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Asymmetric Impact of Monetary Policy Shocks on Output and Price Levels in Nigeria

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Abstract

In economic discourse, there are arguments on the effects of monetary policy shocks on output and price level. To some the effect is asymmetric while to others it is symmetric. Thus, this study added to the existing debate by investigating the asymmetric impact of monetary policy shocks on output and price level in Nigeria using annual data spanning from 1981 to 2018. The study employed the non-linear autoregressive distributed lag (NARDL) model and the Wald test. The hypotheses tested in this study were done at 5 and 10 percent levels of significance. The results obtained suggested strong evidence of monetary policy asymmetry in Nigeria with negative (expansionary) shock having more impact than positive (contractionary) shock in the long run. Based on these findings, the study recommended that a proper monetary policy mix is required to simultaneously achieve economic growth and price stability.

Keywords: *Monetary Shocks, Asymmetric, Symmetric, Output, Price Level*
JEL Classification: *C01, C12, C30, E52*

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INTRODUCTION

The broad objective of monetary policy is to maintain internal and external balances simultaneously within a given period. In recent time, the conduct of monetary policy by the Central Bank of Nigeria (CBN) have been shaped by two major macroeconomic considerations which include; slow output recovery and high but moderate inflation rate which remained above the target range. Conceptually, monetary policy connotes the conscious management of money supply and interest rate to achieve predetermined macroeconomic objectives such as increased productivity, high employment, and controlling the prices of goods and services among others. This is done by manipulating the instrumentality of interest rate, regulating foreign exchange rates, buying, and selling government securities and changing the amount of deposit money banks are required to keep as reserves.

In economic literature, discussions on monetary policy often centre on making a distinction between expansionary monetary policy and contractionary monetary policy. Expansionary policy leads to an increase in the volume of money in circulation at a particular point in time, while contractionary policy results in a decrease in the volume of money in

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circulation. To support this assertion theoretically, Keynesian economists are of the view that an expansionary monetary policy, that is, a decrease in short-term lending interest rate can affect long term rates, leading to increased investment and finally output (Pragidis, Gogas & Tabak, 2013).

When monetary authority embarks on an expansionary monetary policy, it does so to stimulate domestic output and reduce unemployment, while contractionary policy as to do with raising interest rates to fight high inflation (Essien et al. 2016). This is the case of symmetry relationship between monetary policy and macroeconomic variables. However, evidence abounds in the literature that macroeconomic variables respond asymmetrically to movement in money supply (monetary policy variable) with contractionary (positive shocks) monetary policy having a larger absolute impact than expansionary (negative shocks) monetary policy (Rhee & Rich, 1995). The idea that monetary policy has asymmetric effects on output and inflation is not new. The idea was vigorously discussed by the traditional Keynesian economists during the great depression (in the 1930s) under the assumption of sticky nominal wages wherein liquidity trap is seen as a mechanism that could render monetary policy ineffective for increasing aggregate demand. Asymmetric impact of monetary policy action has serious implications for the conduct of the policy and estimating the costs of its shocks (positive and negative shocks) on demand and supply of goods and services (Mamdouh, 2018).

In literature, some of the likely reasons for monetary policy asymmetries as highlighted by Ravn and Sola (2004) are the phase of business cycle an economy is in; the type of monetary policy (expansionary or contractionary); the relative size of the effect of the policy on the real economy; and whether monetary shocks are anticipated or not. Often time, researchers isolate empirically the effect of monetary policy on real variables like output growth and inflation rate on the assumption that such effects are symmetric. There is a paucity of literature on the asymmetric (symmetric) effects of monetary policy on output and inflation in and outside Nigeria. The findings in these studies have shown mixed conclusions as some argued that the relationship is symmetric (Edilean & Marcelo, 2009; Apanisile, 2017; Akanbi & Dada, 2018) while others found it to be asymmetric (Ravn & Sola, 2004; Tan et al., 2010; Pragidis, Gogas & Tabak, 2013; Zakir & Malik, 2013; Ulke & Berument, 2015; Jacob, 2018; Saibu & Oladeji, 2007; Olayiwola & Ogun, 2019). Thus, this study contributed to the existing debate by investigating the asymmetric impact of monetary policy shocks on output and price level in Nigeria using annual data spanning from 1981 to 2018.

This study is divided into six sections. Section one is the introduction; section two is the theoretical review; section three is the empirical review; section four is the methodology; section five is analysis and result, and section six is conclusion and recommendation.

THEORETICAL REVIEW

There are couple of theoretical models that attempt to explain the asymmetric relationship between monetary policy and aggregate output growth. Zakir and Malik (2013) listed these theories as a standard Keynesian model with convex aggregate supply curve; credit constraint model; the liquidity trap theory and menu cost model.

Standard Keynesian Model

According to Ravn and Sola (2004), the traditional Keynesian asymmetry emphasized that positive monetary policy shocks have smaller real effects than negative monetary policy shocks. In other words, it implies that only negative monetary policy shocks (expansionary monetary policy) have real effects on output growth. This asymmetry was derived from the Keynesian economists under the assumption of either upward or downward flexible (Sticky) nominal wages or sticky prices together with the rationing of demand (Ravn & Sola, 2004). In this model, the variable for asymmetric effects is related to different real effects of positive and negative changes in nominal demand. Cover (1992) considers a model with upward (downward) flexible or sticky nominal wages and that labour market clears at the initial nominal wage that corresponds to the expected price levels which are consistent with the current level nominal demand, the supply curve in the long-run will be vertical. This denotes that the aggregate supply curve will be vertical at certain expected price levels but positively sloped for prices below the expected price level. Thus, an unanticipated increase in nominal demand will be linked with lower output and employment rate.

Credit Rationing/Constraint Model

Credit constraint models theorized that tight monetary policy makes financial institutions reluctant to give out loans and they will set a higher cost of funds by raising the lending interest rate. Thus, the impact of tight monetary policy becomes more effective for growing an economy that has a strong demand for credit (Morgan, 1993 as cited in Ulke & Berument, 2015). Thus, constraining the budget of specific borrowers would increase the effects of tight monetary policy, while loose monetary policy will not create such effect or even increase it. Jacob (2018) opined that this behaviour by financial institutions is not necessarily caused by changes in the monetary policy rate but can also be due to changes in credit demands by politicians or autonomous credit changes by the central bank itself. These effects, however, tend to coincide with changes in the monetary policy rate. Hence, financial market imperfections may account for monetary policy asymmetry.

The Liquidity Trap Theory

Monetary policy asymmetry can also occur in an economy due to the liquidity trap experienced during the recession. Hicks (1937) as cited in Jacob (2018) sees liquidity trap as a situation in which the real interest rate is too low that no one is motivated to hold debt and a further decrease in it would not spur anyone to do so. Liquidity trap may be occasioned by uncertainty of expectations or due to very low inflation rate. Thus, the liquidity trap as imbedded in the Keynesian IS-LM framework emphasized the possibility of asymmetric effects as monetary policy is potentially ineffective in stimulating the economy during economic recession. If monetary policy were to become completely ineffective during economic crisis, this might also present itself as a structural break in the model, as the variables would possibly behave differently (Jacob, 2018). Liquidity trap theory gives an explanation to the ineffectiveness of monetary policy in stimulating economic recovery during recession.

Menu Cost Model

The menu cost model was first discussed by Ball and Romer in 1990 and Ball and Mankiw in 1994. In a static or deterministic state, menu cost model implies that big monetary policy shocks are neutral because firms would find it optimal to adjust nominal prices. On the other hand, small monetary policy shocks would have real effects because retaining nominal prices fixed is associated with only second-order cost (Ravn & Sola, 2004). In specific words, firms decide in advance before the monetary policy shocks is observed whether to index their prices at the cost of paying the menu cost or not. Firms are obliged to choose indexation that connotes neutrality only if the variance of monetary policy shocks is high.

EMPIRICAL REVIEW

Monetary Policy Asymmetry

There are few studies that attempt to investigate the asymmetric effects of monetary policy on economic growth and inflation in and outside Nigeria. Some of these studies are reviewed here. In the United States, Ravn and Sola (2004) investigated the asymmetric effects of monetary policy using two post-war quarterly data spanning from 1947 to 1987 and 1960 to 1995. The study employed the regime-switching model to know whether negative and positive monetary policy shocks have different effects on output, whether big or small shocks have different effects and whether low-variance, negative shocks have asymmetric effects on output. The result obtained indicated that when using M1, the evidence is slightly mixed. This implies that they could not conclude that negative monetary policy shocks have the same effects as a monetary policy shocks on output. However, when the federal funds rate was used as monetary policy measure, the study found very strong evidence of small negative shocks having real effects on output.

In Brazil, Edilean and Marcelo (2009) investigated the asymmetric effects of monetary policy on output. The study employed Markov-switching models and two periods' monthly data spanning from 1995:M1 to 1998:M12 and 1999:M1 to 2006:M8. The result showed that the real effects of negative monetary shocks on output are larger than those of positive shocks in an expansion. Similarly, the study found that the real effects of positive and negative monetary policy shocks are the same during economic recession. The study concluded that it is not possible to assert that the effects of a positive (or negative) shock are dependent upon the phase of the business cycle a country is in.

Tan et al., (2010) used the Markov-switching model to examine asymmetric effects of monetary policy in ASEAN-4 (Indonesia, Malaysia, the Philippines and Thailand) economies. The study employed quarterly data on real gross domestic product (GDP), broad money supply (M2), consumer price index and short-term nominal interest rate spanning from either 1978 (for Indonesia, the Philippines and Thailand) or 1974 (for Malaysia) to 2003. The results obtained revealed evidence that a contractionary monetary policy has large absolute impact than an expansionary policy. Similarly, the effects of an expansionary policy are mitigated when inflation rate is increased except in the Malaysian economy. The study concluded that monetary authorities must consider not only the behavior of the inflation process but also the fact that not all economies can react in a similar way to expansionary and contractionary monetary policy shocks.

Pragidis, et al. (2013) empirically tested the effects of anticipated and unanticipated monetary policy shocks on the growth rate of real industrial production in the United States and Brazil. The study employed a Logistic Smooth Transition Autoregressive (LSTAR) forward looking linear and non-linear model and in-sample forecast error in order to identify the unexpected monetary policy shocks for both countries. The study used monthly data for two periods 1981:M1 to 2011:M4 for the United States and 2001:M10 to 2012:M12 for Brazil. The study found asymmetries between anticipated and unanticipated monetary policy shocks as well as between the effects of positive and negative shocks.

Similarly in Pakistan, Zakir and Malik (2013) investigated whether the effects of monetary policy on output are asymmetric or symmetric using quarterly data spanning from 1977:Q2 to 2011:Q1. The study employed a specification consistent with the standard VAR assumption in which policy has no contemporaneous effect on output. The study found evidence of asymmetry in the effects of monetary policy actions on output. The result indicated that monetary policy actions seem ineffective in periods of high growth while having strong effects on output during low growth periods. The result also showed that negative money supply changes affect output while positive changes do not. The study concluded that output strongly respond to small negative policy shocks.

Ulke and Berument (2015) investigated the asymmetric effects of monetary policy shocks on macroeconomic variables (exchange rate, output and inflation) in Turkey using monthly data spanning from 1990:M1 to 2014:M7. The study employed the innovative non-linear vector autoregressive model that allows for different instances (tight or loose) and different sizes (small or large shocks). The empirical result revealed that tight monetary policy shocks captured by positive shock to interest rate, decrease exchange rate, output and prices as suggested by economic theory. On the other hand, loose monetary policy captured by negative shocks to interest rate, increases exchange rate, output and prices. However, the effect of loose monetary policy shock is weaker than tight monetary policy shock because the former is less effective than the latter. The study concluded that as the magnitude of a shock increases, the difference between the effects of tight and loose monetary policy increases.

Using panel regression, Jacob (2018) analyze the asymmetric effects of monetary policy on output and unemployment in Sweden, Norway, the United Kingdom, the Czech Republic, Canada, and the United State of America. The study used data spanning from 1996:Q1 to 2017:Q4. The result showed that monetary policy is more effective when the output gap is positive and that monetary policy conducted when it is positive is contractionary. The study concluded that contractionary monetary policy seems more effective than expansionary policy.

In Egypt, Mamdouh (2018) examined the asymmetric effects of unanticipated monetary policy shocks on inflation and real production using monthly data spanning from 2002:M1 to 2016:M8. The study used the non-linear autoregressive distributed lag (Non-linear ARDL) model and Wald test. The results obtained provided enough evidence of the asymmetric effect of monetary policy in Egypt. In specifics words, only small shocks have considerable effects on both inflation and real production in terms of the size of the policy. With reference to the direction of the policy, only positive shocks have considerable effects on both variables. The study concluded that monetary policy in Egypt can only be effective in certain instances and hence fiscal policy might be effective in these cases.

In Nigeria, Saibu and Oladeji (2007) investigated the asymmetric effects of monetary and fiscal policies on real output growth in Nigeria using annual data from 1960 to 2004. The study employed a modified GARCH model to assess the effects of policy shocks on real aggregate and sectoral output measures. The result showed that the level of aggregation has implications on the asymmetric effects of fiscal policy and monetary policy shocks in Nigeria. The study also found that monetary policy shocks have negative and insignificant effects on output measures but the fiscal policy had asymmetric positive effects on it. The study concluded that the effects of fiscal and monetary policies were not symmetrical on real output growth in Nigeria, loose monetary and fiscal policies were found to reduce output growth while tight policies boosted output growth.

Apanisile (2017) investigated the asymmetric effects of monetary policy shocks on output. The study used data on monetary policy proxied by broad money supply (M2) and output proxied by gross domestic product (GDP) from 1986 to 2015. The study employed a two-stage non-linear error correction model within the framework of the non-linear autoregressive distributed lag (Non-linear ARDL) and Wald test to validate the long-run relationship and asymmetric effects. The results revealed that both positive and negative components of the money supply (M2) has a positive long-run effect on output in Nigeria. However, the positive asymmetry was statistically significant at the 5 percent level while the negative asymmetry was not. The Wald test, on the other hand, showed that long-run relationship between money supply and output is symmetry because their coefficients are the same.

Akanbi and Dada (2018) examined the dynamic effects of positive and negative monetary policy shocks on industrial output in Nigeria using quarterly data from 1986:Q1 to 2015:Q4. The study employed the autoregressive distributed lag (ARDL) model. The result revealed that both negative and positive monetary policy shocks have a negative effect on industrial output in Nigeria in the short and long runs. The study concluded that monetary policy should be used with caution. Olayiwola and Ogun (2019) investigated the asymmetric effect of monetary policy shocks on output and prices in Nigeria. The study used quarterly data from 1986:Q1 to 2016:Q4 and employed the Non-linear Autoregressive Distributed Lag (NARDL) model as its estimation technique. The variables included in the model are output (GDP); interest rate; money supply; inflation rate; investment and real effective exchange rate. The result obtained revealed that negative shocks have more significant effects on output than positive shocks but the effects of positive and negative monetary policy shocks do not have significant effects on price level in the short-run. In the long-run, positive shocks have more significant effects on both output and inflation than negative shocks. The study concluded that monetary policy in Nigeria has asymmetric effects on output and prices in both the short and long runs.

Summary of Empirical Review and Research Gap

There are few studies on the asymmetric effects of monetary policy on output and price level. In Nigeria, this relationship is yet to be exploited and therefore there is dearth's of literature on the subject matter. Few of these studies are summarized below:

Table 1: Summary of Empirical Review

Author(s)/Year of Study	Title and Scope	Variables	Method	Major Findings	Weakness
Saibu and Oladeji (2007)	Asymmetric Policy Shocks and Real Output Fluctuations in Nigeria (1960-2004)	Monetary Measure, Fiscal Measures, real output and Openness,	Modified GARCH model	Asymmetry effects	This study stopped in 2004
Apanisile (2017)	Asymmetry Effects of Monetary Policy Shocks on Output in Nigeria (1986-2015)	monetary policy proxied by broad money supply (M2) and output proxied by gross domestic product (GDP)	Non-linear autoregressive distributed lag (Non-linear ARDL) and Wald test	Symmetry effects	This study only looked at the effects of monetary policy shocks on output without recourse to the inflation
Akanbi and Dada (2018)	Monetary Policy Shocks and Industrial Output in Nigeria: A Dynamic Effect (1986:Q1-2015: Q2)	Industrial Output, broad money supply (M2), Interest rate, and Inflation rate.	Autoregressive Distributed Lag (ARDL) model	Symmetry effects	This study looked at industrial output rather than general GDP.
Olayiwola and Ogun (2019)	Asymmetric Effect of Monetary Policy Shocks on Output and Prices in Nigeria (1986:Q1-2016: Q4)	Real GDP, interest rate, money supply, inflation rate, investment, and real effective exchange rate	Non-linear autoregressive distributed lag (Non-linear ARDL)	Asymmetric effects	This study added too many monetary policy variables in one model.

Source: Compiled by the Author

From Table 1, it is obvious that most of the studies done in Nigeria used different techniques of analysis and arrived at different conclusions. Similarly, most of the studies used annual data (Saibu & Oladeji, 2007; Apanisile, 2017) and others quarterly data (Akanbi & Dada, 2018; Olayiwola & Ogun, 2019) which might be the reason for the differences in results. Thus, this study added to the existing literature by investigating the asymmetric impact of monetary policy shocks on output growth and price level in Nigeria using an extended annual data point spanning from 1981 to 2018.

METHODOLOGY

To empirically investigate the asymmetric impact of monetary policy shocks on output growth and price levels in Nigeria, this study adopted a descriptive research design. This is appropriate for this study because it is based on standardized economic theory applied by gathering, analyzing and presenting the results of the data collected. The theory that underpins this study is the traditional Keynesian model that emphasized that positive monetary policy shocks have smaller real effects than negative monetary policy shocks. The major concern of the model is that variable for asymmetric effects is related to different real effects of positive and negative changes in nominal demand.

This study adopted the model used in the study of Olayiwola and Ogun (2019) in which monetary policy action affects output and price levels differently in Nigeria. This study decomposed the monetary policy variable (interest rate) into positive and negative shocks. Positive shock connotes contractionary policy action while negative shock connotes expansionary policy action. In this study, money supply (M2) was decomposed into positive and negative shocks and other variables (interest rate and exchange rate) that determine economic growth (output) and price levels are introduced as control variables. Similar to the study of Olayiwola and Ogun (2019), two additional series of monetary policy shocks were generated for this study.

Monetary Policy Shocks

$$\varepsilon_t = [\varepsilon_t^+, \varepsilon_t^-] \quad 1$$

$$\varepsilon_t^+ = \max(\varepsilon_t^+, 0) \quad 2$$

$$\varepsilon_t^- = \max(\varepsilon_t^-, 0) \quad 3$$

To estimate the effects of monetary policy shocks on output and price level, these shocks (ε_t^+, ε_t^-) are both for the output and price level equations as an independent variable in addition to other macroeconomic variables. Thus,

$$Y_t = f(Z_t, \varepsilon_t^+, \varepsilon_t^-) \quad 4$$

Where Y_t is the output growth rate in the current period, z_t are other explanatory variables that affect output growth in the current period. Similarly,

$$P_t = f(Q_t, \varepsilon_t^+, \varepsilon_t^-) \quad 5$$

P_t is the growth rate of prices in the current period, Q_t are other explanatory variables that affect price growth in the current period. Employing the non-linear autoregressive distributed lag (NARDL) model, equations for 4 and 5 becomes:

Output Equation

$$Y_t = \delta_0 + \sum_{l=i}^{a} \delta_l Z_{t-l} + \sum_{j=0}^{b} \delta_j \varepsilon_{t-j}^+ + \sum_{k=0}^{c} \delta_k \varepsilon_{t-j}^- + V_t \quad 6$$

Price Level Equation

$$P_t = \gamma_0 + \sum_{l=i}^{e} \gamma_l Q_{t-l} + \sum_{j=0}^{f} \gamma_j \varepsilon_{t-j}^+ + \sum_{k=0}^{g} \gamma_k \varepsilon_{t-j}^- + V_t \quad 7$$

Where Y_t and P_t are the output (economic growth) and price level (inflation rate) respectively, Z_{t-l} and Q_{t-l} are other explanatory variables, ε_t^+ and ε_t^- are the decomposed money supply shocks, and δ_j, δ_k, γ_j and γ_k are the coefficients to be estimated.

After estimating the two equations separately, if the coefficients of ε_t^+ and ε_t^- are equal, that is, $[\delta_i^+ = \delta_i^-]$ and $[\gamma_i^+ = \gamma_i^-]$ it implies that the effects of monetary policy shocks are symmetric or the same. On the other hand, if ε_t^+ and ε_t^- are not equal, that is, $\delta_i^- > \delta_i^+ \geq 0$ and $\gamma_i^- > \gamma_i^+ \geq 0$ it implies that monetary policy shocks are asymmetric for output (economic growth) and price level (inflation rate) respectively.

Similar to the study of Olayiwola and Ogun (2019), equations 6 and 7 was estimated using the non-linear autoregressive distributed lag (NARDL) model developed by Shin, Yu and Greenwood-Nimmo (2013) in their paper titled "Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework". The NARDL is appropriate for this study because short and long-run nonlinearities are introduced through positive and negative partial sum decompositions of the explanatory variables and can be applied irrespective of whether the variables are integrated of order I(0), I(1) or a mixture of I(0) and I(1). It can be used to determine cointegration among variables with a small sample size. This technique does not only gauge short and long-run asymmetries but also detect hidden cointegration (Apanisile, 2017).

Data

This study used annual time series data from 1981 to 2018 to examine the relationship between the variables in the two models above. This period was chosen to avoid micronumerosity and to have a large degree of freedom when lags are taken.

Table 2: Description of Variables, Sources and A Priori Expectation

Variables	Description	Measurement	Source	Theoretical Expectation
Real GDP (RGDP)	GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	Proxy for Output in millions of naira at constant local currency unit	World Bank, World Development Indicators, 2019	Explained Variable
Price Level (PLS)	Inflation, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.	Proxied by the inflation rate	World Bank, World Development Indicators, 2019	Explained Variable
Broad Money Supply(M2)	Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors.	Proxy for monetary policy shocks in millions of Naira in a constant local currency unit	World Bank, World Development Indicators, 2019	Positive and Negative shocks
Interest Rate(INT)	The lending rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector.	Percentage	World Bank, World Development Indicators, 2019	Negative
Exchange Rate (EXR)	Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages	Local currency units relative to the U.S. dollar	World Bank, World Development Indicators, 2019	Positive

Source: Compiled by the Author

ANALYSIS AND RESULTS

Unit Root Test

To avoid spurious regression results that characterize non-stationary time series data, Gujarati, Porter and Gunasekar (2009) proposed that they should be subjected to a stationarity test. Thus, this study tested the stationarity properties of all the variables. The stationarity test employed was Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) to aid accuracy, comparison and boost confidence in the regression result. The results obtained are summarized in Table 3.

Table 3: ADF and PP Unit Root Test Results with Constant

Variables	ADF				PP			
	Level	Prob.	1st Diff.	Prob.	Level	Prob.	1st Diff.	Prob.
LNRGDP	-0.2783	0.9180	-3.8091	0.0063***	0.8185	0.9931	-3.8091	0.0063***
INT	-2.4921	0.1255	-5.3179	0.0001***	-2.4663	0.1317	-6.8085	0.0000***
EXR	1.7361	0.9995	-4.2120	0.0021***	1.5309	0.9991	-4.1676	0.0024***
PLS	-2.8847	0.0568*	-5.5938	0.0000***	-2.7564	0.0745*	-9.4472	0.0000***
LNM2	-0.7695	0.8153	-3.2660	0.0242**	-0.5428	0.8711	-3.0166	0.0428**
Critical		1% = -3.6268				1% = -3.6268		
Values		5% = -2.9458				5% = -2.9458		
		10% = -2.6115				10% = - 2.6115		

(*) indicates significant at the 10%, (**) significant at the 5% and (***) significant at the 1%
Source: Computed by the Author using Eviews 9

The unit root results presented in table 3 showed that all the variables are stationary after first difference except price level (PLS) that was stationary at the level at the 10 per cent level of significance. This implies that the variables are integrated of order I(0) and I(1) using both the ADF and PP tests respectively. This is because the test statistics of all the variables at first difference are greater than their critical values at 5 per cent and 10 per cent levels of significance while the test statistic of the price level (PLS) at level was greater than its critical value at the 10 per cent level of significance. This is also obvious from their respective probability values because they are all less than or equal to 0.05. Consequently, NARDL bounds test for cointegration was deemed appropriate to check for the long-run relationship among the variables in the models used in this study. This is because the variables are integrated at different orders, that is, I(0) and I(1). Similarly, stationarity test was conducted to ensure that none of the variables is integrated at order 2 because the NARDL model will break down in the presence variable(s) that are integrated of order I(2).

Lag Selection

Before testing for the long-run relationship among the variables in the two equations (output and price level), the study tested for the optimum lags to be used in the NARDL bounds test and its short and long-run estimates using the VAR lag order selection criteria. The result obtained is presented in Tables 4 and 5.

Table 4: VAR Lag Order Selection Criteria for Output Equation

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-315.954	NA	1753.528	18.82083	19.00040	18.88206
1	-132.247	313.3812	0.091890	8.955754	9.853613*	9.261949*
2	-119.643	18.53537	0.117145	9.155515	10.77166	9.706668
3	-96.8285	28.18351*	0.087755	8.754620	11.08905	9.550729
4	-76.3195	20.50897	0.084782*	8.489386*	11.54211	9.530451

**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
Source: Computed by the Author using Eviews 9

Table 5: VAR Lag Order Selection Criteria for Price Level Equation

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-483.6287	NA	33686205	28.68404	28.86361	28.74528
1	-336.9723	250.1785	15606.68	20.99837	21.89623*	21.30457*
2	-316.8757	29.55377*	12804.32*	20.75740*	22.37354	21.30855
3	-308.8884	9.866742	22945.94	21.22873	23.56316	22.02484
4	-293.1235	15.76488	29304.58	21.24256	24.29528	22.28362

**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
Source: Computed by the Author using Eviews 9

From Table 4, the different criteria suggested different optimum lags that can be used for the specified output equation. Sequential Modified LR test statistic (LR) choose 3 lags, Final Prediction Error (FPE) and Akaike Information Criterion (AIC) picked 4 lags out of a maximum of 4 lags while Schwarz Information Criterion (SC) and Hanna-Quinn Information Criterion choose 1 lag out a maximum of 4 lags. If there are limited observations in a NARDL model, it is often advised to use the Akaike Selection Criterion (AIC) in selecting the optimum lag length. Thus, this study used 4 lags to determine the long-run relationship among the variables in the output equation.

Similarly, Table 5 showed the lag structure of the price level equation using different criteria. Sequential Modified LR test statistic (LR), Final Prediction Error (FPE) and Akaike Information Criterion (AIC) selected 2 lags out of a maximum of 4 lags while Schwarz Information Criterion (SC) and Hanna-Quinn Information Criterion choose 1 lag out a maximum of 4 lags. If there are limited observations in a NARDL model, it is often advised to use the Akaike Selection Criterion (AIC) in selecting the optimum lag length. Thus, this study used 2 lags to determine the long-run relationship among the variables in the price level equation.

NARDL Bounds Test for Cointegration

Having established the order of integration and the maximum lags to be used in the two equations adopted for this study, it went further to ascertain if there is the long-run relationship among the variables using the non-linear autoregressive distributed lag (NARDL) bounds testing approach. The results obtained for the two equations are presented in Tables 6 and 7.

Table 6: NARDL Bounds Test for Output Equation

Test Statistic	Value	K
F-statistic	6.2785	4

Critical Value Bounds

Significance Level	I(0) Bound	I(1) Bound
10%	2.45	3.52
5%	2.86	4.01

Source: Computed by the Author using Eviews 9

Table 7: NARDL Bounds Test for Price Level Equation

Test Statistic	Value	K
F-statistic	5.8809	4

Critical Value Bounds

Significance Level	I(0) Bound	I(1) Bound
10%	2.45	3.52
5%	2.86	4.01

Source: Computed by the Author using Eviews 9

Tables 6 and 7 showed the result of the NARDL bounds test for cointegration for output and price level equations respectively. The first step in this procedure is to compare the value of the calculated f-statistic and critical value bounds. From the table 6 and 7, the estimated f-statistic of 6.2785 calculated at k=4 (number of explanatory variables) and the estimated f-statistic of 5.8809 calculated at k=4 (number of explanatory variables) for output and price level equations respectively exceeds the upper critical bounds at 10 and 5 per cent levels of significance. Hence, the null hypotheses of no long-run relationship among the variables in the output and price level equations are rejected. This implies that there is a long-run relationship between the variables in the two equations. The next step is to investigate the short and long-run asymmetric (symmetric) impact of monetary policy shocks on output and price level.

Short-run Impact of Monetary policy Shocks

The results of the short-run asymmetric (symmetric) impact of monetary policy shocks on output and price level are presented in Tables 8 and 9 respectively.

Table 8: Short-run Error Correction Model for Output Equation

ARDL(3, 4, 3, 2, 0) Model Selected Automatically Based on AIC
Dependent Variable: LNRGDP

Variable	Coefficient	Std. Error	t-statistic	Probability
D(LNRGDP(-1))	-0.142641	0.164108	-0.869192	0.3968
D(LNRGDP(-2))	0.134374	0.152553	0.880838	0.3907
D(INT)	0.004480	0.002142	2.091323	0.0518*
D(INT(-1))	0.001493	0.002036	0.733454	0.4733
D(INT(-2))	0.002520	0.002190	1.150852	0.2657
D(INT(-3))	0.002741	0.001925	1.424050	0.1725
D(EXR)	-0.000650	0.000316	-2.054072	0.0557*
D(EXR(-1))	-0.000089	0.000500	-0.177587	0.8611
D(EXR(-2))	-0.001194	0.000453	-2.636965	0.0173*
D(LNM2_POS)	-0.008666	0.046779	-0.185265	0.8552
D(LNM2_POS(-1))	-0.066569	0.046616	-1.428012	0.1714
D(LNM2_NEG)	0.469958	1.115620	0.421253	0.6788
CointEq(-1)	-0.283421	0.068263	-4.151876	0.0007**

*Cointeq = LNRGDP - (-0.0063*INT + 0.0032*EXR + 0.1473*LNM2_POS + 1.6582*LNM2_NEG + 30.6089)*

R-squared	0.998596	Mean dependent var	31.13587
Adjusted R-squared	0.997275	S.D. dependent var	0.490266
S.E. of regression	0.025592	Akaike info criterion	-4.186227
Sum squared resid	0.011134	Schwarz criterion	-3.423047
Log-likelihood	88.16586	Hannan-Quinn criteria.	-3.925961
F-statistic	755.8600	Durbin-Watson stat	2.239245
Prob(F-statistic)	0.000000		

(*) indicates significance at 10 % level , (**) indicates significance at 5% level

Source: Computed by the Author using Eviews 9

Table 9: Short-run Error Correction Model for Price Level Equation

ARDL (2, 2, 0, 0, 2) Model Selected Automatically Based on AIC
Dependent Variable: PLS

Variable	Coefficient	Std. Error	t-statistic	Probability
D(PLS(-1))	0.788935	0.178699	4.414877	0.0002**
D(INT)	-0.602634	0.736747	-0.817967	0.4214
D(INT(-1))	-1.866026	0.674260	-2.767519	0.0107*
D(EXR)	-0.318773	0.114568	-2.782389	0.0103*
D(LNM2_POS)	3.853234	2.970058	1.297360	0.2068
D(LNM2_NEG)	-202.284271	474.544944	-0.426270	0.6737
D(LNM2_NEG(-1))	1353.972242	664.467135	2.037681	0.0528*
CointEq(-1)	-1.174277	0.184012	-6.381536	0.0000**

*Cointeq = PLS - (1.5879*INT -0.2715*EXR + 3.2814*LNM2_POs -1649.3812*LNM2_NEG - 0.9916)*

R-squared	0.735869	Mean dependent var	19.50230
Adjusted R-squared	0.625815	S.D. dependent var	17.87440
S.E. of regression	10.93389	Akaike info criterion	7.872888
Sum squared resid	2869.197	Schwarz criterion	8.361712
Log likelihood	-126.7755	Hannan-Quinn criter.	8.041630
F-statistic	6.686414	Durbin-Watson stat	2.164218
Prob(F-statistic)	0.000069		

(*) indicates significance at 10 % level , (**) indicates significance at 5% level
Source: Computed by the Author using Eviews 9

The short-run estimates of the output equation presented in table 8 revealed that positive monetary policy shocks (contractionary) have a negative but insignificant impact on output (economic growth) while negative monetary policy shocks (expansionary) have a positive but insignificant impact on output. This is because the coefficient of positive monetary policy shocks (-0.0086) showed that a unit increase in contractionary monetary policy will reduce output about by 0.01 per cent while a unit increase in negative monetary policy (0.469958) will increase output by 46 per cent. This implies that the impact of positive and negative monetary policy shocks on output (economic growth) in Nigeria are not the same in the short run, thus this is a case of asymmetric impact even though they are both not statistically significant in the short-run. This finding is in line with the standard Keynesian model that opined that positive (contractionary) monetary policy shock have smaller real effects than negative (expansionary) monetary policy shock even though they are not statistically significant. This finding is also in line with the studies of Mamdouh, 2018 and Olayiwola and Ogun (2019).

Similarly, interest rate (INT), an exchange rate (EXR), and previous two years exchange rate D[EXR(-2))] have a significant impact on output in the short-run at 10 per cent level of significance while others are not. The CointEq(-1) in Table 8 is the error correction term for output equation. It revealed that 28.3 per cent of the short-run disequilibrium in output (economic growth) is corrected or converges in the long-run. The model showed a good fit as the adjusted R-squared of 0.9972 indicates that 99 per cent of the variation in the dependent variable is explained by the changes in the independent variables. The Durbin-Watson (DW) statistic of 2.2392 showed there is not a case of autocorrelation in the model.

Similarly, the short-run error correction model result for price level equation presented in Table 9 above showed the opposite result to that of the output short-run estimate. It showed that positive (contractionary) monetary shock has a positive but insignificant impact on a price level while negative (expansionary) monetary shock have a negative and insignificant impact on the price level. However, one period lag negative monetary policy shock has positive and significant impact on price level at 10 per cent level of significance. This implies that a unit increase in contractionary policy (3.853) will increase output by 38.5 percent while a unit increases in expansionary policy (-202.284) will decrease output by 202.3 per cent. This finding is also in line with the proposition of the standard Keynesian model. Thus, the impact of positive and negative shocks on price level is not the same in Nigeria in the short-run. Thus, the impact of monetary policy shocks on price level is asymmetric in the short-run. This is also in conformity with the studies done outside Nigeria (Pragidis et al., 2013; Zakir & Malik, 2013; and Mamdouh, 2018) and those on Nigeria (Saibu & Oladeji, 2007); Olayiwola & Ogun, 2019). The CointEq(-1) in Table 9 is the error correction term for output equation. The result also showed that one period lag of price level (inflation rate), one period lag of interest rate and exchange rate are important determents of price level in the short-run at 5 per cent and 10 per cent levels of significance respectively.

It revealed that 117 per cent of the short-run disequilibrium in price level (inflation) is corrected or converges in the long-run. The model showed a good fit as adjusted R-squared of 0.6258 indicates that 62 per cent of the variation in the dependent variable is explained by the changes in the independent variables. The Durbin-Watson (DW) statistic of 2.1642 showed there is not case of autocorrelation in model.

Long-run Impact of Monetary Policy Shocks

The results of long-run asymmetric (symmetric) impact of monetary shocks on output and price level are presented in Tables 10 and 11 respectively.

Table 10: Long-run Coefficients for Output Equation

NARDL Model (3, 4, 3, 2, 0) Selected Automatically Based on AIC Dependent Variable: LNRGDP				
Variables	**Coefficient**	**Std. Error**	**t-statistic**	**Probability**
INT	-0.006349	0.006669	-0.951960	0.3545
EXR	0.003185	0.001140	2.794550	0.0124*
LNM2_POS	0.147251	0.027561	5.342751	0.0001**
LNM2_NEG	1.658161	4.170631	0.397580	0.6959
C	30.608929	0.100429	304.780533	0.0000**

(*) indicates significance at the 10% level, (**) indicates significance at the 5% level

Source: Computed by the Author using Eviews 9

Table 11: Long-run Coefficients for Price Level Equation

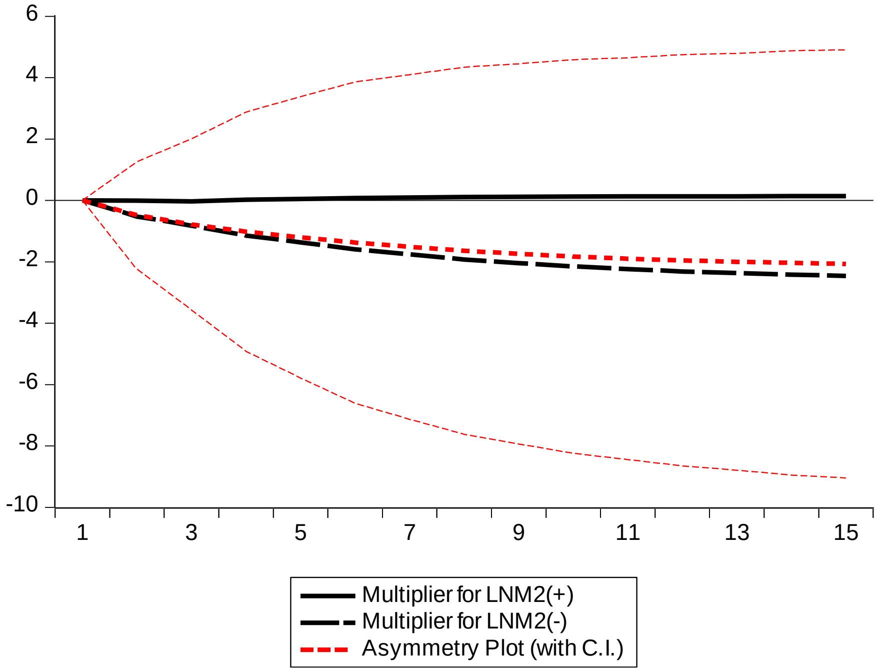
NARDL Model (2, 0, 2, 0, 2) Selected Automatically Based on AIC Dependent Variable: PLS				
Variables	**Coefficient**	**Std. Error**	**t-statistic**	**Probability**
INT	1.587933	0.432058	3.675280	0.0012**
EXR	-0.271463	0.082695	-3.282685	0.0031**
LNM2_POS	3.281367	2.406787	1.363381	0.1854
LNM2_NEG	-1649.381241	454.628396	-3.627977	0.0013**
C	-0.991600	7.830489	-0.126633	0.9003

(**) indicates significance at the 5% level

Source: Computed by the Author using Eviews 9

Tables 10 and 11 showed the long-run asymmetric impact of monetary policy shocks (LNM2_POS and LNM2_NEG) on output (economic growth) and price level (inflation rate). In Table 10, the coefficients of positive monetary policy shocks (LNM2_POS, 0.147251), that is, contractionary monetary policy has a positive and significant impact on output (economic growth) in Nigeria in the long run than the negative monetary policy shocks (LNM2_NEG, 1.658161) even though its coefficient is larger, that is, expansionary monetary policy is positive but not significant. This implies that contractionary or tight monetary policy has a significant impact on economic growth in Nigeria in the long run than expansionary monetary policy. This implies that a unit increase in contractionary policy, in the long run, will increase output by 14.7 percent. On the other hand, a unit increase in expansionary policy will increase output by 16.6 per cent. This also evidence of the asymmetric impact of positive and negative monetary policy shocks. This is because their coefficients are not the same and positive monetary policy shock is significant while negative monetary policy shock is not. This finding is in conformity the Keynesian proposition that positive monetary policy shock have smaller real effects than negative monetary policy shock in terms of the magnitude of the coefficients. Similarly, interest rate has negative but insignificant impact on output (economic growth) while the exchange rate has a positive and significant impact on output (economic growth) in the long-run. To further support the evidence of the asymmetric impact of monetary policy shocks on output (economic growth) in Nigeria, the asymmetric plot was drawn.

Figure 1: Asymmetric Plot of Monetary Policy Shocks on Output (Economic Growth)

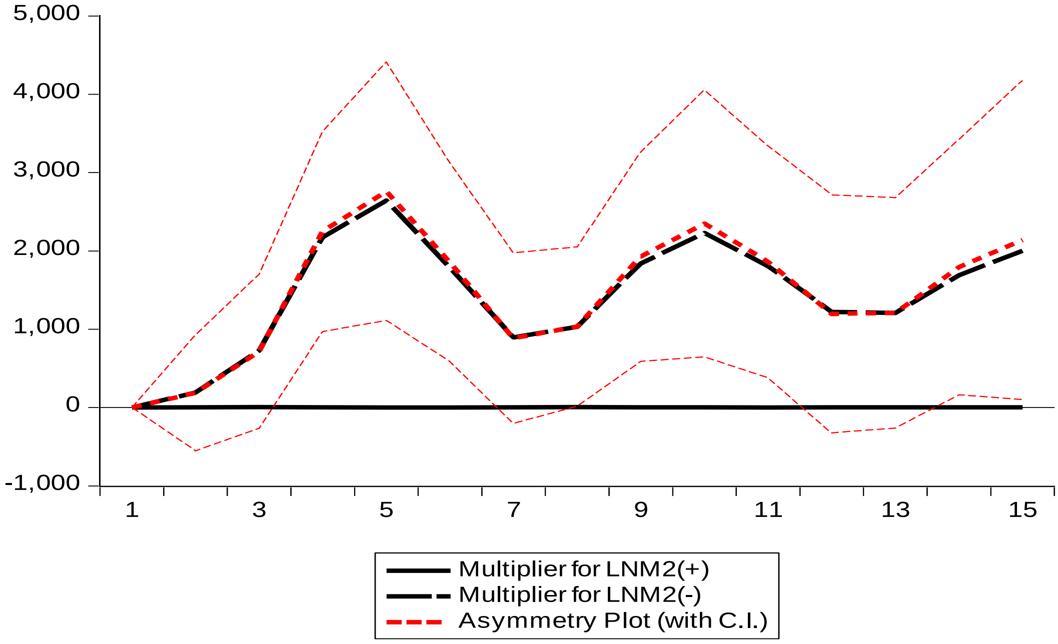


Source: Plotted by the Author using Eviews 9

From figure 1, the dark-thick line represents the multiplier for positive monetary policy shock while the dark-broken line represents the multiplier for negative monetary policy shock. The red, thick-broken line is the asymmetric plot. This showed that negative (expansionary) monetary policy shock has more impact on output (economic growth) in Nigeria. This is because the multiplier for negative monetary policy shock move the same way as the asymmetric plot while the multiplier for positive monetary policy shock did not.

For the price level equation presented in Table 11, positive (contractionary) monetary policy shock has a positive but insignificant impact on price level (inflation rate) in Nigeria in the long run. However, negative (expansionary) monetary policy shock has a negative and significant impact on the price level at 5 per cent level of significance. This implies that one per cent increase in money supply will reduce inflation by -1649.38 per cent. This is contrary to the monetarists' view that inflation is everywhere a monetary phenomenon. This goes a long way to showing that in Nigeria, inflation is not just caused by increased in money supplied but rather other factors not captured in this study might be responsible for inflation. Thus, there is evidence of the asymmetric impact of monetary policy shocks on price level in the long-run. Similarly, interest rate (INT) has a positive and significant impact on price level (inflation) in the long run while exchange rate (EXR) has a negative and significant impact on price level (inflation) at the 5 per cent level of significance. This revealed that lending interest rate and exchange rate are important macroeconomic factors that influence the inflation rate in Nigeria. To further affirm the asymmetric impact of monetary policy shocks on price level (inflation) in Nigeria, the asymmetric plot was drawn.

Figure 2: Asymmetric Plot of Monetary Policy Shocks on Price Levels (Inflation)



Source: Plotted by the Author using Eviews 9

From figure 2, the dark-thick line represents the multiplier for positive monetary policy shock while the dark-broken line represents the multiplier for negative monetary policy shock. The red, thick-broken line is the asymmetric plot. This showed that negative (expansionary) monetary policy shock has more impact on output (economic growth) in Nigeria. This is because the multiplier for negative monetary policy shock move the same way as the asymmetric plot while the multiplier for positive monetary policy shock did not.

Robustness Test

For robustness, this study employed the Wald test to know whether the coefficients of positive and negative monetary policy shocks are the same or equal to zero. The results obtained for the output (economic growth) and price level (inflation) equations are presented in table 12.

Table 12: Wald Test for Symmetric Impact

	Output Equation			Price Level Equation		
Test Statistic	**Value**	**DF**	**Prob.**	**Value**	**DF**	**Prob.**
F-statistic	0.091	(2, 17)	0.9132	1.0423	(2, 24)	0.3681
Chi-square	0.182	2	0.9127	2.0846	2	0.3526

Source: Computed by the Author using Eviews 9

From table 12, the null hypotheses of the symmetric impact of monetary policy shocks on output (economic growth) and price level (inflation) are rejected and the alternative hypotheses are accepted because their probability values of 0.913 and 0.3681 for output and price level equations respectively are not significant at 5 per cent level of significance. This further suggested that monetary policy shocks have an asymmetric impact on output (economic growth) and price level (inflation rate) in Nigeria in the short and long runs. This finding is line with the standard Keynesian theory and studies done outside Nigeria (Ravn & Sola, 2004; Tan et al., 2010; Pragidis et al., 2013; Zakir & Malik, 2013; Ulke & Berument, 2015; Jacob, 2018; Mamdouh, 2018) and in Nigeria (**Saibu** & Oladeji, 2007; Olayiwola & Ogun, 2019). On the other hand, this finding is contrary to the finding of Edilean and Marcelo (2009) and Apanisile (2017).

CONCLUSION AND RECOMMENDATIONS

In this study, non-linear autoregressive distributed lag (NARDL) model has been used to investigate the asymmetric impact of monetary policy shocks on output and price level in Nigeria. The study used time series data from 1981 to 2018 due to the availability of data. The results presented in this study are normalized on output (economic growth) and price level (inflation rate). The result revealed that there is evidence of the asymmetric impact of monetary policy shocks on output and price level in Nigeria in the short and long runs. Negative (expansionary) monetary policy shock has more impact on output and price level. The findings in this study conformed to the a priori expectation and some empirical findings from the literature. Since positive (contractionary) monetary policy shock was found to have a positive impact on output while negative (expansionary) monetary policy shock was found to have a negative impact on the price level, this study recommended that proper monetary policy mix is required to simultaneously achieve economic growth and price stability in Nigeria. Similarly, since expansionary monetary policy could not account for the increases in price level in Nigeria, the government should revamp our price control boards so as to tackle any technical market rigidities responsible for hike in prices.

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