

CREDIT CHANNEL OF MONETARY TRANSMISSION MECHANISM: VALIDATING BERNANKE-BLINDER MODEL IN NIGERIA

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ABSTRACT

This paper examines the effectiveness of credit channel of monetary transmission mechanism in Nigeria by exploring both bank lending and balance sheet variables. Credit to government, credit to private sector, prime lending rate, money supply, inflation rate and growth in GDP were used to capture bank lending channel while banks security holdings, total bank deposit, treasury bill rate, total loan of deposit money banks, exchange rate, inflation rate and growth in GDP captured balance sheet channel. Quarterly data from 1987:Q1 to 2015: Q4 were employed using Bayesian vector auto regressions with impulse response functions and variance decompositions. The results revealed that both balance sheet and bank lending variables responded to monetary policy shocks in accordance with Bernanke-Blinder model. Balance sheet channel is more effective when economic growth is the policy target while bank lending channel is more effective when price stability is the policy target. We conclude that credit channel is an effective monetary policy transmission mechanism in Nigeria and recommend that financial institutions in Nigeria should be strengthened to achieve the desired result.

KEYWORDS: Bank Lending channel, Balance Sheet, BVAR, Minnesota prior

1. Introduction

The effectiveness of monetary policy to achieve macro objectives is no longer debatable but the channels through which these policies influence the economy is one of the controversial issues in monetary economics. Credit channel is one of the monetary policy transmission channels which came about as a result of problem of asymmetric information in financial markets. This view

proposes that two types of monetary transmission channels arise as a result of information problem which are: bank lending channel whose focus is on the possible effect of monetary policy actions on the supply of loans by the banking system and balanced sheet channel which emphasizes impact of changes in monetary

policy on the borrower's balance-sheet (Frederic, 2010).

The channel through which, money affects output often predicts the modalities of implementing monetary policy (Partha, Himanshu & Mridul, 1998) because monetary policy has played a significant role in repositioning the economy (Uma, Ogbonna & Obidike, 2014). The process through which monetary policy affects the economy in general and the price level is known as monetary policy transmission mechanism. This concept has been a subject of interest to economists over the years, popularly known as the black box (Morsink & Bayoumi, 2001).

The study of effectiveness of credit channel of transmission mechanism on real economy was necessitated because of the puzzling and inconclusive results of other scholars (Olowofeso, Bada, Bassey & Dzaan, 2014, Adeoye, Ojapinwa & Odekunle, 2014, Ogun & Akinlo, 2010) in Nigeria coupled with the fact that Bernanke and Blinder model has not been refuted or validated using data from Nigeria. The novelty of this paper is in terms of combining bank lending channel with balance sheet channel in a research thereby validating Bernanke-Blinder model and using BVAR model to ascertain credit channel effectiveness. This paper is divided into four distinctive parts apart from the introduction, they are; Literature review, Methodology, Analysis and discussion of findings, summary and conclusion.

2. Literature Review

The study of effectiveness of credit channel dates back to Bernanke and Gertler (1995) and Romer and Romer (1990). This channel of monetary transmission holds that because of asymmetric information in the credit market, banks are able to play special role by providing loans to some categories of firms which under normal circumstance would have found it difficult to obtain finance from the capital market. The implication of this is that monetary policy affecting the supply of bank credit adversely affects the investment behaviour and the

performance of these firms (Ogun & Akinlo, 2010).

Empirical evidence exploring monetary credit channel in Nigeria is extant, Adeoye et al (2014) examined the credit channel of monetary policy in Nigeria and their study indicates that there is a close relationship between the bank credit and aggregate demand and suggests a stronger monetary system through credit channels and investment multiplier in Nigeria. They based their work on the conventional IS-LM model with the usage of RGDP as the dependent variable and other monetary variables such as; credit to core private sector, interest rate, investment and inflation rate using VAR model. Their study however did not examine the assertion of Bernanke et al (1998) to know whether credit channel affects the real economy in Nigeria through bank lending and/or balance sheet. Bank lending channel was examined by Bondt (1999) whose empirical results provide evidence of bank lending channel in Germany and Netherlands but bank lending seems to be driven by smallest banks in Belgium. This type of research was carried out in Czech by Pruteanu-Podpiera (2007) when he used a panel of quarterly time series on commercial banks and he concludes that lending channel was operative between 1996 and 1998 and found a cross sectional differences in the lending reactions to monetary policy shocks due to degree of capitalization and liquidity.

Jeevan (2013) examines the operations of credit channel of monetary policy transmission in India through change in policy rate by determining the effectiveness and the lag length. The credit channel of monetary transmission is significant and robust; also the transmission of policy rate to nominal or real bank credit growth takes about nine months. The variables used include; nominal/real bank credit, level of real economic activities, nominal/real bank deposit or money supply, price, nominal/real exchange rate, central bank nominal policy rate and so on.

Unlike Jeevan; Walia and Raju (2014) studying a post-reform analysis, carry out a study on monetary transmission mechanism in India by

using bench mark VAR with emphasis on bank lending, asset price and exchange rate channels and found out that bank lending channel plays an important role in India while asset price channel is less important to the economy. Wholesale price index (WPI) was used to measure domestic prices. Other indicators used for exogeneous variables are; Federal Reserve, USAgdp and cash reserve ratio. USAgdp was included to capture world demand. Fiorentini and Tamborini (2001) examine the credit channel of monetary transmission mechanism in Italy linking credit channel to firms' performance. They found that credit condition is important for real supply side effect of monetary policy in Italy.

Focusing on nominal transmission mechanism in Italy, Juselius and Gennari (1999) study the dynamics of excess money and how it affects the domestic economy through its effects on prices, income and interest rates. They used co-integrated VAR model to investigate the dynamic determination of money, income, prices and interest rates. The data were; Monetary aggregate (M2), price index, real GDP, rate of return on M2 and yield on medium-term bonds. They also divided the entire period into two and found that the monetary effects on real income have been different in two periods in which the study is divided into. Real money expansion has a strong positive effect in the first period and strong interest rate effect in the second period. They conclude that the effect of excess money on domestic price inflation is modest. However, the effect of short interest rate seems more important than excess money.

Recent literature on monetary transmission mechanism in Nigeria within methodological realm used Vector Autoregressions (Ogun & Akinlo, (2010), Nwosa & Saibu (2012), Ndekwa

(2013), Adeoye, et al (2014), Olowofeso et.al (2014)), Ishioro (2013) used Pairwise Granger causality, Obafemi and Ifere (2015) used FAVAR and CBN (2015) used BVAR to examine interest rate channel. From other countries, scholars like; Prachi and Peter (2012) used impulse response functions (IRFs) from VARs. Muhammad and Kashif (2010) used structural VAR. Rokon (2008) from Canada used Bayesian structural VAR model and impulse response of monetary aggregate and Spulbar and Nitoi (2013) used Bayesian Vector Auto regression (BVAR) in Romania. BVAR was adopted in this study due to its numerous advantages over other methods such as; objectivity and flexibility, useful for dealing with the problem of over-parameterization of VAR and gives more accurate prediction and the shrinkage help to solve the problem of serial autocorrelation (Banbura, Giannone & Reichlin (2010), Spulbar & Nitoi (2013).

2.1 Theoretical Underpinning

In order to understand the relationship between credit and economic performance, Bernanke and Blinder (1992) develop a model within the framework of IS – LM model. The main characteristic of the model is the introduction of financial asset into the economy, which is credit. In their model, credit rationing was not included as it is less important to credit, they also abandon the assumption of perfect substitutability of credit and bond. Rather they assume a credit market that can be cleared in a short time. They present a demand for credit which depends on the rate on loans (p), the market interest rate, i.e., the rate on bonds (i), and finally on an autonomous transaction motive (y). In brief, the demand for credit can be seen as follows:

$$L^s = L(\rho^-, i^+, y^+) \quad 1$$

On the other hand, the supply of credit is determined by banks' balance sheet (i.e., reserves (R), bonds (B) and loans (L) which must equal total deposits assuming equity zero; and regulatory framework which determines in turn the reserve requirement ratio (τ):

$$L^s = \lambda(\rho^-, i^+)D(1-\tau) \quad 2$$

Equations 3.1 and 3.2 represent the typical LM curve. They derive another equation which they call credit curve (CC) or commodity and credit curve which represent the conventional IS curve. The CC is stated below;

$$y = y(\rho^-, i^+) \quad 3$$

Where ρ (rate of loans) is endogenously determined by rate of bonds, output and monetary policy through bank reserve as stated below;

$$\rho = \phi(i^+, y^+, R^-) \quad 4$$

Hence the two policy instruments adopted are prime lending rate (PLR) to capture bank lending channel and Treasury bill rate (TBr) to capture balance sheet channel. The recursive BVAR is stated below;

$$Z_{i,t} = \Pi Z_{i,t-p} + \varepsilon_t \quad \forall \quad i = 1, 2 \quad 5$$

Where, $Z_{1,j} = [MPR, PLR, CPS, CG, GDPgrow, INFR,]$ is the vector of endogenous variables for PLR and $Z_{2,j} = [TBr, CPI, GDPgrow, TBD, TBL, BSH, NEER,]$ is the vector of endogenous model for TBr. Hence, this study used both balanced sheet and bank lending channel variables. The data used to achieve this objective are; Monetary Policy Rate (MPR), Prime Lending Rate (PLR), Credit to Government (CG), Credit to private sector (CPS), Inflation Rate (INFLR) and Growth in Gross Domestic Product (GDPGrow) to capture bank lending channel and used banks security holdings (BSH), bank deposits (TBD), total loans by deposit money banks (TBL), nominal effective exchange rate (NEER), treasury bill rate (TBR) and consumer price index (CPI) to capture balance sheet channel of transmission mechanism in Nigeria and thus adopts Bernanke and blinder model as revised by Ogun and Akinlo (2010).

3. Methodology

3.1 Bayesian Vector Auto regression (BVAR)

Quarterly data from 1987:Q1 to 2015:Q4 were collected from CBN statistical bulletin and database. VAR model is necessary for this research because it is useful for describing the dynamic behavior of financial and economic time series data and useful for policy analysis. The BVAR model as developed by Spulbar and Nitoi (2013) was adopted in this paper being a developing economy. BVAR was also used in Nigeria for establishment of interest channel by CBN (2015). The model is as stated below;

$$y_t = \alpha_0 + \sum_{l=1}^p A_l y_{t-l} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma) \quad 6$$

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

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

$$Y = XA + E \quad 7$$

And

$$y = (I_M \otimes X)\alpha + \varepsilon \quad \text{Where, } \varepsilon \sim N(0, \Sigma \otimes I_M) \quad 8$$

Y represents a $T \times M$ matrix that stacks the T observations on each of the endogenous variables in columns next to each other. Where; ε and E represent stacking of the errors in a conformable manner of y and Y respectively.

$$\text{Let } x_t = (1, y_{t-1}, \dots, y_{t-T}) \text{ and } X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_T \end{bmatrix} \quad 9$$

Therefore, the vector of $nT \times 1$, $y = \text{vec}(y_t)$, shows the stack of T observations on the first endogenous variable after which the T observations on the rest of the other endogenous variables in that order are stacked in that order. According to Koop and Korobilis (2009), if we let $K = 1 + MP$ be the number of coefficients in each equation of the VAR, then X is a $T \times K$ matrix and lastly, if $A = (\alpha_0 A_1 \dots A_p)'$ we define $\alpha = \text{vec}(A)$ which is a vector of $KM \times 1$ which stacks all the VAR coefficients and the intercepts into a vector.

3.2 Prior Selection

Vector auto regression models are not parsimonious models in that they contain many coefficients. In VAR (6) for instance, if α has KM parameters, it involves 5 equations of about 105 observations, with quarterly data, the number of observations will increase to a few hundreds of which without prior information, to obtain precise estimates of this great number of coefficient coupled with forecast ability will be extremely imprecise (Koop and Korobilis 2009), hence the need to shrink forecasts and prior information. This shrinkage was achieved by selecting the prior distribution.

Selection of prior distribution of BVAR is another important step to take because prior information has the advantage of delivering accurate inference (Rokon, 2008). This study is

premised on Litterman Minnesota prior, which is the most commonly used prior distribution because it is essential to promote forecasting performance of a model (Litterman, (1985), Domenico, Michele & Giorgio, 2012). Also, Minnesota priors result 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 among the error terms due to over-parameterization (Migliardo, 2010).

Litterman Minnesota Priors simplifies equation 3.8 by replacing Σ with its estimate $\hat{\Sigma}$.

There is also an assumption that Minnesota prior for α is:

$$\alpha \sim N(\underline{\alpha}_{Min}, \underline{V}_{Min}) \quad 10$$

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:

$$\underline{V}_{i,jj} = \begin{cases} \frac{\alpha_1}{\rho^2} \\ \frac{\alpha_2 \delta_{ii}}{\rho^2 \delta_{jj}} \text{ for coefficients on lags of variable } j \neq i \\ \alpha_3 \delta_{ii} \end{cases} \quad 11$$

From equation 11, $\frac{\alpha_1}{\rho^2}$ 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 $j \neq i$ (Koop & Korobilis,

2009). CBN(2015) and Koop and korobilis (2009) argued that the likelihood function can be of the form that can be decomposed into two parts which are; a distribution for α given Σ with normal density and another where, Σ^{-1} has a Wishart density as written below;

$$\alpha(\Sigma|y) \sim N\left[\hat{\alpha}, \Sigma \otimes (X'X)^{-1}\right] \quad 12$$

And

$$\alpha\left[(\Sigma^{-1}|y) \sim W(S^{-1}, T - K - n - 1)\right] \quad 13$$

Where $k = 1 + np$, $\hat{\alpha} = (X'X)^{-1} X'Y$ is the OLS estimate of α , and $\hat{A} = \text{vec}(\hat{\alpha})$

and $S = (Y - X \hat{A})'(Y - X \hat{A})$ 14

From the above, if the set of parameters, (α, Σ) is denoted by θ , the prior distribution is given as $\pi(\theta), l(y|\theta)$. This leads us to analysis and discussion of results.

4. Analysis and Discussion of Findings

Correlation is a measure of association between two random variables. A table that shows inter correlation among the regressors is called correlation matrix. This measure was employed to shed more light on possibility of multicollinearity among the variables.

Table 4.1 Correlation Matrix for Bank Lending Channel Variables

	DCG	LCPS	GDPGROW	INFLR	MPR	LM2	PLR
DCG	1.0000						
LCPS	0.1365	1.0000					
GDPGROW	-0.0283	0.1960	1.0000				
INFLR	0.1548	0.1462	0.0023	1.0000			
MPR	-0.0317	-0.6110**	-0.2595	-0.1082	1.0000		
LM2	0.1300	0.9974**	0.1985	0.1242	-0.5974*	1.0000	
PLR	-0.0166	-0.4459*	-0.1835	-0.1501	0.6743**	-0.4355*	1.0000

**significant at 0.01 level

*significant at 0.05 level

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Credit to Government (DCG) is positively correlated with credit to private sector but the correlation coefficient is weak. DCG is negatively and weakly correlated with gdpgrow, MPR and PLR with the coefficient of -0.028, -0.032 and -0.017 respectively and positively but weakly correlated with INFLR and LM2 with correlation coefficient of 0.15 and 0.13 respectively. MPR and PLR are negatively and moderately correlated with LCPS and positively correlated with GDPGROW, INFLR and LM2. There is a strong degree of association between LCPS and LM2 with the coefficient of 0.99. MPR and PLR are negatively and weakly correlated with GDPGROW and positively weakly correlated with INFLR and LM2. INFLR is negatively and weakly correlated with MPR and PLR but positively and weakly correlated with LM2. MPR is negatively and moderately correlated with LM2 and positively moderately correlated with PLR with the correlation coefficient of -0.59 and 0.67 respectively. Lastly PLR is negatively moderately correlated with LM2.

Table 4.2: Correlation Matrix for Balance Sheet Channel Variables

	CPI	GDPGROW	BSH	TBD	TLB	NEER	TBR
CPI	1						
GDPGROW	-0.589**	1					
BSH	0.944**	-0.315	1				
TBD	0.978**	-0.313	0.915**	1			
TLB	0.798**	0.247	0.686**	0.696**	1		
NEER	0.670**	-0.702**	0.618**	0.547**	0.269	1	
TBR	0.504**	-0.187	0.384*	0.643**	0.161	0.326	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

EvIEWS 9.0 (Compiled by the Authors)

Consumer price index is negatively and significantly correlated with growth in GDP and positively, significantly correlated with other variables. The growth in GDP has a negative but insignificant association with banks securities holdings, total bank deposit and Treasury bill rate while it has a negative and significant association with nominal effective exchange rate. It has a positive insignificant association with total loans of DMBs. Banks securities holdings is highly positively and significantly correlated with total bank deposit and relatively highly correlated with total loans of DMBs and exchange rate. BSH has a positively weakly association with TBR. TBD has positively relatively high and

significant association with TLB, NEER and TBR. TLB is positively insignificantly correlated with NEER and TBR. TBR is weakly positively insignificantly correlated with NEER.

4.3: Lag Order selection for BVAR (Bank Lending Channel)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2135.905	NA	1.38e+08	38.61091	38.78178	38.68023
1	-1295.638	1559.416	89.16127*	24.35383*	25.72080*	24.90837*
2	-1252.120	75.27459	99.39591	24.45261	27.01568	25.49237
3	-1217.007	56.30651	130.9620	24.70283	28.46200	26.22782
4	-1175.200	61.76922	156.6629	24.83243	29.78770	26.84264
5	-1115.337	80.89584*	139.9989	24.63670	30.78807	27.13213

* indicates lag order selected by the criterion

The results displayed in table 4.3 show that lag length one was selected by FPE, AIC, SC and HQ with LR selecting lag length four. Since four of the five criteria selected lag length one, this study ought to adopt lag length one but because of the evidence of serial correlation after prior selection for lag length one, this study adopts lag length two to compute BVAR.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	34.93552	NA	2.98e-10	-2.069298	-1.733340	-1.969400
1	204.5741	238.7506*	4.45e-14*	-11.00549*	-8.317827*	-10.20631*

* indicates lag order selected by the criterion

LR, FPE, AIC, SC, HQ selected lag length 1 (one) but lag length two was adopted for the estimation of BVAR for balance sheet channel and bank lending channel because, the problem of serial autocorrelation was not solved at lag length one as depicted in table 4.1.4 The problem was only corrected from lag length two.

4.6 Minnesota Litterman Prior Selection

After series of iteration to get the best result with high precision, the overall tightness Lambda 1 was set as 0.8 while the relative cross variable weight, Lambda 2 was left as 0.99 and the lag decay lambda 3 was set as 1. As explained earlier, litterman/Minnesota prior was chosen for this result due to its ability to solve serial autocorrelation problem.

4.7 VAR Residual Serial Correlation LM before/After Prior Specification

Appendix 4.6 shows the evidence of serial correlation among the residuals of credit channel variables and shows that the problem of serial correlation has been taken care of by the Litterman/Minnesota prior selection from lag length two. This is the reason why lag length two was selected in this study.

4.8 BVAR Stability Test for Bank lending channel model

Appendix 4.7 shows that no root lies outside the unit circle and hence VAR satisfies the stability condition. Normality of residual does not matter with VAR and monetary variables are said to exhibit random walk. From the above, the impulse response functions and forecast from variance decomposition are reliable.

4.9: BVAR Stability Check for Balance sheet channel model

Appendix 4.8 shows that the VAR equation is stable, otherwise the impulse response functions and variance decomposition estimates will not be reliable.

4.10 Impulse Response Functions of Inflation and GDPGROW to Shocks in Credit Channel Variables (Bank lending channel)

The variables used to measure bank lending channel in this research are; prime lending rate, monetary policy rate, credit to private sector, credit to government, money supply and inflation.

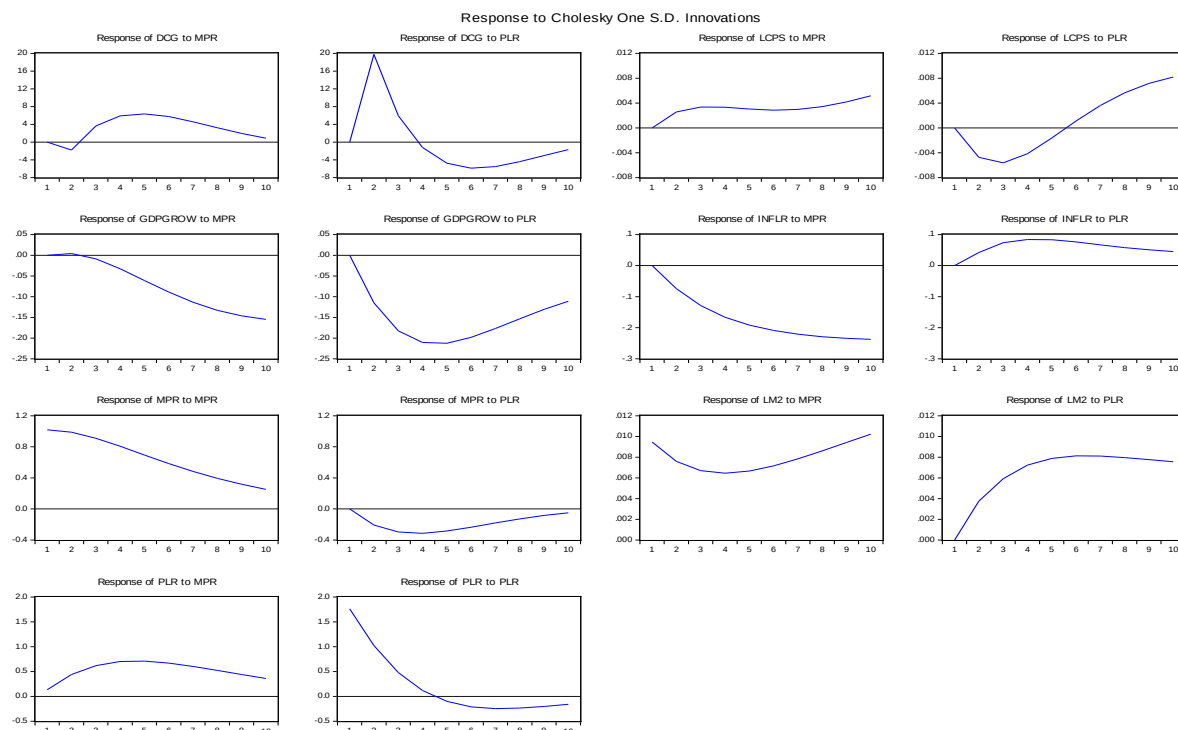


Figure 1: Responses of Bank Lending Channel to a Shock in Inflation rate and GDPgrow
Authors, 2018(Eviews version 9)

From figure 1, credit to government (DCG) reduced immediately as a result of a shock in MPR in the first period and started increasing in the second period which peaked in the fourth period after which it started reducing till the end of the period. Unlike the downward response of DCG to shock in MPR, the DCG responded positively to a shock in prime lending rate before it started decelerating in the second period and reduced to negative values in the fourth quarter where it remained until the seventh period when it started increasing. This actually shows that the credit channel is somehow effective in Nigeria.

Also, credit to private sector responded to a shock in MPR as expected from the first period to the last period as well as its response to a shock in PLR. A one standard deviation shock to PLR reduced the CPS by 0.3 per cent in the second quarter and the magnitude of response increased continuously throughout the horizon. The immediate decrease in money supply in responding to increase in monetary policy rate is in line with Fishers quantity theory of money. When interest rate increases, money supply automatically reduces because demand for money reduces which also reduces inflation.

4.11 Impulse Response Function of INFLR, GDPGROW to a shock in TBR (Balance sheet Channel)

The variables used to examine balance sheet channel of transmission mechanism in this research are; consumer price index, growth in gross domestic product, banks securities holdings, total bank deposit, total loans of deposit money banks, exchange rate and Treasury bill rate.

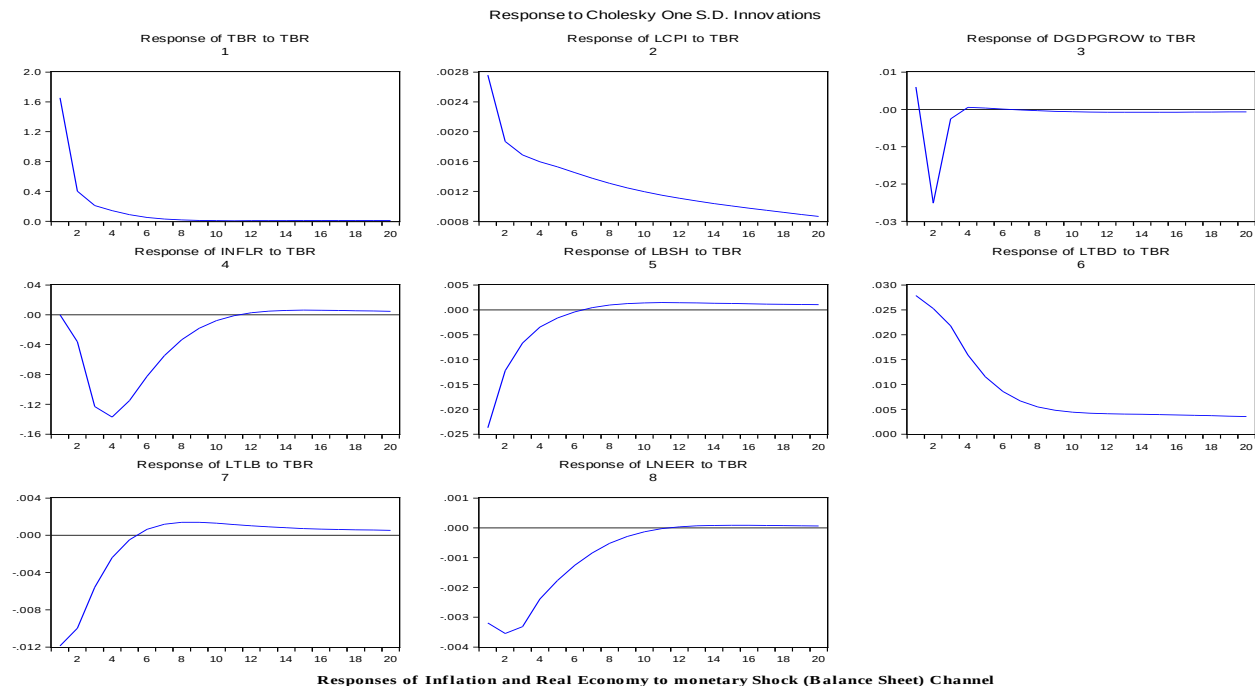


Figure 2: Responses of Inflation and Real Economy to a Shock in Balance Sheet Channel Variables
Authors, 2018 (Compiled from Eviews version 9)

From figure 2, CPI reduced drastically from 0.27 per cent in first quarter to 0.19 per cent in the second quarter and further decayed till the end of the horizon in response to monetary shock in plane 2. The response of consumer price index to a shock in Treasury bill rate supports quantity theory of money in that an increase in Treasury bill rate decreases bank deposit as explained in plane 6 which is a component of money supply ($MS = C + D$), thereby reducing prices (CPI). Likewise, the monetary shock brought about a fall in growth in GDP in plane 3 from 0.6 per cent to -0.25 per cent and increased to -0.03 after which growth in GDP fluctuated between -0.001 and 0.001 from the fourth period to the twentieth period. Inflation rate fell immediately after monetary shock from the first period and reached the lowest point of -13.7 per cent in the fourth quarter and improved till the fourteenth

quarter when inflation rate became stable and became stable at 0.6 per cent. Bank securities holdings improved immediately to monetary shock which contradicts Bernanke-Blinder (1998) proposition of immediate fall of securities as soon as there is monetary shock. The response of bank securities holdings became positive from seventh quarter to twentieth quarter. Total bank deposit however responded according to theory by falling immediately after monetary shock from 2.8 per cent in the first quarter to 2.2 per cent in the third quarter and further dropped to 0.5 per cent in the eighth quarter when it became stable till the end of the horizon. Total loans of deposit money banks increased in response to monetary shocks from -0.1 per cent in the first quarter to -0.005 per cent in the fifth quarter after which the response became positive and eventually stabilizing at an appreciation of 0.14 per cent.

The response of exchange rate to monetary shock contradicts the theoretical expectation in that exchange rate depreciated immediately after increase in Treasury bill rate which ought not to be. A hike in Treasury bill rate should increase nominal exchange rate immediately. This can be attributed to the sharp practices of round-tripping of foreign exchange by Nigerian banks as explained by Ogun and Akinlo (2010). The response of exchange rate to a shock in Treasury bill rate is in line with the result of Ogun and Akinlo (2010) despite the fact that the scope and methodology differ, this tells much about the

financial sector of Nigerian economy. Exchange rate decelerated between the first and second quarter and started accelerating from the third quarter to the tenth quarter, by the thirteenth quarter, exchange rate became stable at 0.01 per cent till the end of the horizon. The shape of response of growth in GDP to a shock in Treasury bill rate is similar to the response of real GDP to a shock in MPR of CBN (2015) and corroborates the result of Ogun and Akinlo (2010). In essence, planes 3 and 4 show the effectiveness of balance sheet channel in stabilizing the economy.

4.2: Variance Decomposition for Bank Lending Channel

Tables 4.2.1 and 4.2.2 show the variance decomposition of inflation rate and economic growth with the various contributions of bank lending channel variables.

Table 4.2.1 Forecast Error Variance Decomposition of INFLR

Period	S.E.	MPR	PLR	LCPS	DCG	LM2	INFLR	GDPGROW
1	0.9734	0.3492	0.0770	0.3100	0.0702	0.9327	98.2606	0.0000
4	2.1735	1.0770	0.4885	1.0951	2.7385	3.0341	91.4839	0.0825
8	2.7442	0.7842	0.5152	5.8663	2.3926	9.5738	80.8060	0.0617
12	2.9644	0.6110	0.4746	10.721	2.0034	14.5241	71.6097	0.0552
16	3.1155	0.5676	0.4439	14.1620	1.7777	17.3146	65.6827	0.0513
20	3.2339	0.5866	0.4258	16.1831	1.6850	18.5199	62.5504	0.0488
24	3.3157	0.6234	0.4177	17.1857	1.6658	18.8408	61.2163	0.0501

Table 4.2.2

Period	S.E.	MPR	PLR	LCPS	DCG	LM2	INFLR	GDPGROW
1	1.5597	1.3927	0.0247	0.0717	0.6062	0.1445	0.5069	97.2529
4	2.4369	1.3232	0.9028	1.3581	1.6396	0.3389	0.1086	94.3284
8	2.8871	2.7013	3.3583	3.1951	1.7596	0.3811	0.7196	87.8846
12	3.1203	5.0999	3.7862	3.4981	1.9987	0.5240	2.3738	82.7190
16	3.2437	6.2088	3.7131	3.4318	2.2136	0.6253	4.6329	79.1741
20	3.3401	6.4066	3.6309	3.4841	2.3185	0.8658	6.6674	76.6264
24	3.4146	6.3493	3.5664	3.7210	2.3401	1.2864	7.9928	74.7436

EvIEWS 9.0 (Compiled by the Authors)

Tables 4.2.1 and 4.2.2 show the variance decomposition of Inflation rate and growth in GDP respectively using credit channel's variables. The former shows that inflation is influenced by its own perturbation by 98 per cent in the first period and reduced to 91 per cent in the fourth

quarter which further dissipated to 81 per cent in the eight quarter and further reduced to 71 per cent in the twelfth quarter. The influence of inflation's own perturbation reduced drastically to 61 per cent in the twenty-fourth quarter. The table also shows that money supply (LM2) and

credit to private sector (LCPS) exhibit upward movement from 0.93 per cent in the first quarter to 18.84 per cent in the twenty-fourth quarter and from 0.31 per cent in the first quarter to 17.19 per cent in the twenty-fourth quarter respectively. The contributions of other variables were not significant in the period.

From table 4.2.2, the real economy is more responsive to its own shock in the first quarter while the contributions of other variables were insignificant but in the eighth quarter, all other variables apart from money supply and inflation

demonstrated relative influence. The result indicated that 2.7, 3.4, 3.2 and 1.8 per cent variation in growth in GDP was due to monetary policy rate, prime lending rate, credit to private sector and credit to government respectively. As the impact of its own shock decays to 74.7 per cent in the twenty-fourth quarter, the influence of all other variables witnessed a general upward movement ranging from the contribution of inflation rate of 7.99 per cent to the contribution of money supply of 1.29 per cent.

4.2.3: Variance Decomposition for Balance Sheet Channel

Table 4.2.3 displays the variance decomposition of economic growth and the contributions of balance sheet variables.

Table 4.2.3: Forecast Error Variance Decomposition of GDPGROW

Period	S.E.	GDPGROW	INFLR	CPI	LNEER	LBSH	LTBD	LTLB	TBR
1	0.4078	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.5047	73.0861	0.2725	4.7761	5.0562	5.0605	1.4155	6.1465	4.1860
8	0.5291	67.8801	4.3135	4.5361	4.9928	5.0402	2.4102	6.3914	4.4352
12	0.5427	64.9835	6.2950	4.5070	6.3140	5.0976	2.4161	6.0953	4.2911
16	0.5513	63.5543	6.3198	5.1662	7.1787	4.9784	2.3625	6.1008	4.3389
20	0.5529	63.2262	6.5387	5.1660	7.1780	4.9541	2.4276	6.1333	4.3758

EvIEWS 9.0 (Compiled by the Authors)

Growth in GDP is principally affected by its own perturbation (100 per cent) in the first period, while other variables in the model did not contribute at all. In the fourth period, the contribution of growth in GDP to its own innovation dissipated to 73.08 per cent while the contributions of other variables improved significantly. The contribution of total loans of deposit money banks increased to 6.14 per cent which is in line with theory followed by bank security holdings (5.06 per cent) and exchange rate (5.05 per cent). The relationship between prices (CPI) and growth in GDP also followed economic theory because GDP is measured in

monetary terms. 4.18 per cent of the innovations in GDP were contributed by Treasury bill rate in the fourth quarter. All through the period, the contributions of growth in GDP dissipated while that of other variables improved significantly. In the twentieth period, inflation rate, consumer price index, exchange rate, bank securities holdings, bank deposit, bank loans and advances and Treasury bill rate contributed 6.53 per cent, 5.16 per cent, 7.17 per cent, 4.95 per cent, 2.42 per cent, 6.13 per cent and 4.37 per cent respectively. This shows the effectiveness of credit channel on the real economy through balance sheet variables in Nigeria

Table 4.2.4: Forecast Error Variance Decomposition for INFLR

Period	S.E.	GDPGROW	INFLR	CPI	LNEER	LBSH	LTBD	LTLB	TBR
1	1.6468	0.0416	99.9583	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	1.9824	2.6487	79.5081	0.6669	12.7352	1.7940	0.0439	0.2704	2.3324
8	2.3050	5.2380	63.8905	6.5272	15.5990	2.1279	0.5379	1.8476	4.2315
12	2.3406	5.2038	63.1082	6.6114	15.4519	2.1406	1.0699	2.0421	4.3719
16	2.3689	5.5542	61.8173	6.9090	16.1625	2.1242	1.0811	2.0584	4.2928
20	2.3864	5.7227	61.1960	7.1416	16.2512	2.1047	1.1117	2.1457	4.3260

Evview 9.0 (Compiled by the Authors)

Table 4.2.4 displays the variance decomposition of inflation rate and as expected, inflation rate was greatly affected by its own perturbation in the first period with other variables contributing insignificantly. The contribution of inflation rate to its own innovation dissipated in the fourth quarter to 79.50 per cent from 99.95 per cent in the first quarter and other variables contributed significantly to innovations in inflation rate. The contribution of exchange rate to inflation rate in the fourth period was 12.73 per cent which is in line with Marshall Learner's theory and the concept of imported inflation. Growth in GDP and Treasury bill rate contributed 2.64 per cent and 2.33 per cent respectively while others evolved slightly. The contribution of exchange rate to innovations in inflation rate increased to 16.25 per cent in the twentieth period while that of CPI, GDPGROW and TBR were 7.14 per cent, 5.72 per cent and 4.32 per cent respectively. The contribution of TBR to innovations in inflation rate depicts the effectiveness of credit channel through balance sheet channel to price stability in Nigeria. In comparison, the contributions of balance sheet variables to innovations in growth rate of GDP were higher than their contributions to innovations in inflation rate but the channel is still effective.

4.10 Discussion of Findings

Given the results above, the following discussion of outcomes are germane. The IRFs displayed the potency of credit channel variables to stabilize the economy through both bank lending and balance sheet variables. A tightening PLR has a puzzling outcome on inflation at the beginning of

the period but decayed in the fourth quarter and became stable from the seventh period. This shows that a tightening PLR can bring stability to prices in Nigeria. This result is in line with that of Olowofeso et al (2015). A standard deviation shock to PLR increased money supply by 0.4 per cent in the second period and accelerated to 0.8 per cent in the fourth period and became stable till the end of the horizon. The array of pictures in figure 4.10 shows that credit channel is effective in achieving economic stability in Nigeria which is in line with the results of Adeoye et al (2014) and shows that both bank lending and balanced sheet channels of credit exist in Nigeria.

The Variance Decomposition results on tables 4.2.3 and 4.2.4 show that balanced sheet channel is effective in stabilizing the economy in Nigeria due to the upward movements of contributions of credit to private sector and credit to government to the variation in GDPgrow and inflation. However, credit to private sector has a higher contribution than all other variables included in the model. This shows that balanced sheet channel as measured by bank securities, bank deposit, loan and advances, Treasury bill rate, exchange rate and consumer price index is effective as well as bank lending channel though the later contributed more significantly through credit to private sector and money supply. This result with adjustments on variables and different methodology contradicts the result of Ogun and Akinlo (2014) who used SVAR but in line with the report of Ishioro (2013) as previously reviewed in chapter two and Adeoye et al (2014).

5. Summary and Conclusion

This paper set out to determine the effectiveness of credit channel through; bank lending and balance sheet variables and therefore validate Bernanke-Blinder model and the results show that credit channel of monetary transmission mechanism is effective in Nigeria most especially through bank lending channel when the focus is price stability when the contribution of credit to private sector to inflation rate was 17.18 per cent and the contribution of M2 was 18.84 per cent. When economic growth is the policy target, balance sheet channel is the most appropriate because its contribution to real economy as measured by growth in GDP through Treasury bill rate, total loan of deposit money banks, bank securities holdings and exchange rate were 4.37

per cent, 6.13 per cent, 4.95 per cent and 7.17 per cent respectively was higher than the contributions of bank lending channel variables as measured by prime lending rate, credit to private sector, credit to government and money supply.

This paper validates Bernanke-Blinder model in that the both channels are effective in Nigeria depending on the policy objectives since balance sheet channel is more effective in achieving economic growth and bank lending channel is more effective in achieving price stability. Thus, when economic growth is the target, balance sheet variables should be used in addition to other channels and when price stability is the objective, bank lending channel should be explored.

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Appendices

Appendix 4.6

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 10/10/17 Time: 11:43

Sample: 1987Q1 2016Q4

Included observations: 118

Lags	LM-Stat	Prob
1	144.0821	0.0000
2	126.2141	0.0000
3	112.8706	0.0000
4	127.0032	0.0000
5	120.9939	0.0000
6	113.9461	0.0000
7	108.1373	0.0000
8	142.3507	0.0000
9	145.3485	0.0000
10	113.3867	0.0000
11	114.4682	0.0000
12	113.2920	0.0000

Probs from chi-square with 49 df.

Table 4.6 Serial Correlation LM Tests after Prior Selection

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 10/10/17 Time: 11:51

Sample: 1987Q1 2016Q4

Included observations: 118

Lags	LM-Stat	Prob
1	82.89680	0.0018
2	62.53376	0.0927
3	53.83308	0.2946
4	56.43402	0.2169
5	58.58596	0.1641
6	42.14774	0.7451
7	41.71735	0.7603
8	76.69181	0.0069
9	72.37929	0.0166
10	48.09336	0.5098
11	52.11773	0.3536
12	53.31626	0.3118

Probs from chi-square with 49 df.

Appendix 4.7

Roots of Characteristic Polynomial

Endogenous variables: LCPI DGDPGROW LBSH LTBD

LTLB LNEER TBR

Exogenous variables: C

Lag specification: 1 2

Date: 01/16/18 Time: 22:23

Root	Modulus
0.971312	0.971312
0.812581 - 0.207989i	0.838777
0.812581 + 0.207989i	0.838777
0.369149 - 0.370047i	0.522691
0.369149 + 0.370047i	0.522691
0.026502 - 0.516259i	0.516939
0.026502 + 0.516259i	0.516939
-0.509462	0.509462
0.380292	0.380292
0.142162 - 0.298132i	0.330292
0.142162 + 0.298132i	0.330292
-0.267527	0.267527
-0.118653 - 0.163185i	0.201762
-0.118653 + 0.163185i	0.201762

No root lies outside the unit circle.

VAR satisfies the stability condition.

Table 4.7 Roots of Characteristic Polynomial

Endogenous variables: MPR PLR LCPS DCG LM2 INFLR GDPGROW

Exogenous variables: C

Lag specification: 1 2

Date: 10/10/17 Time: 16:44

Root	Modulus
0.992199	0.992199
0.923451 - 0.072232i	0.926271
0.923451 + 0.072232i	0.926271
0.800537	0.800537
0.707950 - 0.223054i	0.742257
0.707950 + 0.223054i	0.742257
0.413559 - 0.045539i	0.416058
0.413559 + 0.045539i	0.416058
-0.098623 - 0.286851i	0.303332
-0.098623 + 0.286851i	0.303332
-0.010233 - 0.303051i	0.303223
-0.010233 + 0.303051i	0.303223
-0.031258 - 0.034108i	0.046264
-0.031258 + 0.034108i	0.046264

VAR satisfies the stability condition.