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Asymmetric Effects of Monetary Policy Shocks on Output Growth in Nigeria: A Sectoral Analysis

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ABSTRACT

In this study, the asymmetric effects of monetary policy on real output both at aggregate and disaggregate levels in Nigeria were scrutinized using data sourced from the Central Bank of Nigeria Statistical Bulletin and Bureau of Statistics. Data for the study was analysed with the nonlinear Autoregressive Distributed Lag (ARDL) and Structural Vector Autoregressive Model (SVAR). The study decomposed money supply (MS) and monetary policy rate (MPR) into positive and negative in order to capture expansionary and contractionary monetary policies. The real output was proxied by Gdpgr. Results from long-run nonlinear ARDL showed long-run co-movement between monetary policy variables and real output both at aggregate and sectoral levels. Results obtained from further empirical estimations showed that the response of real output to shocks emanating from both positive and negative monetary policies was significant with different magnitudes. While the response of output growth rate to shocks from positive monetary policy was significant but negative, its response to shocks from negative monetary policy was positive and significant. It was equally noted in our analysis that positive monetary policy shocks to domestic interest reduces the exchange and output growth rate both at aggregate and sectoral levels. However, the effects of negative monetary policy were wider than that of positive effects. This shows that negative monetary policy would be more efficacious when output is desired to be increased. Results from variance decomposition revealed that, among variables employed in the study, money supply and monetary policy rate explained much of the variations in Nigeria's real output. Based on these findings, the study, therefore, concludes that the effects of monetary policy on real output are asymmetric and not symmetric.

ملخص

في هذه الدراسة، تم التمحيص في الآثار غير المتماثلة للسياسة النقدية على الناتج الحقيقي على المستويين الإجمالي والمفصل في نيجيريا باستخدام البيانات التي تم الحصول عليها من النشرة

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الإحصائية للبنك المركزي النيجيري ومكتب الإحصاء. وتم تحليل بيانات الدراسة باستخدام الانحدار الذاتي للإبطاء الموزع (ARDL) ونموذج الانحدار الذاتي الهيكلي للمتجه (SVAR). كما قسمت الدراسة الإصدار النقدي (MS) ومعدل السياسة النقدية (MPR) إلى إيجابي وسلبي من أجل التعرف على السياسات النقدية التوسعية والانكماشية. وتم تمثيل الناتج الحقيقي بواسطة معدل نمو الناتج المحلي الإجمالي. وأظهرت نتائج الانحدار الذاتي للإبطاء الموزع غير الخطي طويل المدى حركة مشتركة طويلة المدى بين متغيرات السياسة النقدية والإنتاج الحقيقي على المستويين الإجمالي والقطاعي. كما أظهرت النتائج التي تم الحصول عليها من التقديرات التجريبية الإضافية أن استجابة الناتج الحقيقي للصدمات الناجمة عن كل من السياسات النقدية الإيجابية والسلبية كانت كبيرة بأحجام مختلفة. وفي حين كانت استجابة معدل نمو الناتج للصدمات من السياسة النقدية الإيجابية كبيرة ولكنها سلبية، كانت استجابتها للصدمات من السياسة النقدية السلبية إيجابية وكبيرة. كما لوحظ في تحليلنا أن صدمات السياسة النقدية الإيجابية على الفائدة المحلية تقلل من معدل نمو الصرف والناتج على المستويين الإجمالي والقطاعي. ومع ذلك، فإن تأثيرات السياسة النقدية السلبية كانت أوسع من التأثيرات الإيجابية. وهذا يدل على أن السياسة النقدية السلبية ستكون أكثر فعالية عندما تكون الرغبة في زيادة الإنتاج. وقد كشفت نتائج تحليل التباين أنه، من بين المتغيرات المستخدمة في الدراسة، الإصدار النقدي ومعدل السياسة النقدية يوضحان الكثير من الاختلافات في الناتج الحقيقي لنيجيريا. وبناء على هذه النتائج، تخلص الدراسة إلى أن تأثيرات السياسة النقدية على الناتج الحقيقي غير متكافئة وليست متماثلة.

ABSTRAITE

Dans cette étude, les effets asymétriques de la politique monétaire sur la production réelle, tant au niveau agrégé que désagrégé au Nigeria, ont été examinés à l'aide de données provenant du Bulletin statistique de la Banque centrale du Nigeria et de l'Office des statistiques. Les données de l'étude ont été analysées à l'aide des modèles non linéaires ARDL (Autoregressive Distributed Lag) et SVAR (Structural Vector Autoregressive Model). L'étude a décomposé la masse monétaire (MS) et le taux de politique monétaire (MPR) en positif et négatif afin de capturer les politiques monétaires expansionnistes et contractionnistes. La production réelle a été représentée par Gdpgr. Les résultats de l'analyse ARDL non linéaire à long terme ont montré une co-mobilité à long terme entre les variables de politique monétaire et la production réelle, tant au niveau global que sectoriel. Les résultats obtenus à partir d'autres estimations empiriques ont montré que la réponse de la production réelle aux chocs émanant de politiques monétaires tant positives que négatives était significative avec des magnitudes différentes. Alors que la réponse du taux de croissance de la

production aux chocs de politique monétaire positive était significative mais négative, sa réponse aux chocs de politique monétaire négative était positive et significative. Nous avons également noté dans notre analyse que les chocs positifs de politique monétaire sur l'intérêt national réduisent le taux de croissance de la production et du taux de change tant au niveau global que sectoriel. Toutefois, les effets de la politique monétaire négative ont été plus larges que ceux des effets positifs. Cela montre qu'une politique monétaire négative serait plus efficace lorsque l'on souhaite augmenter la production. Les résultats de la décomposition de la variance ont révélé que, parmi les variables utilisées dans l'étude, la masse monétaire et le taux de politique monétaire expliquent une grande partie des variations de la production réelle du Nigeria. Sur la base de ces résultats, l'étude conclut donc que les effets de la politique monétaire sur la production réelle sont asymétriques et non symétriques.

Keywords: Asymmetric, Monetary Policy, Shocks Structural VAR, Nonlinear ARDL, and Sectoral Analysis.

1. Introduction

The connection between monetary policy and economic growth is a perennial and a contentious discussion both in theoretical and empirical literature across countries (Parker and Rothman, 2004; Rodduts and Rigbon, 2003; Stephen, 2016; David, Prakash and Aleksandra, 2016). The intensive, extensive and ever-increasing stream of studies on this topic is not unconnected with its relevance in designing and implementing of macroeconomic management policies across nations. Monetary policy is considered as one of the effective tools of macroeconomic policy objectives. It complements other instruments such as fiscal, income, trade and debt management policies. The basic aims of monetary policy revolve around achieving: price stability, steady economic growth, exchange rate stability, full employment and balance of payment equilibrium (James and Hamisu, 2020).

The question of whether the response of real output to monetary policy shocks is symmetric or asymmetric in the short run or long run is still an empirical debate (Central Bank of Nigeria, 2014; Apanisile, 2017; Oloyede, 2014; Alam and Waheed, 2006; Fasanya *et al.*, 2013; Ulke and Berument, 2016). This is because previous studies were unable to provide precise empirical guides on this all-important relationship in guiding policy stance. In other words, empirical results are still ambiguous on the

discussion. However, Crawford (2007) shows that the transmission channel of monetary policy on economic growth depends on sectors, in that, reactions of sectors to actions from monetary authority may not be the same. In macroeconomic theory, reactions of output to actions from monetary policy come from two sides, that is, anticipated and unanticipated as presented by the rational expectation hypothesis championed by Lucas (1972) and Sargent and Wallace (1975). According to this theory, an economy that envisages changes in price may not necessarily have its macroeconomic variables being seriously impacted on since such changes would simply translate into changes in price level. In an economy where rational expectation is absent, however, unanticipated changes in monetary policy would definitely have real effects since economic agents find it difficult to differentiate among current, relative and absolute demand (Apanisile, 2017).

The efficacy of monetary policy on macroeconomic performance has continued to generate debates among academic researchers and policy makers. This is because monetary policy has become one of the constantly employed macroeconomic policy tools across countries for the purpose of putting in place macroeconomic policy objectives due to differences in domestic and external macroeconomic environment as noted by Jiang, Liping and Sharma (2013). Based on this, attentions have now been shifted to investigating if the responses of output to monetary policy are symmetric or asymmetric at disaggregate level. This is based on the fact that sectors respond to shocks from monetary policy in different ways. Take for instance, the response of agricultural sector to shocks emanating from expansionary monetary policy may be positive and significant while that of manufacturing sector may be negative but significant. It is therefore pertinent to discover the appropriate monetary policy (expansionary or contractionary) for each of the sectors.

Knowing the sectors that may be impacted either by expansionary or tightening monetary policy gives valuable policy directions for the monetary authority to work with. Understanding the responses of each of the sectors to shocks from monetary policy is essential since it enables policy makers to know those sectors that do not have capital intensities to stand shocks from either expansionary or contractionary monetary policies.

Quite a number of studies have attempted to investigate the efficacy of monetary policy on macro-economic variables, particularly economic growth (Cover, 1992; Alam and Waheed, 2006; Anyanwu and Kalu, 2010). Besides, the empirical results from these studies produced conflicting outcomes, as majority of them used a ggregate data that was unable to show individual characteristics of each of the sectors. In Nigeria particularly, majority of the studies conducted by Apanisile (2017), James and Hamisu (2020), Ajisafe and Folorunso (2002), Olayiwola and Ogun (2019) to examine economic variables have been on aggregate level. A study conducted by the Central Bank of Nigeria (2014) investigated monetary policy and sectoral real output, which no other study has attempted. However, this particular study employed only structural VAR which may not be able to capture asymmetric effects adequately. Also, Cover (1992), DeLong and Summers (1998), Olayiwola and Ogun (2019), Morgan (1993), James and Hamisu (2020) found the relationship between monetary policy and output to be asymmetric while Apanisile (2017), Ravn and Sola (1996), Oloyede (2014) and Stephen (2016) discovered the relationship to be symmetric.

Based on the foregoing, the broad objective of this paper is to investigate whether the response of output to monetary policy is symmetric or asymmetric or is in the short run or long run. This paper contributes to the existing body of knowledge in that it is one of the few studies, probably the second in Nigeria, that has attempted to investigate the connection between monetary policy and output at disaggregate level.

The remaining part of the paper is organized thus; after section one is section two which reviews existing literature on the topic. In section three, methods and materials are discussed while results and its discussion are presented in section four. Section five concludes the paper.

2. Empirical Literature

Series of studies have attempted to investigate the connections between monetary policy and macroeconomic fundamentals in advanced, emerged market economies and developing nations. However, these efforts have only yielded diverse research outcomes. Some of these studies are presented here empirically to guide and provide directions for this current study.

The issue of whether the effects of monetary policy on macroeconomic variables are symmetric or asymmetric, in the short or long run commenced with the seminal work carried out by Cover in 1992. In Cover's view, the effects of contractionary and expansionary monetary policies on macroeconomic fundamentals are not uniform. Researchers such as Morgan (1993), Delong and Summers (1998), Regis, Christian and Tim (2017), Morten and Martin, (2004) were of the opinion that positive and negative monetary policy shocks have asymmetric effects on real output while Ravn and Sola (1996) submitted that positive and negative monetary policy shocks displayed symmetric and not asymmetric effects on real output. These two schools of thoughts have generated controversial debates and each of them has its own followers. Parker and Rothman, (2004), Ulke and Berument (2016), Hayford (2006), Cover (1992), Nampewo *et al.*, (2013) school of thought agreed that the relationship is asymmetric while Raidwan (2016), Favero and Rovelli (2003) found the relationship to be symmetric. These studies from both symmetric and asymmetric positions employed various forms of vector Autoregressive model as estimation technique while few of them used non-linear ARDL to estimate their model.

Coming down to studies conducted using Nigerian data, the empirical results from them produced conflicting research outcomes. However, most of these studies were carried out using aggregate data. For example, the studies empirically conducted by Oloyede (2014), Olayiwola and Ogun (2019), Ogunsakin and Ogunoye (2019) found the response of output to shocks emanating from monetary policy to be asymmetric using vector autoregressive models while Akanbi (2016), Apanisile (2017) and Olayiwola (2018) in their own studies found the response of output to shocks coming from monetary policy to be symmetric.

In conclusion, it is discovered that majority of the studies above, if not all, used aggregate data. Besides, while some found the relationship between them to be symmetric, some discovered the relationship to be asymmetric. Therefore, it is essential to establish the exact direction of causality between output and monetary policy in order to guide policy stance.

3. Data and Methodology

To investigate whether the response of sectoral real output in Nigeria reacts symmetrically or asymmetrically in the short or long run to positive

or negative monetary policy shocks, data was gathered from the Central Bank of Nigeria and Bureau of Statistics. Both policy and non-policy variables were incorporated in the analysis. The policy variables employed in the study are money supply (ms) real effective exchange rate REER, interbank rate (IBR) domestic interest rate and monetary policy rate while non-policy variables are output growth rate Gdp_{gr} and consumer price index (CPI). To achieve the objective of this paper, both structural vector Autoregressive model and Autoregressive Distributive lag are employed.

$$y_t = \alpha_0 y_t + \alpha_1 y_t + \ldots + \alpha_k y_{t-k} + e_t \qquad \text{eq. 3.1}$$

Where $[y_t = CPI_t, MPR_t, MS_t, DIR, IBR_t, DITR, EXR_t, GDP_t]^1$ is a vector containing output growth, consumer price index, monetary policy rate, money supply, domestic interest rate, interbank rate and real effective exchange rate. All variables except the domestic interest rate are in logarithms. e_t represents wise nose with a zero mean and a diagonal variance, covariance matrix $A = (e_t\, e_t)$, where the diagonal entries are the variance of structural shocks.
The corresponding reduced – foam VAR can be estimated by

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + . + \phi_k y_{t-k} + \varepsilon_1 \qquad \text{eq 3.2}$$

$$y_t = (1-\alpha_0)^{-1}\alpha_1 y_1 + (1-\alpha_0)^{-1} a_2 y_{t-2} + \ldots + (1-\alpha_0)^{-1}\alpha_k y_{t-k} + (1-\alpha_0)^{-1} e_t$$

eq 3.3

Where ε_t denotes the regression residuals

The structural shocks and the reduced form related by $(1-\alpha_0)^{-1} e_t$ and the relationship between the coefficients in equations (3.1) to (3.3) is

$$\phi_t = (1-\alpha_0)^{-1}\alpha_j \forall_j = 1,2\ldots k .$$

$$+ \sum_{t=1}^{W} P_{it}\Delta Y_{t-1} + \sum_{t=0}^{r} Y_1 = \Delta CPT_{t-1} + \sum_{t=0}^{s} Y_2 MPR_{t-1} + \sum_{t=0}^{t} \lambda \qquad \text{eq. 3.4}$$

$$\Delta R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 CPI_{t-1} + \alpha_3 MPR_{t-1} + \alpha_4 MS_{t-1} + \alpha_5 IBR_{t-1} + \alpha_6 REEX + DIR_{t-1}$$

eq. 3.5

3.1 Asymmetric Effects of Monetary Policy Shocks

When the structural shocks to domestic interest rate are determined, e_t^R, then contractionary monetary policy shock is now presented thus $e_t^{R+} = \max[0, e_t^R]$ and the expansionary monetary policy shock, as $e_t^{R-} = \min[0, e_t^R]$. The reason being that, positive (negative) value of e_t^R shows contractionary or tightness (expansionary) monetary policy. The equation 3.4 and 3.5 show nonlinear autoregressive distributed lag (AKDL) which is introduced into the analysis to determine if the response of real sectoral output to monetary policy is symmetric or asymmetric in Nigeria between $2000q_1$ to $2018q_4$.

4. Results

Table 1: Descriptive Statistics of Variables

Variables	**GdPar**	**MS**	**Exr**	**IRI**	**IBR**	**CPI**	**MPR**
Mean	164.652	162.341	83.1432	81.6111	73.123	63.421	43.231
Median	132.41	131.63	69.241	242.113	34.221	131.231	16.432
Maximum	963.432	88.231	88.634	84.113	232.132	361.452	247.44
Minimum	71.231	45.22	34.44	27.23	20.44	21.221	18.21
Std. Dev	96.23	25.231	31.2311	20.45	21.331	17.422	40.211
Skewness	5.21421	-0.4321	0.3211	1.231	0.621	1.367	0.432
Kurtosis	18.432	1.6212	7.3412	8.3311	9.234	6.234	2.456
Jargon-Bera	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Probability	56245.22	34.562	25.6221	422.41	534.622	456.422	342.311
Sumsq Dev	3924562	324562	24562	243241	224231	2145021	204256

Author's Computation

In any econometric analysis that involves ARDL co-integration method, it is essentially required to conduct unit root test to ascertain that none of the variables is of integrated order 1(2). In this regard, three stationarity tests were employed, that is, Augmented Dicky Fuller (ADF), Phillips – Perron (PP) and KIM, Pesaran and Shin (1PS).

In Table 1, the behaviour of the variables of interest is presented through descriptive statistics of the variables used in the study. It is noted in the table that, the median and mean of output growth and money stock are very close. The implication of this result is that their distributions are almost symmetrical. This shows that variability existence is low. Skewness statistics result indicates that all the variables employed in the model were positively skewed. It was equally noted that JargutBera probability values for all the variables employed are below the 0.05 critical levels. This is an indication of rejection of the null hypothesis of normal distribution for the entire variables at 5 percent level of significance. The cross-sectional and heterogeneous nature of the data used in the study might be the reason for the absence of normal distribution.

Table 2: Results of Stationarity Test

Variables	Adfier without trend	With trend	Pptes without trend	With trend	Kpsster without trend	With trend
GDpgr	-11.002***	12.005***	-26.161***	-25.123***	0.052***	0.041***
Exr	-4.121***	-4.322***	-3.531***	-3.422***	0.410***	0.406***
IRT	-1.641	-1.734***	-2.045***	-2.041***	1.321***	1.231***
IBR	-7.231***	-7.942***	-9.523***	-9.432***	-0.502***	0.501
MS	-5.721***	-6.341***	-9.535***	-9.341***	-1.672***	-1.661
C.P.I	-6.214***	-6.411***	-7.421***	-7.411***	1.456***	1.431
M.P.I	-5.412***	-5.621***	-8.231***	-8.221***	1.621***	1.610

Author's Computation

Note: In all stationarity test used, the null hypotheses of no unit root is rejected because all the stationarity tests employed (ADF, PP and KPSS) have unit root at various levels while ADF and PP have it at 1(1), KPSS has it at 1(0). Also*** connotes the significance level both at 1% and 10%

Results obtained from Augmented Dicky-Fuller (ADF), Phillips – Perron (PP) and Kwiatkowaski – Phillips – Schmidt – Shin (KPSS) stationarity tests for each of the series were shown that at level, variables are integrated of difference orders. Therefore, we can conveniently reject the null hypothesis of no unit root. That is, all variables of interest contained unit root. Following Kilian and Park (2007), the null stationarity of all the variables are at all levels and any attempt to go into first difference may

lead to losing of asymptotic efficiency as revealed in wider error bands in the estimation. Therefore, taking the first difference of these variables may lead to a removal of the slow moving components in the series. As noted by Kilian and Park (2007), incorrect differencing can make the estimates to be unstable going by the nature of unit root.

Table 3: VAR Lag order selection

Lag	Log L	LR	FPE	AIC	SC	HQ
0	843.6224	NA	1.79e.06	-7.6621	-7.6214	-7.6843
1	848.7262	24.0321	1.67e.06	-7.63214	-7.6132	-7.6334
2	857.33241	16.3321	1.66e.06	-7.68621	-7.6414	-7.6523
3	859.21131	1.2304	1.63e.06	-7.6714	-7.6234	-7.68314
4	862.4321	12.4321	1.64e.06	-7.6342	-7.6133	-7.7332
5	865.2211	2.5321	1.66e.06	-7.6621	-7.6345	-7.6814
6	871.2413	12.5325	1.65c.06	-7.6324	-7.6214	-7.64143
7	872.2162	7.3456	1.66e.06	-7.6932	-7.6632	-7.6842
8	872.3841	0.32112	1.68e.06	-7.6312	-7.0621	-7.1634

- Shows lag order selected by the Criterion

Author's Computation

In Table 3 above, the results obtained from lag criteria selection for nonlinear ARDL model is presented. In selecting both dependent and independent variables, different lags can be employed. However, it is required to select a suitable lag before estimating nonlinear ARDL model. In this regard, the most employed selection methods are AIC and SBC in time series data.

In this study, we therefore, employed AIC approach for our lag selection to estimate nonlinear ARDL. Based on the results from AIC results on Table 3, lag 2 is the most suitable lag to estimate nonlinear ARDL model.

Table 4: Critical Bound Value

Significance	Critical Value Bounds 1(0)	1(1)
10%	3.19	4.16
5%	3.82	4.92
2.5%	4.51	5.68
1%	5.18	6.42

Author's Computation

Since results obtained from unit root tests showed that none of the variable is 1(2). Therefore, we can proceed to estimate bounds test. This is

however reported in Table 4 following the steps suggested by Pesaran, Shin, and Smith (2001). With reference to Table 4, the computed value of F – statistics showed 33.423 which exceeded the upper bound critical value of the bounds testing which stood at 4.02 at 5 percent level of significance. With this finding, we can therefore, reject null hypothesis of no co-integration. This implies that there is long-run co-movement among variables used in the analysis.

Table 5: Asymmetric ARDL bounds test

	Yearly			**Monthly**
Test statistic	Value	K	Test statistics	Value K
F – statistics	15.3212	2	F – statistics	75.32142

Table 5 shows the results from asymmetric ARDL bound test for the long run co-movement, Bound testing approach is used. Table 5 shows that at 5%, the I(0) value was 3.82 and the I(1) was 4.92, respectively. The calculated F statistics value was 15.3212 and 75.3214 both for yearly and monthly respectively which was greater than I(0) compared to I(1) value. This shows the existence of asymmetric co-integration.

Table 6: Nonlinear panel ARDL long-run estimates

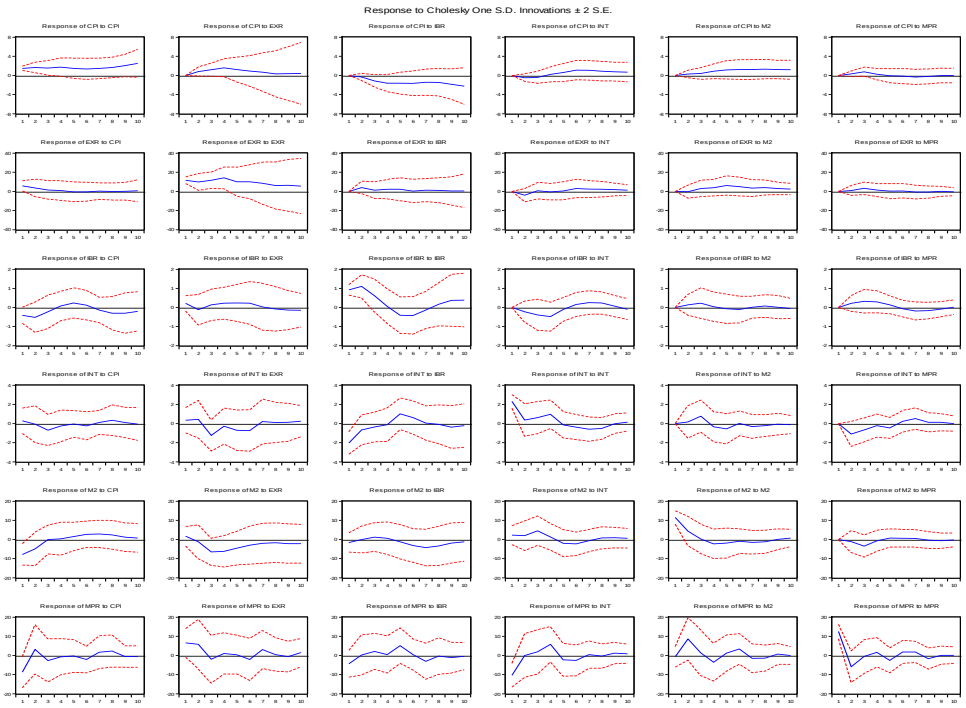
Variables	**Coefficients**	**Std. error**	**t-statistics**	**P-value**
CPI	1.432213	0.1324567	10.245621	0.01421
EX	1.3624314	0.0674562	-4.231462	0.054232
MPR	-0.3245721	0.0745622	7.456231	0.062411
IBR	0.4367142	0.143221	6.364210	0.04322
FIR	1.62456	0.045231	-7.53343	0.024562
MS+	0.0345622	0.138412	6.4562114	0.010321
MS-	07456722	0.07241	-4.512338	0.45621
MPR^{+}	1.624521	0.462331	12.23456	0.02145
MPR-	-0.345214	0.145621	-4.45621	0.063456

Author's Computation

Table 6 shows the impact of both negative and positive monetary policies on output growth. In this regard, money supply (MS) and monetary policy rate (MPS) are used to capture negative, positive, expansionary and contractionary monetary policies. In summary, expansionary monetary policy has negative but significant influence on aggregate real output while contractionary monetary policy has positive and significant impact on aggregate real output.

4.1 Impulse Response

Figure 1



Panel Structural VAR showing connections between Monetary Policy and Real Output at Aggregated Level

The results obtained from Impulse response function and variance decomposition are presented.

4.1.1 Impulse Response Function

The results from Figure 1 shows that the response of real output to an increase in inter-bank rate was positive but significant right from first the quarter till the last period. This corroborates a macroeconomic theory which says that contractionary monetary policy has an influence on output in the short run, though neutral in the long run (Blanchard, 2009). The figure also revealed that an interbank rate accompanied by an unanticipated increase in interest rate brings about a decline in interbank lending. A monetary supply shock corresponding to sudden increase in

inter-bank rate leads to a raise in real interest rate and this however reduces real output growth. This is because output accelerates when cost of borrowing (interest rate) and consumer price index reduces.

Both consumer price index and exchange rate devaluation bring about significant reactions from real output. A contractionary monetary policy with an unanticipated increase in the bank rate causes a significant rise in money supply. Output and consumer prices respond positively and significantly to an unexpected increase in money supply. An unanticipated increase in money supply increases output. Consumer price index responds significantly and positively to the expansionary monetary policy which makes output to increase. Contractionary monetary policy is harmful to an increase in the value of domestic currency. Contractionary monetary policy causes exchange rate to appreciate. This is compatible with a macroeconomic theory, which says "an interest rate is assumed to increase the portfolio induced inflows; for domestic interest rate and, brings about increase in the value of domestic currency". Also from Figure 1, the contemporaneous effects of negative and positive shocks on interest rate are identical. However, the contemporaneous effects of interest rates on other macroeconomic variables are not asymmetric, while the responses for interest rate are asymmetric. Therefore, we conclude that there are some evidences of asymmetric effects in monetary policy.

Table 7: Variance Decomposition Analysis

Horizon	**MPR**	**CPI**	**MS**	**EX**	**RDGP**	**IBR**	**DIR**
0	1.000	0.014	0.041	0.013	0.001	0.001	0.0132
1	0.962	0.246	0.0172	0.0220	0.046	0.036	0.0461
2	0.8440	0.730	0.046	0.0241	0.042	0.0611	0.0362
3	0.706	0.262	0.145	0.033	0.0622	0.0462	0.0562
4	0.624	0.674	0.145	0.341	0.043	0.0532	0.0315
5	0.741	0.432	0.149	0.021	0.041	0.062	0.0466
6	0.824	0.523	0.146	0.031	0.052	0.072	0.048
7	0.952	0.728	0.146	0.045	0.042	0.023	0.0181
8	0.423	0.645	0.146	0.062	0.045	0.046	0.031
9	0.524	0.443	0.621	0.041	0.041	0.062	0.058
0.434	0.623	0.623	0.146	0.033	0.039	0.031	0.045

4.2 Variance Decomposition (VDC)

The results in Table 7 show that output growth rate, exchange rate and real interest rate contributed about 32%, 39% and 37% respectively. However, money supply contributed the highest, which was about 48%, to variation in monetary policy rate. The implication of this is that the channels through which monetary policy impacts Nigerian economy are: money supply, real interest rate, domestic interest rate, consumer price index, exchange rate and output growth rate.

4.3 Asymmetric Effect of Monetary Policy on Individual Sectors selected

This sub-section is necessarily carried out in order to overcome the inherent problem of panel analysis that always fails to show the individual characteristics of selected components. Also, it helps to know whether results from panel VAR is compatible with sector-by-sector analysis. The sectors examined are: agricultural, manufacturing, finance and insurance, solid mineral and wholesale and retail trading.

i. Agriculture

From Figure 2, the reaction of agricultural real output to the shocks from monetary policy rate was negative but significant from the first period to the eighth period. However, the responses became insignificant at the ninth period and died off at the tenth period. Meanwhile, the effects were positive for these two periods. The economic interpretation of these results is that agricultural sector in Nigeria has been neglected just because of discovery of crude oil in commercial quantity in the 1950s. Also, agriculture is at subsistence level in Nigeria; mainly practiced through small scale farming. In this analysis, it was discovered that the major determinants of agricultural sector of Nigerian economy are real interest rate and consumer price index as they accounted for 45 and 53 percents respectively in the forecast horizon. The finding of this study negates the findings of the Central Bank of Nigeria 2014, which showed that money supply was the major determinant of agricultural output in Nigeria and supports the findings of Saibu and Nwosa (2011), which reveals that among the macro-economic variables, interest rate is the most important determinants of effectiveness of agricultural sector in contributing to Nigerian economy. Results for variance error

decomposition show that the variables that contribute significantly to variation in the output of the sector are interest rate and money supply.

AGRICULTURE	CPI	MPR	GDPgr	INT	EXR	IBR	DIR
1	82.40743	0.496455	6.487873	0.422618	10.18563	0.64321	4.6511
2	78.82882	0.291757	7.176995	1.444277	12.25815	6.64943	0.3562
3	74.23649	0.215822	8.787415	2.243714	14.51656	1.27991	0.5221
4	69.54787	0.220748	10.89942	2.812233	16.51973	2.47505	4.1864

ii. Manufacturing

From Figure 2, a standard deviation shock from monetary policy rate exerts positive but insignificant influence on the manufacturing sector of Nigerian economy from the first period up to the third period when the positive impact was still maintained but became significant at the eighth quarter when it turned to negative but significant. This shows that, during the period of positive and significant impact, expansionary monetary policy was employed by monetary authority but negative and insignificant period reflect tightening monetary policy regime. This shows that when conditions for loan are relaxed, that is, not too tight, output from manufacturing sector increases but when the conditions for loan are too strict, production suffers. This finding is in line with the finding from a study carried out in Uganda by Nampewo *et al.*, (2013), which showed that manufacturing sector responded positively and significantly to a shock emanating from monetary policy rate. From the variance decomposition results, exchange rate, money supply and interbank rate contributed the highest to output variation in this sector.

MANUFACTURING	CPI	MPR	GDPgr	INT		EXR	IBR	DIR
1	0.044139	99.58533	0.098472	0.107772		0.164284	2.44542	0.015183
2	0.043192	98.74781	0.461037	0.582040		0.165925	2.96192	0.516621
3	0.246861	97.46062	0.853124	1.318108		0.121285	0.97488	0.782351
4	0.618093	95.95384	1.055597	2.280144		0.092321	2.41048	5.211812

iii. Finance and Insurance

From Figure 2, the response of finance and insurance sector to shock emanating from monetary policy was negative and insignificant right from the first period till the eighth quarter, when it started to oscillate. The economic interpretation of this result is that expansionary monetary policy is not a good policy for finance and insurance sector of Nigerian economy. The variance decomposition results showed that money supply, interest rate and interbank rate are major determinants of finance and insurance sector in Nigeria.

FINANCE AND INSURANCE	CPI	MPR	GDPgr	INT	EXR	IBR	DIR
1	0.185544	0.37672	1.438307	96.06166	1.937774	0.63084	1.67244
2	1.130875	0.339291	6.906096	80.21204	11.41170	1.13531	4.81125
3	2.005485	0.231217	8.158119	75.81009	13.79509	1.13173	0.18752
4	2.644168	0.210943	10.17983	71.08447	15.88059	5.18600	1.622173

iv. Solid Mineral

From Figure 2, the response of this sector to a standard deviation shock from monetary policy was initially positive, and diverged toward

equilibrium in 6th and 5th periods after which it started to decrease. The reason for this result might be that this sector is yet to be well developed in Nigeria. The sector is suffering from underutilization. Only money supply and interest rate significantly contributed to the variation in the output of this sector. The variance decomposition results show that exchange rate, consumer price index and interbank rate are the major determinants of this sector

SOLID MINERAL	CPI	MPR	GDPgr	INT	EXR	IBR	DIR
1	0.095756	0.455129	0.985938	7.846765	90.61641	3.12459	4.56711
2	0.259294	0.238685	7.029772	5.625792	86.84646	0.84797	1.84755
3	2.009295	0.221326	8.110871	6.995162	82.66335	0.68761	0.56711
4	5.494036	0.297422	8.990503	7.127494	78.09054	2.59174	0.295531

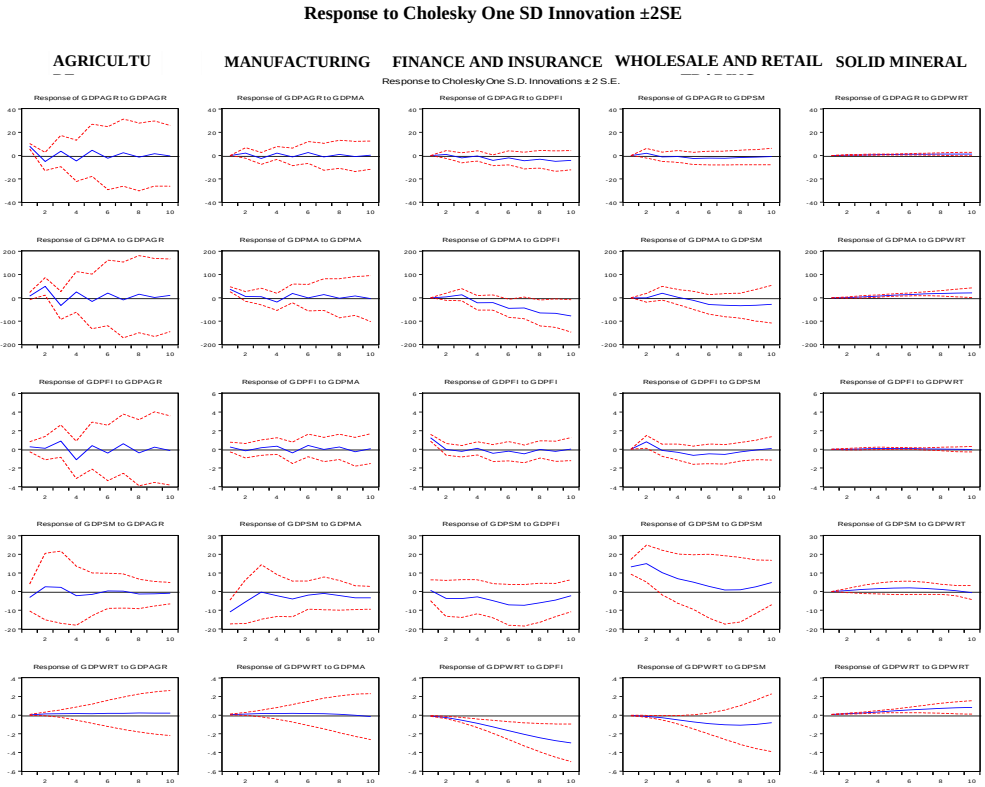
v. Wholesale and Retail Trading

From Figure 2, the response of this sector to the shock coming from monetary policy rate was negative and insignificant from the first quarter till the fourth quarter. Thereafter, the response became positive and still insignificant till the eighth quarter. After this, the response became positive till the tenth quarter. This result is not surprising because the management and implementation of monetary policies have been somehow erratic in Nigeria. Results from variance error decomposition show that the variation in the output of this sector is mainly responsible for interest rate, consumer price index and interbank rate.

WHOLE SALE AND RETAIL TRADING	CPI	MPR	GDPgr	INT	EXR	IBR	DIR
1	82.42534	0.455185	0.067459	7.247844	9.804169	2.93245	2.15562
2	78.82593	0.216719	0.147643	7.380935	13.35264	9.652382	2.89227
3	74.16673	0.216719	0.171382	9.149767	16.29540	7.866557	0.45226
4	69.45512	0.208791	0.165320	11.33261	18.83816	10.31682	3.06522

Impulse Response

Figure 2



6. Summary and Conclusion

In this study, structural vector Autoregressive model and Autoregressive Distributive lag were employed to investigate the response of sectoral real output both at aggregate and sectoral levels to asymmetric monetary policy in Nigeria's between $2000Q_1$ to $2018Q_4$ using data gathered from the Central Bank of Nigeria statistical Bulletin and Bureau of Statistics. ARDL results revealed long-run co-movement between real output at aggregate and disaggregate monetary policy variables. VAR Impulse response function indicated that the responses of real output across sectors to both expansionary and contractionary monetary policies were not the same. For instance, Agricultural and manufacturing sectors responded negatively and significantly to contractionary monetary policy while their

responses to expationary monetary policy were positive and significant. The responses of real output from services, building and construction, wholesale and retain were positive but insignificant to contractionary monetary policy. However, real output across selected sectors responded positively and significantly to shocks from expansionary monetary policy. Considering the magnitudes and coefficients of the variables in their contemporaneous, money stock and monetary policy rate had positive and significant relationship with sectoral real output across sectors while other variables, inter-bank rate, consumer price index, and exchange rate have mixed effects across sectors. Results obtained from variance decomposition showed that percentage contributions of money supply and monetary policy as well as inter-bank rate were the highest to shocks coming from both expansionary and contractionary monetary policies in Nigeria during the study period.

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