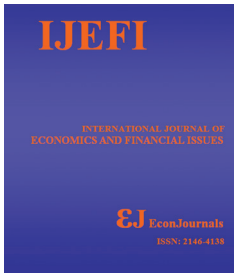

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Interest Rate Channel and Real Economy in Nigeria: A Bayesian Vector Autoregression Approach

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ABSTRACT

This study examined the dynamic response of real economy to interest rate shocks using Bayesian vector autoregression model with Minnesota/Litterman prior criterion. Impulse response functions showed that all the variables were consistent with the theory apart from investment whose response was counter intuitive. Forecast error variance decomposition confirmed theoretical interactions between monetary policy rate through interest rate and inflation. Interest rate channel under this framework is effective to bring the economy to stability by suppressing inflation rate and bring it to normalcy in Nigeria with adverse effect on growth rate of gross domestic product due to necessary and policy conflicts.

Keywords: Minnesota/Litterman Prior, Bayesian, Interest rate.
JEL Classifications: C11, C58

1. INTRODUCTION

There has been a consensus on the effectiveness of monetary policy in stabilizing the economy most especially since the invisible hands of demand and supply could not solve the problem during the great depression of 1930s which gave rise to Keynesian proposition of government intervention. The channels through which monetary impulses are communicated to the economy remain a puzzle in the literature of monetary economics. Monetary policy is categorized as effective if changes in its tools cause rapid and expected results on aggregate demand and prices (Frederic, 1995). The transmission of monetary policy can be through different means such as; interest rate, other asset prices, credit and expectations channel but the focus of this paper is on interest rate channel which has caught attention of so many researchers (Ikechukwu, 2014, Onanuga and Tella, 2015) and the bedrock of other channels of monetary transmission mechanism. A channel may be adjudged effective in a country but not effective in another country due to the structural differences. Studies on effectiveness of interest rate channel abound in developed and emerging economies but evidence in Nigeria remains limited with contradictory results (Nwosa and Saibu, 2012; Ishioro, 2013; Bitrus, 2014; Ndekwu, 2013; Okaro, 2014).

The effectiveness of monetary policy solely depends on a proper understanding of the transmission mechanism is the channel through which changes in a central bank's policy action influence the economy, particularly; prices and output (Bitrus, 2014). Monetary transmission mechanism is the process by which changes in monetary policy decisions affect the rate of economic activity as measured by output and inflation (Taylor, 1995). The time it takes monetary policy to transmit to the other parts of the economy and the magnitude of the effect on macroeconomic variables determine how successful the policy is (Thorarin, 2001).

Interest rate channel states that a monetary restriction by raising the expected real interest rate will trigger a decrease in expenditure for investment and consumption goods which in turn lowers output of the industries producing such commodities (Dedola and Lippi, 2005). The interest rate channel focuses on how changes in the central bank's policy rate affect various commercial interest rates. Accordingly, a decline in the long-term real interest rate reduces both the cost of borrowing, and the money paid on interest-bearing deposits therefore encouraging household spending on durable goods as well as investments by corporations. This rise in investments and durable goods purchases boosts the level of aggregate demand and employment.

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The kernel of this study is to investigate the dynamic response of growth in gross domestic product (GDP) and inflation rate to interest rate impulse using Bayesian vector autoregression (BVAR) model because of its numerous advantages and as used in other countries such as Canada (Rokon, 2008), Romania (Spulbar and Nitoi, 2013) and Nigeria (CBN, 2015). The advantages of BVAR include; objectivity and flexibility, it helps in solving the problem of over-parameterization of VAR, the result is not affected by the presence of unit root and it gives a more accurate prediction (Banbura et al., 2010). In addition to this, most Nigerian financial series follow a random walk and have unit root which is taken care of by Litterman/Minnesota prior type (Spulbar and Nitoi, 2013). The BVAR model in this paper like other VAR models was presented in two forms; ımpulse responses (which measures the responses of real economy to impulses from interest rate) and variance decomposition (which measures the relative importance of different shocks to the variation in different variables that are included in the model). The novelty of this paper is the use of BVAR model and the inclusion of investment in the interest rate channel according to the theory which has not been empirically documented in Nigeria and usage of BVAR model.

This paper is divided into four sections; the first is introduction, the second is literature review, the third is the empirical analysis and discussion of findings while the last section deals with conclusion and policy implication of the findings.

2. LITERATURE REVIEW

Using monthly data between 2006 and 2015, Onanuga and Tella (2015) examine the interest rate pass – through from wholesale rate to some deposit money banks retail rates being intermediate rates with autoregressive distributed lag (ARDL) econometrics approach. Their results suggest that, interest rate pass – through from wholesale rate to deposit money banks is near complete in the short run and complete for the deposit money banks prime lending rate. Hence, interest rate channel from their findings seems effective contrary to Ikechukwu (2014) who examines interest rate channel of monetary transmission in Nigeria using two variables; prime lending rate and real gross domestic product (GDP) and found that interest rate and output have unstable long run relationship using error correction mechanism and co-integration. Nwosa and Saibu (2012) submit that interest rate channel is the most effective channel to agricultural and manufacturing sectors in Nigeria while examining the effect of monetary transmission mechanism on sectoral output growth. Also, Arto (2011) carried out a somewhat similar research in Ghana by studying the interest rate pass - through, he found out that changes in the policy interest rate are gradual in the wholesale market. The findings of Arto (2011) and Onanuga and Tella (2015) seem to be related in both countries. In the research carried out by Aliyu and Englema (2009), on evaluating whether Nigeria was ready for inflation targeting regime, they found a weak link between prices and interest rate channel and recommended that Inflation targeting lite (IT lite) is appropriate for Nigeria.

Methodologically, some of the recent literature in Nigeria comprises of Ogun and Akinlo (2010) who used Vector Autoregressions (VARs), Ishioro (2013) used Pairwise Granger causality, Nwosa and Saibu (2012) used Granger causality and VAR, Ndekwu (2013) used VAR with dynamic logarithm form and OLS. Adeoye et al. (2014) used VAR. Obafemi and Ifere (2015) used FAVAR, Olowofeso et al. (2014) used OLS and VAR, Onanuga and Tella (2015) used ARDL while in other countries, scholars like; Prachi and Peter (2012) used impulse response functions (IRFs) from VARs. Muhammad and Kashif (2010) used structural VAR and Cholesky decomposition. Rokon (2008) from Canada used Bayesian structural VAR model and impulse response of monetary aggregate. Shamim and Ezazul (2004) used unrestricted VAR approach. Alexandru and Christophe (2009) used generalized IRFs and criticized SVAR as being ordered dependent. Spulbar and Nitoi (2013) used BVAR in Romania.

The ınvestment – savings and liquidity – money generally known as IS – LM theory, despite its criticism has been accepted generally as the foundational theory of macro economics (Adeoye et al., 2014). The IS curve depicts savings – investment curve in the real sector with negative slope as interest rate being the equilibrating factor between Investment and Savings (IS) while, LM curve shows liquidity –money demand and supply. IS equation in an open economy is shown as follows;

$$Y=C+I+G+NX \quad (1)$$

While;

C is consumption, I is investment, G is government spending and NX is the difference between export and import (Net export).

LM equation is written as follows:

$$\frac{M^d}{P} = f(\underset{-}{i}, \underset{+}{y}) \quad (2)$$

The variables used in this Hicks model include; GDP (Y), consumption (C), physical investment (I), government spending as exogenous variable (G), nominal money supply (M), price level (P) and interest rate (i).

3. EMPIRICAL ANALYSIS, RESULTS AND DISCUSSION OF FINDINGS

3.1. Methodology

Monetary transmission mechanism of a nation is backed up by several theories depending on the channel through which an economy is examined. Therefore, interest rate channel is based on traditional IS-LM model. Traditional IS – LM model was adopted to ascertain effectiveness of interest rate channel on real economy in Nigeria. The IS – LM theory, despite its criticism has been accepted generally as the foundational theory of macro economics.

In order to emphasize Bayesian approach to estimate the parameters of basic VAR, we state the VAR model as;

$$y_t = \alpha_0 + \sum_{l=1}^{p} A_l y_{t-l} + \varepsilon_t,\ \varepsilon_t \sim N(0,\Sigma) \quad (3)$$

Where y_t is an M×1 vector containing observations of M time series variables for t = 1,…, T, α_0 is an M×1 vector of intercepts, likewise ε_t is independently and identically distributed (i.i.d) $N(0,\Sigma)$, A_t is an M×M matrix of regression coefficients with maximum lag length ρ.

VAR can also be written in two ways (Koop and Korobilis, 2009) and CBN, (2015) they are;

$$Y = XA + E \quad (4)$$

And

$$y = (I_M \otimes X)\alpha + \varepsilon \qquad \text{Where, } \varepsilon \sim N(0, \Sigma \otimes I_M) \quad (5)$$

The basic VAR model specified in Equation (3.3) has over-fitting properties which may make some estimates ineffective. This suggests that the equation is highly over parameterized and the estimates may not be efficient due to multicollinearity and out – of- sample error due to loss of a large number of degree of freedom. In order to solve these problems, the equation was rewritten as Equation (3.4) and Equation (3.5) to accommodate some restrictions by specifying normal prior distribution with mean zero and reduced standard deviation as lag increases.

This shrinkage can be achieved by selecting the prior distribution to be adopted. Selection of prior distribution of BVAR is another important step to carry out because prior information has the advantage of delivering accurate inference (Rokon, 2008). A number of different priors can be used such as Normal – Wishart, Sims–Zha (Normal – Wishart) etc. (Koop and Korobilis, 2009), this study adopted Litterman Minnesota which is the most commonly adopted priors distribution because it is essential to promote forecasting performance of a model (Domenico et al., 2012). Also, Minnesota/Litterman priors results to simple posterior inference that involves only normal distribution and accounts for posterior independence between equations (CBN, 2015). Another advantage of Litterman prior is that it prevents misspecification of coefficients and it corrects possible presence of serial correlation (Migliardo, 2010).

Litterman Minnesota Priors simplifies Equation 3.5 by replacing Σ with its estimate. There is also an assumption that Minnesota prior for α is:

$$\alpha : N(\underline{\alpha}_{Min}, \underline{V}_{Min}) \quad (6)$$

Where; $\underline{\alpha}_{Min}$ is the prior mean and $\underline{V}_{Min}$ is the prior covariance. The shrinkage takes place in order to reduce the risk of over – fitting of the model and this is done by setting mean prior to zero and assume prior covariance matrix $\underline{V}_{Min}$ to be diagonal. Generally, Minnesota prior is set as:

$$\underline{V}_{i,jj} = \begin{cases} \dfrac{\alpha_1}{\rho^2} \\ \dfrac{\alpha_2 \delta_{ii}}{\rho^2 \delta_{jj}} \text{ for coefficients on lags of variable } j \neq i \\ \alpha_3 \delta_{ii} \end{cases} \quad (7)$$

From equation 3.7, $\frac{\alpha_1}{\rho^2}$ is the prior for coefficients on own lags, $\alpha_3\delta_{ii}$ is the prior for coefficients on exogenous variables and $\frac{\alpha_2\delta_{ii}}{\rho^2\delta_{jj}}$ is the prior for coefficients on lags of variable j≠i (Koop and Korobilis, 2009).

3.2. Data

The data covered a period of 30 years from 1987: Q1 to 2016: Q4 making 120 data points for each of the variables. The variables used in the original model include; GDP (Y), Consumption (C), physical investment (I), government spending as exogenous variable (G), nominal money supply (M), price level (P) and interest rate (i). Hence, for GDP this paper used growth in real GDP (CBN statistical bulletin), gross fixed capital formation (CBN, statistical bulletin) was used in place of physical investment, minimum rediscount rate (MRR) and monetary policy rate (MPR) (CBN database) were used as policy instruments, inflation rate calculated using consumer price index (CBN database) was used, base money (BM) (CBN statistical bulletin) was included based on the explanation of Anyanwu (1993).

Appendix 1 shows that on the average, the growth rate of GDP between 1987 and 2016 was 5% with the maximum of 11.36% in the first quarter of 1990 and the minimum of −2.24% in the third quarter of 2016. The residual is normally distributed with probability of 0.14. The average rate of MRR/MPR over the years was 14% with the maximum value of 26% recorded in first quarter of 1993 and the minimum value of 6% recorded between the third quarter of 2009 and second quarter of 2010 consecutively. The residual for MPR is also normally distributed with probability of 0.67. Also, on the average, investment level was ₦2.28 billion with the maximum investment level of ₦2.47 billion and the minimum level of ₦2.02 billion however, the Jaque bera test for normality shows that the residual was not normally distributed (P = 0.00015). Likewise, the average inflation rate and interest rate were 5.84% and 8.95% respectively. The highest inflation rate recorded was 18.6% while the lowest inflation rate was 1.28% between 1987:Q1 and 2016: Q4 while the highest interest rate during the period was 22.6% with the minimum value of 1.77%. The residuals of inflation and interest rates are not normally distributed.

Correlation matrix (Appendix 2) shows that interest rate and MPR are positively correlated which is in line with theory. The higher the MPR, the higher the interest rate and MPR is inversely related to investment which is in line with theory, the higher the interest rate, the higher the investment because an increase in interest rate will

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reduce money demand and encourage investments in either time or/and fixed deposit. MPR is negatively correlated with GDP_{grow} and positively correlated with investment while inflation rate is positively related with GDP_{grow}.

Figure 1 shows the graphical representation of GDP_{grow} and MPR. The two variables tend to move in the same direction until between 2007 and 2008 when the policy instrument was lowered and the growth in GDP increased according to the theory. Thereafter, when MPR increased, the growth in GDP started reducing until recession set in 2016.

Figure 2 describes the growth rate of GDP and inflation rate graphically. GDP_{grow} was almost as high as inflation rate after which, they reduced drastically and inflation rate started increasing but the growth in GDP reduced. Inflation rate reached its peak in 2016 due to economic meltdown as evidenced by consecutive negative growth rate.

3.3 Empirical Analysis

The recursive BVAR model utilized to capture interest rate channel is:

$$Z_{i,t} = \Pi Z_{i,t-p} + \varepsilon_t \quad \forall \ i=1 \tag{8}$$

Where, $Z_{1,t}$ = [MPR, RIR, M2, INV, GDP_{Grow}, INFR] is the vector of endogenous variables for the MPR equation and the rationale for the arrangement follows the transmission mechanism as stated; an increase in policy instrument (MPR), increases interest rate, which reduces BM and in turn reduces investment and reduces economic growth as well as inflation. The reversal of policy affects the economy otherwise depending on the objective of monetary policy.

The lag length selection test was conducted (Appendix 1) in order to estimate the BVAR by conducting diagnostic tests. The lag length selection such as; LR, FPE, AIC, SC and HQ selected lag length one. After series of iteration, in order to solve the problem

Figure 1: Gross domestic product growth rate and monetary policy rate

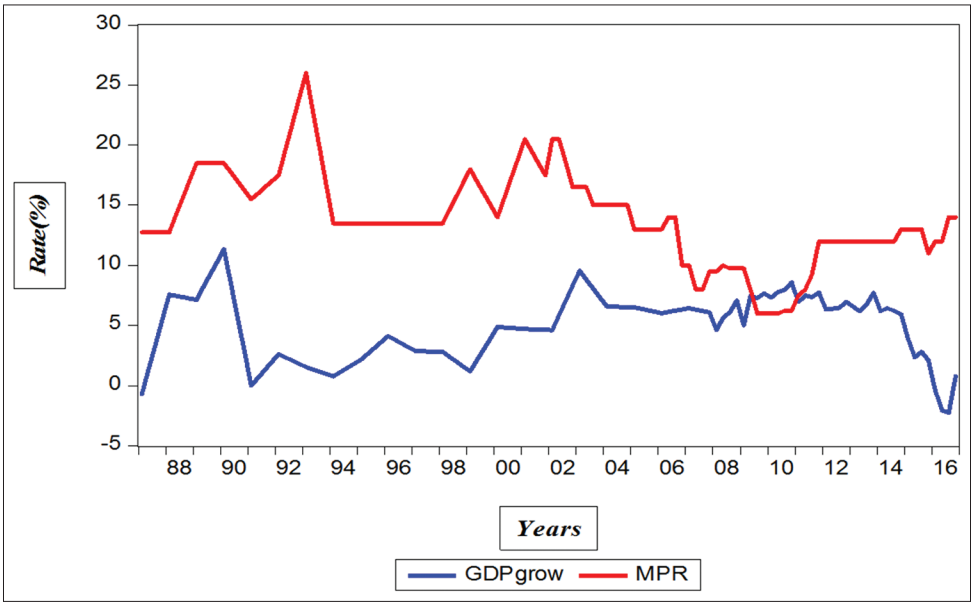
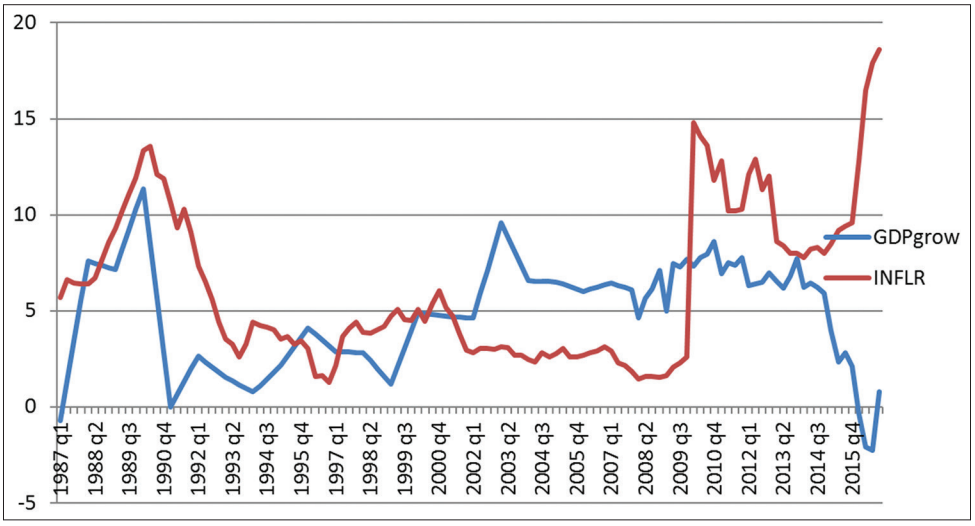


Figure 2: Gross domestic product growth rate and ınflation in Nigeria



of serial correlation, lag length two was found appropriate for the endogenous variables. Lag length two is justified because it avoids the problem of loss of degree of freedom. Afterwards, priors were imposed on the parameters for shrinkage. The shrinkage was necessary to reduce the risk of over-fitting of the model and therefore, Litterman/Minnesota prior type was selected because of its advantage of its potential to correct possible presence of serial correlation (Migliardo, 2010). The data utilized here followed a random walk process with constant mean and the variance not being constant.

The α_1 was set at 0.75, $\alpha_2 = 0.99$ and $\alpha_3 = 1$ because the data used have unit root. IRF and variance decomposition of the BVAR were computed from the estimates of regression.

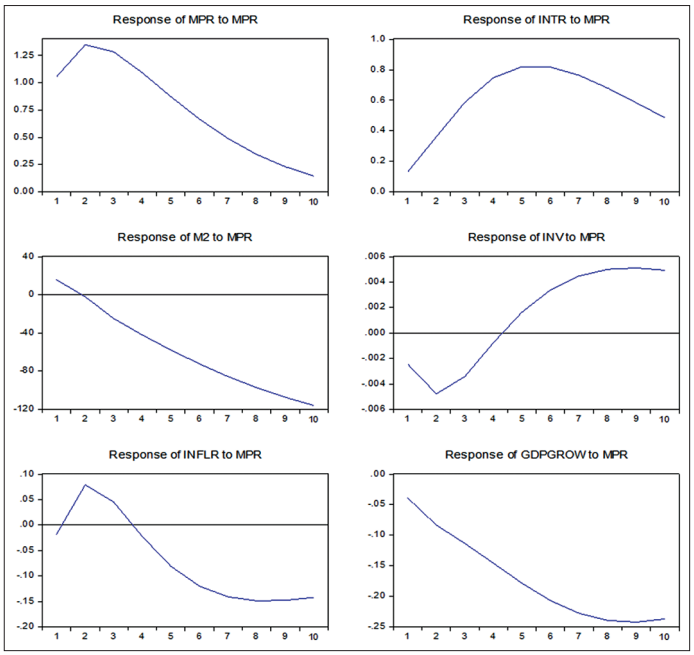
3.4. Results

3.4.1. IRFs

Figure 3 shows the responses of interest rate, investment, money supply, GDP_{grow} and inflation rate to shocks in MPR. The vertical axis shows the standard deviation from the baseline scenario while, the horizontal axis indicates the periods in quarter. A tightened monetary policy consolidates monetary transmission mechanism by increasing interest rate.

A one standard deviation shock to MPR increases real interest rate by 16% in the first quarter and continued to accelerate it until the fifth quarter when it reached its peak. However, it decelerates in the sixth quarter. This contractionary measure has an immediate effect on money supply by decelerating it continuously throughout the period; this reaction supports LM theory of money. Investment's response however is counterintuitive because it decelerates in the first quarter until the second quarter when it began to improve possibly due to other factors responsible for investment apart from interest rate such as; money outside bank, cooperative money etc, this relation shows that interest rate shock has an immediate effect on investment which frizzled away after the second quarter, although from the eight quarter, investment became stable which shows that MPR has the ability to stabilize the level of investment. The response of growth in real GDP to MPR shock on the other hand was consistent with theory, a tightened MPR as monetary instrument decelerates the growth in GDP sharply in the first quarter and increased sharply also in the second quarter but from the third quarter, the growth in GDP decelerates continuously till quarter ten. This continuous deceleration supports the lagged effect of MPR on real economy and a tightened monetary policy will lead to decrease in growth of gross domestic product. A positive MPR shock (unexpected increase of MPR) will reduce inflation rate which consolidates monetary transmission mechanism channel and this result is in line with that of CBN (2015), Spulbar and Nitoi (2013) and Rokon (2008). From quarter two, inflation rate started decelerating in response to MPR shock and was persistent until the seventh quarter when it started disappearing. This response is negative and it means that with tightened MPR, inflation rate will continue to decrease until it comes back to its previous level or as consistent with the objective of the policy. The policy implication of this is that MPR is an effective instrument to bring the economy to normalcy and interest rate channel is effective in Nigeria while, investment response to MPR shock may be as a result of other channels not considered in this paper or the peculiarity of the economy.

Figure 3: Response to Cholesky one SD innovations



3.4.2. Variance decomposition

Since it has been established that MPR is an effective monetary instrument to stabilize the economy, there is need to deepen the understanding of the behavior of these variables as MPR changes by exploring forecast error variance decomposition.

Table 1 shows that inflation is influenced significantly by investment (52.1%) followed by its own perturbation (41.4%) during the first quarter followed by interest rate while MPR, intr and M2 are accountable for the balance. The influence of investment on inflation however dissipated to 39.6% while the contribution of GDP_{grow} increased to 7.05% in the fifth quarter. By the ninth period, the influence of investment on inflation dissipated further to 30% and the proportion of the variation influenced by own shock had reduced to 51% while the influence of MPR on inflation increased to 1.1%. By quarter twelve, influence of MPR and GDP_{grow} on inflation had increased to 1.5% and 19.76% respectively while that of investment reduced to 26.61%. This further corroborates the results of IRF that with time, MPR shocks

Table 1: Variance decomposition of inflation (INFLR)

Period	S.E.	MPR	INTR	M2	INV	INFLR	GDP_{grow}
1	1.056915	0.016796	5.056217	1.395114	52.11270	41.41917	0.000000
5	2.640277	0.253298	3.169886	0.486508	39.55501	49.48622	7.049079
9	3.093718	1.100203	2.389086	0.360920	30.01343	50.99771	15.13865
12	3.274429	1.517218	2.197846	0.325928	26.60673	49.59971	19.75257

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Table 2: Variance decomposition of ınvestment (INV)

Period	S.E.	MPR	INTR	INV	GDP_{grow}	INFLR
1	1.092038	0.007338	2.580345	97.41232	0.000000	0.000000
5	2.987066	1.433705	2.092815	96.13251	0.004436	0.336530
9	3.494049	9.192718	1.573733	88.80640	0.004479	0.422666
12	3.647021	15.43571	1.371414	82.79463	0.012999	0.385247

Table 3: Variance decomposition of growth in real GDP (GDP_{grow})

Period	S.E.	MPR	INTR	M2	INV	INFLR	GDP_{grow}
1	1.056915	0.208571	2.914054	1.050574	0.004525	0.309243	95.51303
5	2.640277	1.799623	0.874688	2.044352	0.512210	1.024112	93.74502
9	3.093718	5.379852	0.818610	2.207474	0.909598	1.445674	89.23879
12	3.274429	7.690797	0.842798	2.156977	1.033287	3.204711	85.07143

will achieve the objective of reducing inflation. This result is in line with that of CBN (2015) in which policy tightening through MPR has a desirable influence if curbing inflation is the major objective of monetary policy.

Table 2 shows that investment is influenced significantly by its own perturbation (97.4%) and also responsive to interest rate (2.58%) in the first quarter. In the fifth quarter, its influence dissipates slightly to 96% while it becomes responsive to MPR. The influence of MPR on investment increased drastically to 9.19% in the ninth quarter while its influence on self perturbation reduced to 88.8%. Investment became more responsive to MPR shocks in quarter twelve but the influence of inflation and GDP_{grow} was insignificant throughout the period.

Table 3 shows that the growth in GDP is greatly influenced by its own perturbation and also responsive to interest rate in the first quarter whose influence reduced by the fifth quarter and subsequently throughout the period. The influence of MPR, M2 and inflation rate on GDP_{grow} increased slightly during the period. Interest rate and investment exact no significant influence on GDP_{grow}, also investment's contribution to GDP improved slightly. This may be as a result of the limitation of this paper to interest rate channel without considering credit channel through financial institutions and other asset price channel. This is evidenced by the dwindling performance of manufacturing sector output in Nigeria (Appendix 3).

4. CONCLUSION AND POLICY IMPLICATIONS

The effectiveness of monetary policy largely depends on a proper understanding of the transmission mechanism through which changes in a central bank's policy action influence the economy, particularly; prices and output (Bitrus, 2014). Monetary economics is a dynamic field and as such, theories are tested, methodology reviewed in order to achieve a better result.

This study examined the effectiveness of interest rate channel on real economy in Nigeria with the use of BVAR analysis with a Minnesota/Litterman prior distribution. This methodology was selected based on the assertion of Sims (1980) that VAR modeling has become a standard method of evaluating macroeconomic properties and due to its numerous advantages. BVAR solves the problem of over parameterization encountered in VAR and has higher predictive power and the estimates not affected by non stationarity of data (Koop and Korobilis, 2009; Spulbar and Nitoi 2013).

From IRF, MPR is effective in reducing inflation as all the variables behaved according to theory apart from investment. However, variance decomposition shows that the contribution of MPR to changes in Investment will increase with time. The variance decomposition also shows that MPR which determines interest rate is effective in achieving the objective of inflation rate reduction though it has an adverse effect on the growth of GDP. The policy implication is that, interest rate channel is effective in curbing inflation and bring the economy to stability and it is expedient to examine the effectiveness of other channels using the appropriate method of analysis to account for the counter intuitive result of investment's response to MPR shock.

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APPENDIX 1

Table A1: Descriptive statistics of ınterest rate channel

Sample: 1987Q1 2016Q4					
Indicators	**GDP_{grow}**	**MPR**	**INV**	**INFLR**	**INTR**
Mean	5.080217	14.09891	2.286902	5.843826	8.950957
Median	5.865000	13.50000	2.344706	4.420000	7.210000
Maximum	11.36000	26.00000	2.470327	14.80000	22.60000
Minimum	0.010000	6.000000	2.022178	1.280000	1.770000
Std. Dev.	2.481264	3.910517	0.135095	3.645213	4.806339
Skewness	−0.097646	0.144639	−0.905754	0.749998	0.682816
Kurtosis	2.128634	3.286946	2.388633	2.327211	2.626270
Jarque-Bera	3.820961	0.795514	17.51512	12.95012	9.605484
Probability	0.148009	0.671825	0.000157	0.001541	0.008207
Sum	584.2250	1621.375	262.9938	672.0400	1029.360
Sum Sq. Dev.	701.8605	1743.305	2.080585	1514.784	2633.502
Observations	115	115	115	115	115

Table A2: Residual correlation matrix

	MPR	**INTR**	**M2**	**INV**	**INFLR**	**GDP_{grow}**
MPR	1.000000					
INTR	0.101051	1.000000				
M2	0.039252	−0.007786	1.000000			
INV	−0.057476	0.161357	0.069179	1.000000		
INFLR	−0.012960	−0.225019	−0.115868	−0.754151	1.000000	
GDP_{grow}	−0.045670	0.165217	−0.106220	0.030377	0.005247	1.000000

APPENDIX 2

VAR lag order selection criteria						
Endogenous variables: MPR INTR INV GDP_{grow} INFLR						
Exogenous variables: C						
Sample: 1987Q1 2016Q4						
Included observations: 103						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	−937.0982	NA	60.56922	18.29317	18.42107	18.34497
1	−393.7485	1023.397*	0.002578*	8.228126*	8.995523*	8.538948*
2	−374.1846	34.94914	0.002875	8.333681	9.740576	8.903522
3	−356.6371	29.64338	0.003352	8.478390	10.52478	9.307248
4	−341.7569	23.69269	0.004146	8.674891	11.36078	9.762768
5	−316.9706	37.05919	0.004277	8.679040	12.00443	10.02594
6	−291.8977	35.05335	0.004447	8.677625	12.64251	10.28354
7	−275.0938	21.86138	0.005523	8.836773	13.44115	10.70170
8	−262.0632	15.68734	0.007541	9.069188	14.31307	11.19314
9	−229.1658	36.41068	0.007190	8.915841	14.79922	11.29881
10	−206.9367	22.44491	0.008715	8.969645	15.49252	11.61163
11	−170.8727	32.91275	0.008415	8.754811	15.91718	11.65582
12	−130.8909	32.60656	0.007932	8.463901	16.26577	11.62392

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

VAR residual serial correlation LM tests		
Null hypothesis: no serial correlation at lag order h		
Sample: 1987Q1 2016Q4		
Included observations: 113		
Lags	**LM-Stat**	**P**
1	34.20093	0.1037
2	34.41411	0.0993

Probs from Chi-square with 25 df.

APPENDIX 3

Variance decomposition of growth in real GDP (GDP_{grow})							
Period	**S.E.**	**MPR**	**INTR**	**M2**	**INV**	**INFLR**	**GDP_{grow}**
1	1.056915	0.208571	2.914054	1.050574	0.004525	0.309243	95.51303
2	1.713622	0.469746	1.843766	1.542470	0.124559	1.103294	94.91616
3	2.149130	0.765575	1.281873	1.775647	0.258879	1.253207	94.66482
4	2.438403	1.195694	1.004218	1.931386	0.386533	1.164705	94.31746
5	2.640277	1.799623	0.874688	2.044352	0.512210	1.024112	93.74502
6	2.791060	2.571794	0.821913	2.123696	0.633142	0.936285	92.91317
7	2.910868	3.469326	0.807292	2.174293	0.742804	0.960364	91.84592
8	3.010048	4.428039	0.809850	2.200637	0.835733	1.126831	90.59891
9	3.093718	5.379852	0.818610	2.207474	0.909598	1.445674	89.23879
10	3.164554	6.266010	0.828264	2.199590	0.965158	1.911263	87.82971
11	3.224295	7.044272	0.836564	2.181458	1.005190	2.506169	86.42635
12	3.274429	7.690797	0.842798	2.156977	1.033287	3.204711	85.07143

Variance decomposition of ınvestment (INV)							
Period	**S.E.**	**MPR**	**INTR**	**M2**	**INV**	**INFLR**	**GDP_{grow}**
1	1.056915	0.330351	2.823230	0.539948	96.30647	0.000000	0.000000
2	1.713622	0.818778	3.043926	0.659283	95.19749	0.250366	0.030155
3	2.149130	0.842188	2.833087	0.756475	95.15304	0.315598	0.099613
4	2.438403	0.705289	2.610021	0.892067	95.27574	0.396916	0.119971
5	2.640277	0.661046	2.422659	1.076587	95.23598	0.483135	0.120598
6	2.791060	0.764095	2.272212	1.316707	94.95648	0.574271	0.116236
7	2.910868	0.978591	2.155586	1.617873	94.46865	0.667204	0.112099
8	3.010048	1.248182	2.068944	1.984281	93.83000	0.759036	0.109552
9	3.093718	1.525494	2.007625	2.418008	93.09261	0.847191	0.109071
10	3.164554	1.779849	1.966276	2.918592	92.29455	0.929420	0.111309
11	3.224295	1.995916	1.939340	3.483010	91.46059	1.003757	0.117390
12	3.274429	2.169521	1.921625	4.106039	90.60543	1.068540	0.128843

Variance decomposition of ınflation (INFLR)							
Period	**S.E.**	**MPR**	**INTR**	**M2**	**INV**	**INFLR**	**GDP_{grow}**
1	1.056915	0.016796	5.056217	1.395114	52.11270	41.41917	0.000000
2	1.713622	0.197534	4.998156	0.802329	49.11288	43.80574	1.083362
3	2.149130	0.193025	4.265088	0.627437	45.78775	46.24651	2.880199
4	2.438403	0.169143	3.629516	0.541983	42.61248	48.13046	4.916418
5	2.640277	0.253298	3.169886	0.486508	39.55501	49.48622	7.049079
6	2.791060	0.436775	2.853511	0.444572	36.68195	50.38973	9.193464
7	2.910868	0.666206	2.638958	0.410715	34.09260	50.90534	11.28618
8	3.010048	0.895859	2.492402	0.383045	31.85962	51.08981	13.27926
9	3.093718	1.100203	2.389086	0.360920	30.01343	50.99771	15.13865
10	3.164554	1.270379	2.312057	0.344107	28.54701	50.68349	16.84295
11	3.224295	1.407493	2.250456	0.332480	27.42726	50.20072	18.38159
12	3.274429	1.517218	2.197846	0.325928	26.60673	49.59971	19.75257