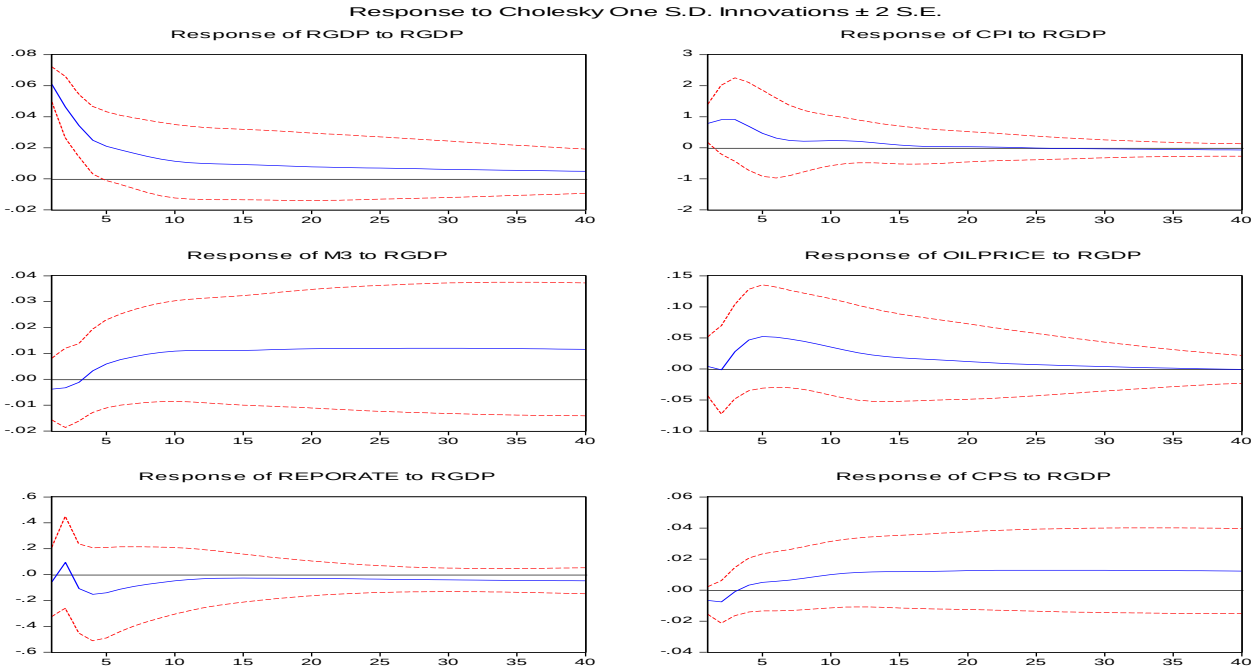
In response to a shock in the GDP (equivalent of one standard deviation of the GDP variable) impact of own shock in GDP is felt after five period and it normalizes. Interest channel affected the GDP before 5th period after which it normalizes closely to standard deviation. Other variables remain insignificant to GDP.

Figure 3: Impulse responses of exchange rate channel



The impulse responses obtained from the SVAR model indicate that the exchange rate fluctuates at normal rate and the transmission of exchange rate channel has a strong own innovations, most of the variables emerge insignificant and this could be due to the fact that Rwanda's exchange rate has generally been stable over the sample period. Basing on these impulse responses the exchange rate channel has a shock on economic growth of Rwanda trough GDP in long run where it affects GDP at 14th period, CPI and Oil price affected GDP at 5th period and variables REPORATE, CPI and M3 have no effect on GDP when the exchange rate is added to the basic model.

Figure 4: Impulse responses of credit channel



Basing on the results of impulses responses the credit channel had a shock on all variables in the study except the Reporate and consumer price index. The credit channel affected the RGDP with small shock at 1st period and there is no shock of other variables to GDP when the credit to private sector is added to the basic model.

5. Conclusion and Recommendations

The purpose of this study to analyze the effectiveness of monetary transmission mechanism in Rwanda. The findings from variance decomposition depicts that there is a long run relationship between the channels of monetary transmission mechanism and GDP, CPI, M3, Repo rate &international price oil. The results from the variance decomposition revealed that in long run the credit channel will be effective more than other channels of monetary transmission mechanism by affecting the RGDP with a shock of 52.15% in long run at 64th period followed by interest rate channel with a shock of 5.8% and lastly by exchange rate channel with a shock of 5.3% in long run at 64th period. But in short run at 1st period the interest rate channel is more effective with a shock of 13.75% on GDP followed by exchange rate channel and lastly credit channel with a shocks of 2.62% and 2.25% on GDP respectively. Given the above results, a number of policy recommendations emerge from these conclusions. First, there is need for constant

revision of policy and instruments targeting framework and operating procedure to enhance monetary policy effectiveness particularly in stabilizing the exchange rate and keeping inflation levels at the generally recommended rate. Second, there is need for BNR to harmonize and combine the functionality of all channels to achieve optimum output goals of monetary transmission mechanism. This could be complemented with adoption of one policy rate used to signal the market and by so doing will reduce on duplication of activities by different rates and lead to optimum outcomes of monetary policy goals. Other factors could be used to control inflation other than monetary tools among them being diversification of energy sources large scale mechanized agriculture, engaging in hedging activities so as to prevent the economy from price shocks occasioned by fluctuation of the dollar when importing crude oil this could assisting maintaining inflationary levels at a rate below the government recommended rate of 5%. Third, in advent of monetary policy, it's advisable that the BNR combines other channels of monetary transmission mechanism to achieve optimum policy outcome as opposed to concentrating on single channel. Fourth, the apparent lack of a transmission to output suggests the need to improve structural rigidities in the financial system and regulatory framework which may hamper the proper transmission of monetary policy to the real sector of the economy. Fifth, in terms of estimation, it is important to continue to improve the models so that they better reflect the characteristics of the Rwandan economy. While an attempt was made in this research to consider a structural identification which imposes a commonly used set of relations for the variables in the system, other structural identifications may be better suited. Lastly but not least, it is important to keep in mind possible data limitations given the short period of analysis.

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