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Monetary policy shocks and stock market prices volatility in Nigeria

Abstract

This study empirically analyzes the impact of monetary policy shocks on stock market prices volatility in Nigeria using time series data for the period of June 1999 to December 2016. The model developed is analyzed using autoregressive distributed lag (ARDL) model and exponential generalized conditional heteroscedasticity (EGARCH) model. The findings from the study show that there is a strong and positive relationship between monetary policy shocks and stock market prices volatility in Nigeria. However, only interest rate, among the monetary policy variables examined, is significant in explaining the stock market prices volatility in both the short and long run, while M1 is significant only in the short run. The implication is that the Central Bank might be able to influence stock market volatility and the efficiency in the stock market through better communication or increased transparency. We therefore recommend that, monetary policy decision should be an all-round engagement and not a periodic activity so as to ensure immediate response to prevailing economic conditions for prompt corrective measures.

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1. Introduction

The stock market remains a chief player of financial intermediation in the financial market of both advanced and emerging economies. It represents that part of the economy in the business of transferring excess fund from the surplus side to the deficit side using financial instruments for investment purposes (Adeniji, 2015). This role becomes imperative as more resources are required to ensure efficient and effective functioning of speedy increase in economics activities. Hence, stock market assists in mobilizing the savings of the surplus earners as well as effectively allocating it which in turn aids capacity utilization, improved productive activities as well as economic growth in the economy.

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In recent times, the concept of stock market volatility has caught the interest of both policy makers and market participants. Policy makers are concerned about the aftermath impact of stock market volatility on macroeconomic variables as well as aggregate economy, while market participants are worried on how fluctuation in the stock market prices causes instability in asset pricing. However, the general belief remains that stock market prices volatility has a negative impact on economic activities in every economy (Zare, Azali and Habibullah, 2013). Hence, efforts to avoid or reduce this negative impact requires understanding the causes of the problem.

According to Gospodinov and Jamali (2012), one of the major factors influencing stock market prices volatility is central bank policies. Decisions on monetary policy by the central bank authority causes instability (increase or decrease) in the stock prices through its impact on the interest rate which as well affect how the present value of the expected future cash flows are discounted. Hence, as expounded by the leverage effect, increase (decrease) in stock prices which in turn bring about increase (decrease) stock returns will bring about decrease in stock market volatility. This conclusion is also widely recorded in the literature as the asymmetric association between stock market returns and volatility (Gospodinov and Jamali, 2012).

In the developed economies, studies (Lobo, 2002; Bomfim, 2003; Chen and Clements, 2007; Farka, 2008; Konrad, 2009; Vahamaa and Aijo, 2011) on the impact of monetary policy on stock market prices volatility concluded that stock market volatility is highly vulnerable to the monetary policy decision of the central bank. The disclosure of government policies on monetary policies instruments by the central bank brings noteworthy changes (demand and supply forces, investor psychology, economic strength of the market, uncertainty about the future economic outlook) which have serious impact on the investors. Therefore, the understanding of the concept of monetary policy and the channels through which it affects stock market prices cannot be overemphasized.

Monetary policy serves as one of the important tools employed by the government in achieving the economic growth of a country (Evans and Kelikume, 2015; Evans, 2016; Nwaogwugwu and Evans, 2016; Evans and Saibu, 2017; Evans, Adeniji, Nwaogwugwu, Kelikume, Dakare and Oke, 2018; Evans, 2019). The central bank as decided by the government seeks to achieve stability in price, external payment equilibrium, increased employment, output growth, exchange rate stability and sustained economic growth and development. The achievement of these goals is a function of how well the monetary authority can manipulate monetary instrument in response to the state of business cycle in the economy. Hence, Mira (2008) was of the opinion that, macroeconomic objectives of the central bank response to manipulation of monetary policy is often indirect, gradual, and in most cases difficult to quantify. However, he further maintained that, asset prices in the stock market respond immediately and directly to changes in monetary policy. Therefore, the immediate response of the stock market to monetary policy decisions is imperative in understanding the transmission process in the stock market as this is capable of changing household consumption through their financial wealth and firms' investment ability on future investment decision (Muibi, Osi, Evans and Seun, 2016).

On this note, monetarists' frequent concern is on the sensitivity of the economy to monetary policy instruments (Olivier, 2012; Evans et al, 2018). It is generally believed that, central bank policy actions are a function of the current state of the economy. However, in practical sense, it is not all the actions of the central bank that can be attributed to the current state of the economy but anticipated ones is also been captured in the decision taken. Hence, the decision with respect to the current state of the economy is referred to as accounted variation, while the anticipated one is called unaccounted variation and this according to Lawrence, Felson, Helmick, Arnold, Choi, Deyo and Jordan (2008) can be referred to as monetary policy shock. Therefore, it is in the interest of this paper to examine the impact of this monetary policy shocks on stock market prices volatility in Nigeria covering the period of 1999:6 to 2016:12. The choice of monthly data was based on the sensitivity of various models to be used in the analysis to the frequency (large sample data) of the data. It is believed this will solve the problem of degree of freedom usually encountered in the introduction of lags and increase the reliability of the data for analysis. Hence, following this introduction, the remainder of the paper is organized as follows. Section two reviews literature related to the study, section three presents the methodology of the study, while section four presents analysis and interpretation and section five concludes the paper.

2. Theory and the Review of Literature

2.1 Theoretical Framework

This study adopted the present value or discounted cash flow as its theoretical framework which gives valuable discernment on how stock markets and its prices are affected by monetary policy variations. The model shows that stock price (S_t) is the present value of expected future dividends (D_{t+j}) based on the postulation of constant discount rate (R). In a simpler form, we postulate that investors are open to two alternative investment opportunities (i.e. a stock with expected gross return $E_t[S_{t+1} + D_{t+1}]/S_t$, or a risk-free bond with constant nominal gross return 1+R) over a given period of time (one-period horizon). In line with the idea of arbitrage concept, for investors to care less about the one to choose among the two alternative, the expected return from investing in the stock or bond must be equal i.e. $E_t[S_{t+1} + D_{t+1}] / S_t = 1+R$. When taken further, this gives rise to anticipated difference equation presented in eqn. (1) below;

$$S_t = E_t\left[\sum_{j=1}^{k}\left(\frac{1}{1+R}\right)^j D_{t+j}\right] + E_t\left[\left(\frac{1}{1+R}\right)^k S_{t+k}\right] \qquad (1)$$

where, E_t is the conditional anticipations operator founded on information accessible to market partakers at time t, R is the rate of return employed by market partakers to discount future dividends, and K is the investor's time horizon (stock holding period). The standard transversality condition suggests that as the horizon K increase the second term in the right-hand side of Eq. (2.1) disappears to zero (no rational stock price bubbles) as shown in eqn 2;

$$\lim_{k\to\infty} E_t\left[\left(\frac{1}{1+R}\right)^k S_{t+k}\right] = 0 \quad (2)$$

Thus, grounded on the dialog of Campbell and MacKinlay (1996) on models of sensible bubbles that lessen the transversality condition and their derivation of the present value model with time changeable discount rates. We attain the conversant form of the present value model as given in eqn 3;

$$S_t = E_t\left[\left(\sum_{j-1}^{k}\frac{1}{1+R}\right)^j D_{t+j}\right] \quad (3)$$

From eqn 3, it can be inferred that a variation in monetary policy can move stock prices in two folds.

To begin with, changing of discount rate employed by market partakers has direct impact on stock prices. Consequently, tighter monetary policy leads to an upsurge in the rate at which firms' future cash flows are capitalized causing stock prices to drop. This is grounded on the molds that, the discount factors employed by market participants are usually connected to market rates of interest and the central bank is able to sway market interest rates (Fuhrer, 1995).

Furthermore, monetary policy ups and downs put forth an indirect impact on the firms' stock value by changing anticipated future cash flows. Monetary policy facilitation is expected to escalate the general level of economic activity and the stock price rejoins in a positive manner (expecting higher cash flows in the future). Hence, this channel usually takes up the presence of an association between monetary policy and the aggregate real economy. As Patelis (1997) contends, stocks are entitlements on future economic output, so if monetary policy has real economic effects then stock markets should be swayed by monetary conditions.

2.2 Empirical Review

Attempt have been made by several scholars to examine the impact of monetary policy shocks on the stock market volatility or how stock market responds to variations in monetary policy both in developed as well as developing countries using different approaches or methodology.

The first common method used by scholars is event study approach. Kurov (2012) examined the determinants of stock market's response to monetary policy declarations in US for the period of 1994:1 to 2008:9 using event study approach and found out that there is a negative response of stocks to any pronouncements about future increase in rate for the period of economic expansion, while a strong positive reaction of stocks is found for pronouncements about future increase in rate during a situation of contractions in monetary policy. It was concluded that the response of stock market is influenced by information on anticipated equity premium and future corporate cash flows as presented in monetary policy reports. Hence, releasing of information on monetary policies relating the activities of the stock market have a great implication on the stability of stock prices in the market.

Also, Basistha and Kurov (2008) investigated macroeconomic cycles and the stock market's reaction to monetary policy employing event study method for the period of 1990 to 2004 with 138 declarations concerning the Federal funds target rate. The result of empirical findings revealed that stock return responded strongly to unpredicted fluctuations in the targeted rate of the Federal funds in the course of periods of economic faintness and in tight credit market situations. Also, another result analyzed with firm-level data revealed that firms with high possible financial constraint are further affected by monetary shocks in tight credit situations compared to those that are financially buoyant. These results are in line with the transmission channel of credit.

In the same vein, Rigobon and Sack (2004) assessed the reaction of asset prices to fluctuations in monetary policy for the period of January 3, 1994 to November 26, 2001. New method of estimation using heteroscedasticity which occurs in high frequency data was employed and showed that the reaction of asset prices to fluctuations in monetary policy can be acknowledged centered on the upsurge in the alteration of policy shocks that happens on days of FOMC meetings as well as testimony by Chairman on semi-annual monetary policy testimony presented to the Congress. Employing identification and event-study approach the results showed increase in short-term interest rate will lead to a drop in stock prices, while an uphill shift in the yield curve leads to lower prices at elongated maturities. Hence, it was concluded that, the event study method favours effect on treasury yields which produces large result as compared to that of stock prices which appears to be too small.

Bernanke and Kenneth (2003), examined the effect of unanticipated fluctuations in the federal funds rate goal on equity prices for the period of 1989:6 to 2002:12 with event study approach, they found out that a usual unanticipated rate cut of 25 origin points is allied with an increase of unevenly 1 percent in the level of stock prices, as measured by the CRSP value-weighted index and that stock prices respond strongly to fluctuations in the rates resulting from those that will be long-lasting or that characterize a difficulty in the path of rate fluctuations.

Using vector autoregressive model (VAR), Galiy and Gambetti (2014) investigated the reaction of stock prices to externally influenced monetary policy shocks employing a vector-autoregressive model with time-varying parameters for the period of 1960Q1 to 2011Q4. Their findings pointed to lingering occurrences such that with the event of a decline in the short run, stock prices rise doggedly in reaction to an externally influenced monetary policy. They concluded that, such reaction is not in line with the general view on the effects of monetary policy on bubbles which at the same time less prediction for bubble models.

Employing cointegration and causality test, Cassola and Morana (2004) studied the association between monetary policy and the stock market in the euro area using quarterly data for the period of 1987:Q1–2000:Q4. They employed cointegrated VAR system and the findings as shown by the impulse response function pointed that a momentary positive effect of real stock prices is influenced by a long-lasting positive monetary shock.

Adeniji (2015) examined the association between stock market prices volatility and macroeconomic variables' volatility in Nigeria using time series data for the period of January 1990 – December 2014. He employed bi-variate and multivariate VAR Granger causality tests and GARCH (1,1) model. The findings revealed that, stock market prices are influenced by instability in interest rate and exchange rate to Granger-cause stock market prices volatility and it was concluded that the weak relationship between stock market prices volatility and macroeconomic variables is caused by the presence of problem of irregularity of information among investors in developing countries like Nigeria.

Using ARCH, GARCH, EGARCH model, Aliyu (2011) assessed the responses of Nigeria's stock market to monetary policy advances during the period of global financial crisis using monthly data which covers the period January, 2007 to August, 2011. Stock market return was regressed against narrow money, broad money and monetary policy rate (MPR). He employed GARCH and EGARCH approaches and the results revealed that the unanticipated part of policy innovations on M2 and MPR exerts disrupting consequence on NSE's returns, however the anticipated part does not.

Fair (2002) examined the event that shook the market in US for the period of 1982-1998 using descriptive method, his findings revealed that changes in equity prices is mostly as a result of released information on monetary policy rate. Lobo (2002) examined the effect of unanticipated variations in the federal funds target on stock prices for the period of 1988 to 2001 using EGARCH model. He found that amazements related with upsurges in the directed increase stock market volatility on the pronouncement day, with volatility regressive to pre-surprise levels on the day after the pronouncement and determined that astonishments related with reductions in the target aid stock prices to increase meaningfully.

Employing structural VAR model, Bjornland and Leitemo (2004) examined the impact of US monetary policy on stock market prices with structural VAR methodology. They employed both short and long run restrictions as a means of finding solution to simultaneity problem in the process of identifying the monetary and stock price shocks. The findings showed that stock market prices depend greatly on monetary policy shocks and that, stock prices drop instantly by two percent owing to a monetary policy shock that increases the federal funds rate by 10 basis points.

Ioannidis and Kontonikas (2007) examined the consequence of monetary policy on stock yields in 13 OECD countries for the period 1972–2002. They employed regular stock price data, nominal stock returns and interest rate data for the G7 countries and six additional European countries. The investigation does not engage the normal money supply variables M1, M2 or M3; as an alternative they used short term Treasury bill rate and dummy variables to incarceration variations in the central banks' discount rate. The research also explains the non-normal distribution of the stock market returns and any associations between international stock markets. The findings of the research specify that contractionary monetary policy is attached with drop in stock returns for more than 80% of the countries examined. They determined that, monetary policy has direct or indirect impact on developed economies.

Neri (2002) assessed the impact of exogenous monetary policy shocks on stock market guides in the G-7 countries and Spain with a monthly data for the period of 1982:1 to 1998:12 using structural VARs approach. He estimated a model for every single country and the impact of policy shocks on stock prices were appraised through of impulse responses and variance decompositions. The findings revealed that, a contractionary monetary shock has a negative and transitory effect on stock market indices and that, there was evidence of a significant cross-country heterogeneity in the tenacity, degree and timing of these responses. He concluded that monetary policy significantly affects stock prices variability.

Hence, from the literature reviewed, it is very clear that, analysis of how stock market respond to monetary policy shocks is a study that is mostly carried out in developed countries and little or no account is available for developing countries like Nigeria. However, Aliyu (2011) assessed the reactions of Nigeria's stock market to monetary policy innovations during the period of global financial crisis and it was deduced that, his study was limited to the period of global financial crisis. It is therefore imperative for a study that will give a clear picture on how stock market respond to monetary policy shocks to be carried out in Nigeria.

3. Data and Methods

3.1 Data

This study relies on secondary sources of data for its analysis and monthly data from July 1999 to December 2015 were collected from; CBN statistical Bulletin 2014, CBN website and Nigeria stock exchange fact book (Various Issues).

3.2 The Model

Based on the theoretical framework and following the work of Aliyu, (2011) this study make use of all share index (ASI) as a proxy for the stock market prices and considered M1, M2 and interest rate as monetary policy instruments in order to empirically analyze monetary policy shocks and stock market prices volatility as opposed Aliyu (2011) who used M1, M2 and monetary policy rate as monetary policy instruments. These considered variables can be put in a functional form as thus;

$$ASI_t = f(M_{1t},\ M_{2t}\ \ and\ INT_t) \quad (4)$$

Where ASI is all share index; M_{1t} is narrow money supply; M_{2t} is broad money supply; INT_t is interest rate

Equation 3.1 can further be presented in an econometrics form as thus;

$$ASI_t = \alpha + \beta_1 M_{1t} + \beta_2 M_{2t} + \beta_3 INT_t + \mu_t \quad (5)$$

Where μ_t is the error term.

3.3 Methods of Data Analysis

In testing for stationarity, two customary techniques of unit root test; the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests were used as a pre-test for the examination of the variables in the model to ascertain their order of integration.

To test the long run relationship among the variables, this study deviates from the well-known Engle and Granger (1987) and Johansen and Juselius (1990) approaches to cointegration and make use of new and advanced approach known as autoregressive distributive lag model (ARDL) bounds testing approach developed by Pesaran, Shin & Smith (2001) to test whether long run relationships exist between the variables or not. This method is recently embraced because it is valid if the variables of interest have vague order of integration i.e. purely I(0), purely I(1) or I(0)/I(1) which is not acceptable in previous approaches. Also, as maintained by Haug (2002), ARDL bounds testing approach is more appropriate and gives better results for small sample size while the short and long-run parameters can be estimated simultaneously. Hence, the ARDL representation of equation 5 can be presented as thus;

$$\Delta VOL_t = \beta_0 + \beta_1 VOL_{t-1} + \beta_2 INTSHOCK_{t-1} + \beta_3 M1SHOCK_{t-1} + \beta_4 M2SHOCK_{t-1} + \beta_5 \Delta VOL_{t-i} + \beta_6 \Delta INTSHOCK_{t-i} + \beta_7 \Delta M1SHOCK_{t-i} + \beta_8 M2SHOCK_{t-i} + \mu_t \quad (6)$$

Where; Δ is the first-difference operator, and β's shows the long run coefficients and short run coefficients. Hence, the null hypothesis (H_0) of no cointegration states that, H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ and the alternative hypothesis of existence of cointegration state that; $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8$ 0.

The above hypothesis is tested by comparing the calculated F-statistic with critical values from Narayan (2005) which were produced for small sample sizes of between 30 and 80 observations on the assumption that all variables in the model are I(0) in one side and that all the variables are I(1) on the other side. Following the norms of hypothesis testing, if the calculated F-statistic exceeds the upper critical bounds value, then the H_0 is rejected and we accept H_1, while if the F-statistic falls within the bounds then the test is inconclusive and lastly if the F-statistic falls below the lower critical bounds value, it implies that there is no co-integration.

The exponential generalized autoregressive conditional heteroscedasticity model (EGARCH) model was presented by Nelson (1991) to explain some asymmetric effects that other symmetric ARCH models could not explain. Its greatest remarkable landmark anchors on the concept of leverage effect which is widely associated with effect of news release on volatility. More precisely, this impact become conspicuous when the volatility is intensified as a result of reduction in prices (bad news) as against that when the prices are increased (good news) on similar level. These situations cannot be explained by the ARCH and GARCH, hence the reason for Nelson (1991) developing conditional variance as thus;

Given;

$$\varepsilon_t = \sqrt{h_t} \,.\, Z_t \quad (7)$$

$$h_t = \delta + \sum_{i=1}^{\infty} \psi_i \{IZ_{t-i}I - E(IZ_{t-i}I) + \theta Z_{t-i}] \quad (8)$$

with $Z_t \sim iidN(0 , 1)$.

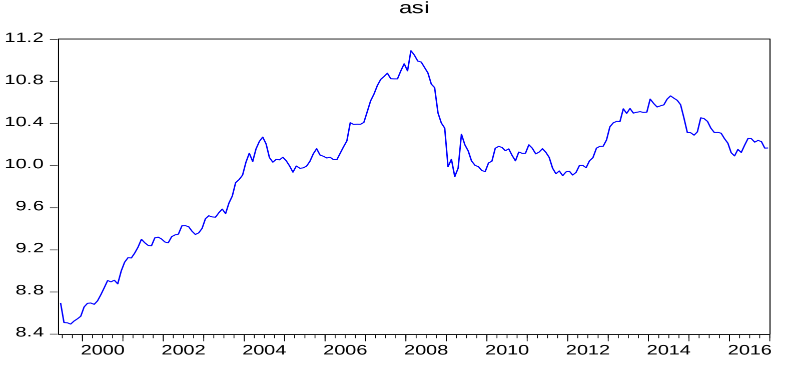
Any model with the above features is called exponential GARCH or EGARCH.

The asymmetric impact is conveyed by the parameter (θ) in eqn. (8). If θ=0 then any positive shock has the similar impact on volatility with any negative sock. If $-1<\theta<0$ then a negative shock reduces volatility in an advanced degree than any positive sock. When $\theta<-1$, any random negative shock upturns the volatility whereas any positive random shock reduces the volatility.

4. Empirical Analysis

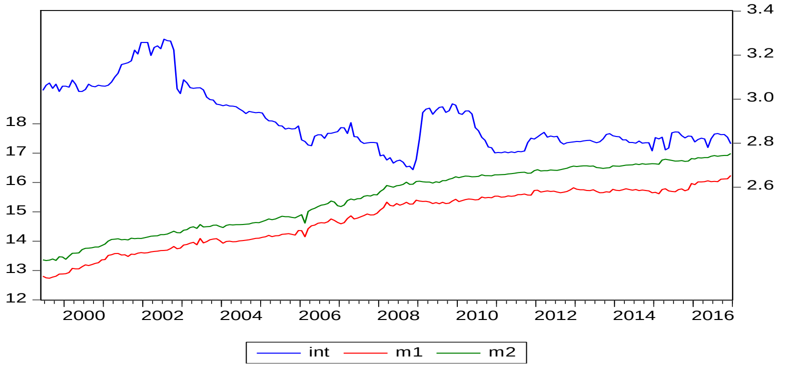
All share index as one of the macroeconomic variables exhibited an upward trend during the period of the study with some level of fluctuations. As shown in Figure 1, the variable experienced a fall by June 2004 which persist till March 2005 after which it continued to increase at up to February 2008 when a drastic drop was experienced again. The drop continued till April 2009 after which there was a constant Infiniti decimal hike fluctuation in the variable as accounted by the effect of global financial crises which only managed to reach its peak in July 2014 after which a continuous downward fall followed suit.

Figure 1. Trend of ASI (1999:6 – 2016:12)



In the same vein, Figure 2 depicts the trend analysis of other macroeconomic variables used in the study such as narrow money (M1), broad money (M2) and interest rate (INT). Narrow and broad money maintained relatively a constant upward trend for the period with a relatively small shot-up of M2 in May 2009 as well as a fall in M1 at the same rate till the present period. Interest rate experienced relatively large fluctuations over the period with a drastic fall in July 2002 and April 2010 and rose in the rate in January 2003 and October 2008. Hence, it is however imperative based on the figures that the stationarity of the variables should be tested and confirmed before they are utilized for empirical analysis.

Figure 2. Trend of INT, M1 and M2 (1999:6- 2016:12)



The result in Table 1 is the conditional mean equation result of ASI regressed on its lagged value. This is in the spirit of Engle (2002) who suggested that the residual of autoregressive process is liable to reveal volatility more than any other method. GARCH variance series (VOL) as shown in Figure 3 was generated from the model and it serves as the pure volatility (with neither exogenous nor endogenous) of ASI. Also, the graph depicts that the process of VOL is stationary as it possesses no trend pattern. It can be shown that all the variables in the model are statistically significant except the constant (mean of ASI) that is not significant at both 5% and 10% conventional level.

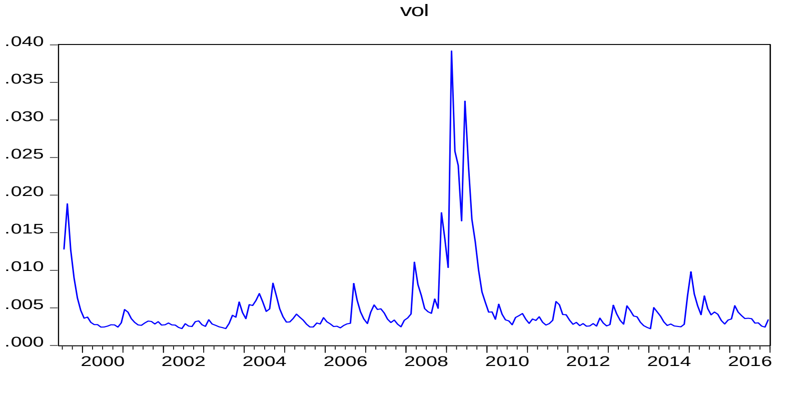
Table 1. ASI Volatility Equation

Dependent variable: ASI

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	0.108758	0.078941	1.377726	0.1683
ASI(-1)	0.990573	0.007860	126.0266	0.0000***
Variance equation				
C	0.000699	0.000309	2.260257	0.0238**
RESID(-1)^2	0.225092	0.097611	2.306007	0.0211**
GARCH(-1)	0.624754	0.135058	4.625820	0.0000***

Source: Authors' computation from E-Views 9.5, 2017.

Figure 3. Trend of Stock Market VOL (1999:6 – 2016:12)



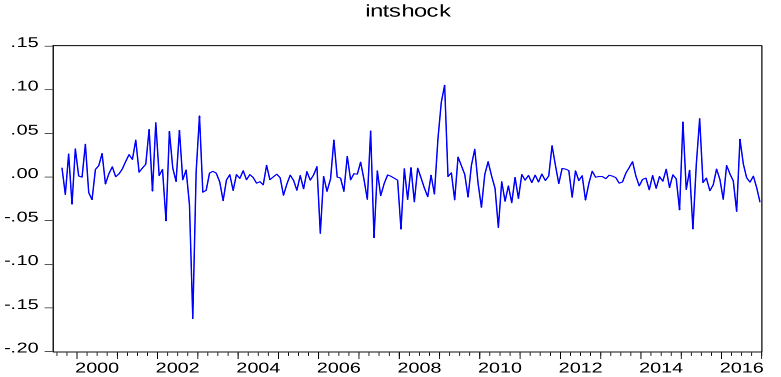
The result in the Table 2 shows INT regressed in its two periods lagged value. The economic meaning of residual from autoregressive process is the shock of that equation (Qin and Gilbert, 2001). Following this, the residual from the autoregressive process above is the shock of INT series (INTSHOCK) as shown in Figure 4. Similar to the case above, the graph depicts that the process of INTSHOCK is stationary as it possesses no trend pattern. It can be shown that all the variables in the model are statistically significant except the constant (mean of INT) that is not significant at both 5% and 10% conventional level.

Table 2. INT Shock Equation

Dependent variable: INT

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.062585	0.038039	1.645300	0.1014
INT(-1)	1.116879	0.069041	16.17703	0.0000***
INT(-2)	-0.138801	0.068944	-2.013232	0.0454**

Figure 4. Trend of INT Shock (1999:6 – 2016:12)



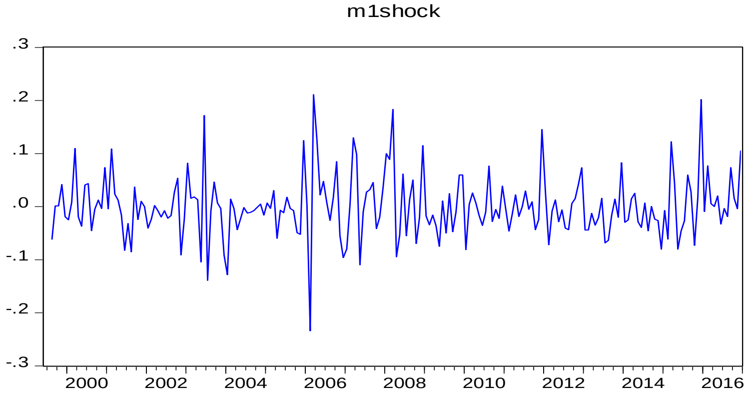
The result in the Table 3 is the result of M1 regressed in its two periods lagged value. The economic meaning of residual from autoregressive process is the shock of that equation (Qin and Gilbert, 2001). Following this, the residual from the autoregressive process above is the shock of M1 series (M1SHOCK) as shown in the Figure 5. In the spirit of above cases, the graph depicts that the process of MISHOCK is stationary as it possesses no trend pattern. It can be shown that all the variables in the model are statistically significant at both 5% and 10% conventional level.

Table 3. MI Shock Equation

Dependent variable: M1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.141123	0.063482	2.223054	0.0273
M1(-1)	0.802019	0.068585	11.69373	0.0000
M1(-2)	0.189768	0.068211	2.782093	0.0059

Figure 5. Trend of M1 Shock (1999:6 – 2016:12)



The result in the Table 4 is the result of M2 regressed in its two periods lagged value. The economic meaning of residual from autoregressive process is the shock of that equation (Qin and Gilbert, 2001). Following this, the residual from the autoregressive process above is the shock of M2 series (M2SHOCK) as shown in Figure 6. There is no doubt that the shock of M2 is similar to that of M1 as their graph both shows. Likewise, the case of M1 and the other cases above, the graph depicts that the process of M2SHOCK is stationary as it possesses no trend pattern. It can be shown that all the variables in the model are statistically significant at both 5% and 10% conventional level.

Table 4. M2 Shock Equation

Dependent variable: M2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.123590	0.051691	2.390964	0.0177
M2(-1)	0.785104	0.068143	11.52135	0.0000
M2(-2)	0.208261	0.067829	3.070379	0.0024

Figure 6. Trend of M2 Shock (1999:6 – 2016:12)

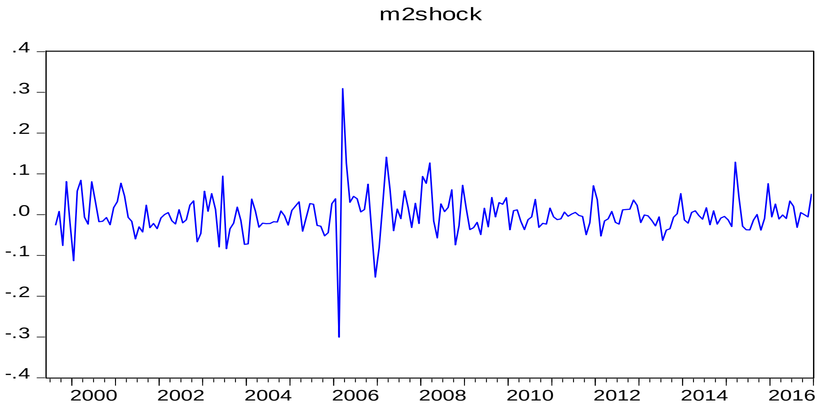


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Table 5 and 6 depict the unit root test result using Phillip-Perron and ADF unit root test at their constant, constant and trend and without constant and trend forms respectively. The tables reveal that ASI, INT, M1 and M2 in their constant, constant and trend and without constant and trend forms are not stationary at level using PP and ADF test. Therefore, the test is further conducted on the first difference of the data and the result of both PP and ADF from the tables show that the variables are all stationary at constant, constant and trend and without constant and trend forms. Hence, ASI, INT, M1 and M1 are said to be integrated of order I(1).

Table 5. Unit Root Test Result

Phillip-Perron Unit-Root Test Statistics (At Level)									
Variables	With Constant			With Constant & Trend			Without Constant & Trend		
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
ASI	-2.2161	0.2012	NS	-1.5130	0.8224	NS	1.0066	0.9171	NS
INT	-1.5420	0.5105	NS	-2.2142	0.4788	NS	-1.9341	0.6331	NS
M1	-1.8758	0.3433	NS	-1.9341	0.6331	NS	4.8864	1.0000	NS
M2	-2.1701	0.2180	NS	-1.3836	0.8632	NS	5.9289	1.0000	NS
Phillip-Perron Unit-Root Test Statistics (At First Difference)									
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
ASI	-12.3706	0.0000	I(1)	-12.6300	0.0000	I(1)	-12.3152	0.000	I(1)
INT	-12.6328	0.0000	I(1)	-12.6048	0.0000	I(1)	-12.6361	0.0000	I(1)
M1	-17.8013	0.0000	I(1)	-17.9872	0.0000	I(1)	-15.8017	0.0000	I(1)
M2	-17.9951	0.0000	I(1)	-18.5849	0.0000	I(1)	-15.7092	0.0000	I(1)

Source: Authors' computation from E-Views 9.5, 2017. Note: NS - Not Significant

Table 6. Unit Root Test Result

ADF Unit-Root Test Statistics (At Level)									
Variables	With Constant			With Constant & Trend			Without Constant & Trend		
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
ASI	-2.2858	0.1776	NS	-1.2769	0.8906	NS	-1.2584	0.9470	NS
INT	-1.4295	0.5673	NS	-2.3007	0.4313	NS	-0.7042	0.4108	NS
M1	-2.3701	0.1515	NS	-2.0009	0.5970	NS	-5.2648	1.0000	NS
M2	-1.9932	0.2898	NS	-1.4972	0.8278	NS	-5.3518	1.0000	NS
Phillip-Perron Unit-Root Test Statistics (At First Difference)									
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
ASI	-12.3835	0.0000	I(1)	-12.6405	0.0000	I(1)	-12.2733	0.0000	I(1)
INT	-12.6311	0.0000	I(1)	-12.6031	0.0000	I(1)	-12.6344	0.0000	I(1)
M1	-13.6139	0.0000	I(1)	-13.8434	0.0000	I(1)	-15.8569	0.0000	I(1)
M2	-17.5913	0.0000	I(1)	-17.7624	0.0000	I(1)	-15.6246	0.0000	I(1)

Source: Authors' computation from E-Views 9.5, 2017.

Table 7 depicts the unit root test on the variables such as VOL, M1SHOCK, M2SHOCK and INTSHOCK derived from the raw data. The result of the Phillips-Perron and ADF unit-root tests show that stock market VOL, M1SHOCK, M2SHOCK and INTSHOCK are all stationary at level; they are integrated of order zero I(1) in their constant, constant and trend as well without constant and trend forms. This is also confirmed in Figures 7-9.

Table 7. Unit Root Test Result

Phillip-Perron Unit-Root Test Statistics (At Level)									
Variables	With Constant			With Constant & Trend			Without Constant & Trend		
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
VOL	-5.33810	0.0000	I (0)	-5.3193	0.0000	I (0)	-3.4105	0.0000	I (0)
M1SHOCK	-15.2020	0.0000	I (0)	-15.1671	0.0000	I (0)	-15.2446	0.0000	I (0)
M2SHOCK	-15.0307	0.0000	I (0)	-14.9912	0.0000	I (0)	-15.0721	0.0000	I (0)
INTSHOCK	-14.3175	0.0000	I (0)	-14.3542	0.0000	I (0)	-14.3525	0.0000	I (0)
ADF Unit-Root Test Statistics (At Level)									
	t-statistic	Prob.	Level	t-statistic	Prob.	Level	t-statistic	Prob.	Level
VOL	-4.11910	0.0000	I (0)	-4.10250	0.0000	I (0)	-2.47860	0.0000	I (0)
M1SHOCK	-12.7852	0.0000	I (0)	-12.7602	0.0000	I (0)	-12.8173	0.0000	I (0)
M2SHOCK	-14.8446	0.0000	I (0)	-14.8101	0.0000	I (0)	-14.8808	0.0000	I (0)
INTSHOCK	-14.3175	0.0000	I (0)	-14.3542	0.0000	I (0)	-14.3525	0.0000	I (0)

Source: Authors' computation from E-Views 9.5, 2017.

The information criterion table show that ARDL (2, 1, 2, 0) is appropriate for the model in this study. This explains the advantage of an ARDL methodology as it is not necessary for all the variables to have the same lag(s) contrary to that of VAR which all variables are given the same lag(s). The optimal lag selection must be considered as this may result to the problem of misspecification and autocorrelation if ignored. Also Schwarz model selector is a parsimonious model selector (Giles, 2016).

Table 8. Lag selection criteria

AIC	SIC	HQ	Adj. R-sq	Specification value
-8.913277	-8.768376*	-8.854681	0.646813	ARDL(2, 1, 2, 0)
-8.910735	-8.781934	-8.858649	0.644273	ARDL(2, 0, 2, 0)
-8.905482	-8.744481	-8.840375	0.645683	ARDL(2, 2, 2, 0)
-8.904927	-8.743926	-8.839820	0.645486	ARDL(2, 1, 2, 1)

-8.902569	-8.789868	-8.856994	0.639685	ARDL(2, 1, 0, 0)

Source: Authors' computation using E-views 9.5, 2017
*Note: * Means that ARDL model selected by the selection criteria*

Table 9 revealed that all the variables have positive relationship and impact on VOL in the long run respectively. Also, a percentage increase in M2SHOCK, M1SHOCK and INTSHOCK will bring about 0.0035%, 0.035586% and 0.174680 percent increase in VOL in the long run respectively. It can also be shown that all the variables are not significant in the long run except INTSHOCK. This signifies that, INTSHOCK is the major determinant of VOL (stock market volatility) in the long run.

Table 9. ARDL long-run equation

Dependent Variable: VOL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M2SHOCK	0.003520	0.034987	0.100621	0.9200
M1SHOCK	0.035586	0.044422	0.801098	0.4240
INTSHOCK	0.174680	0.061466	2.841920	0.0050**
C	0.004501	0.000984	4.576139	0.0000

Source: Authors' computation using E-Views 9.5, 2017

From the Table 10, M1SHOCK and INTSHOCK have positive relationship and impact on VOL in the short run while VOL (-1), M2SHOCK and M1SHOCK (-1) have negative impact on VOL in the short run respectively. Also, a percentage increase in M1SHOCK and INTSHOCK will bring about 0.003276% and 0.21821% increase in VOL in the short run while a percentage increase in VOL(-1), M2SHOCK and M1SHOCK(-1) will bring about 0.238062%, 0.000849% and 0.007579% decrease in VOL in the short run respectively. It can also be shown that all the variables are significant in the short run except the current M1 and M2 shocks (M1SHOCK and M2SHOCK). This signifies that the current M1 and M2 shocks (M1SHOCK and M2SHOCK) do not jointly contribute to stock market volatility (VOL) in the short run.

Table 10. Short Run Equation and ARDL Error Correction Form

Dependent Variable: D (VOL)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(VOL(-1))	-0.238062	0.062715	-3.795926	0.0002***
D(M2SHOCK)	-0.000849	0.004551	-0.186490	0.8523
D(M1SHOCK)	0.003276	0.004156	0.788216	0.4315
D(M1SHOCK(-1))	-0.007579	0.002557	-2.964435	0.0034***
D(INTSHOCK)	0.021821	0.006143	3.552082	0.0005***
ECM(-1)	-0.194567	0.036784	-5.289436	0.0000***

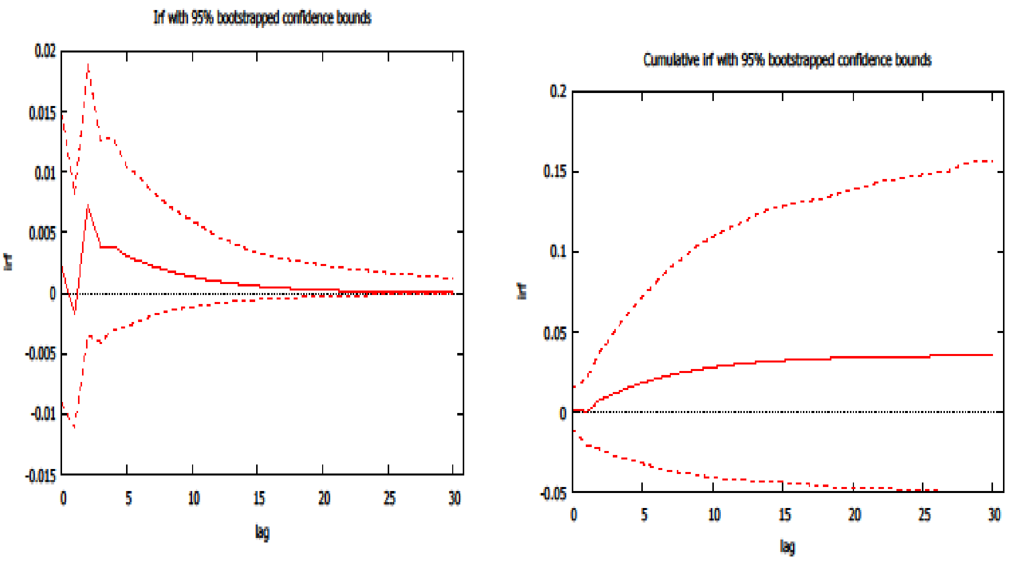
ECM = VOL - (0.1747*INTSHOCK + 0.0356*M1SHOCK + 0.0035 *M2SHOCK + 0.0045)

Source: Authors' computation using E-views 9.5, 2017
*Note * (**) (***) denotes null hypothesis at 10%, 5% and 1% respectively*

Also from Table 10, the result indicates that the coefficient of the error correction term ECM (-1) has a correct sign and significant at 1% level. The value of the coefficient is -0.194567; this means that, about 19.5% of the disequilibrium in the level of stock market volatility (VOL) of previous year's shock adjust back to the long run equilibrium in the current year. In other words, the level of stock market volatility adjusts to equilibrium with lags and only about 19.5% of the discrepancy between long and short run stock market volatility (VOL) in Nigeria is corrected within a year. This signifies that stock market volatility (VOL) in Nigeria is not persistent.

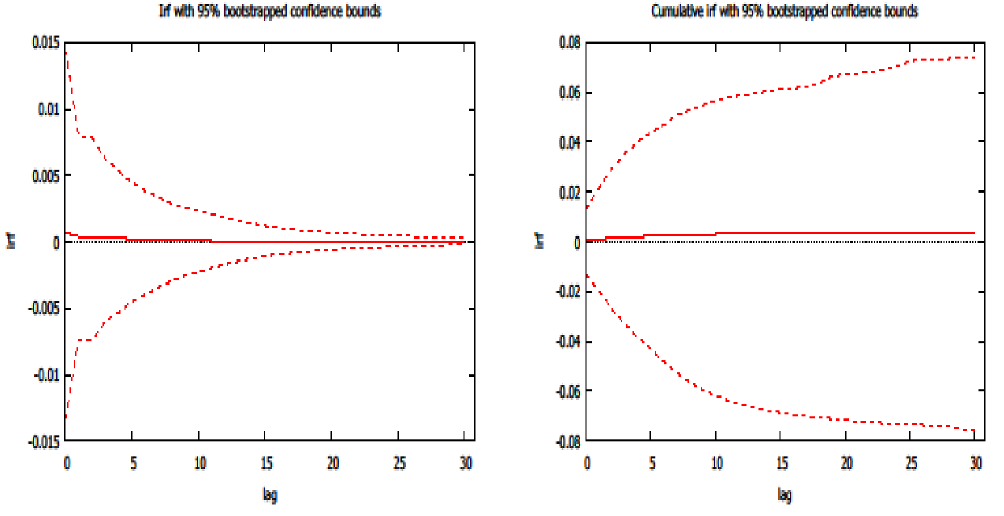
The first and the second graph in Figure 7 show the temporary and the permanent response of VOL dynamics to M1SHOCK. If there is one percentage temporal increase in the M1SHOCK, VOL will respond positively in the first month, respond negatively in the second month, respond positively in the third month and thereafter dies off. The second graph shows that the effect of M1SHOCK on VOL in the long run is not much as the accumulation is not copious.

Figure 7. Response of VOL TO 1% Temporary and 1% Permanent Change in M1SHOCK WITH 95% BOOSTRAP Confidence Interval



The first and the second graph in figure 8 shows the temporary and the permanent response of VOL dynamics to M2SHOCK. If there is one percentage temporal increase in the M2SHOCK, VOL will respond positively throughout the seasons. The second graph shows that the effect of M2SHOCK on VOL in the long run is nearly not visible. Both the short run and the long run response of VOL to M2SHOCK is highly not significant. This means that M2SHOCK does not significantly constitute the stock market volatility at any horizon.

Figure 8. Response of VOL to 1% Temporary and 1% Permanent Change in INTSHOCK with 95% BOOSTRAP Confidence Interval



The first and the second graph in figure 9 shows the temporary and the permanent response of VOL dynamics to INTSHOCK. If there is one percentage temporal increase in the INTSHOCK, VOL will respond positively throughout the seasons. The temporal effect of INTSHOCK on VOL will last up to 30 months (2 years 6 months). The second graph shows that the effect of INTSHOCK on VOL in the long run is large and highly significant in all seasons. In fact, both the short run and the long run response of VOL to INTSHOCK is highly significant in all seasons. This means that INTSHOCK is the major monetary policy shock that cause volatility in Nigeria stock market.

Figure 9. Response of VOL to 1% Temporary and 1% Permanent Change in INTSHOCK with 95% BOOSTRAP Confidence Interval

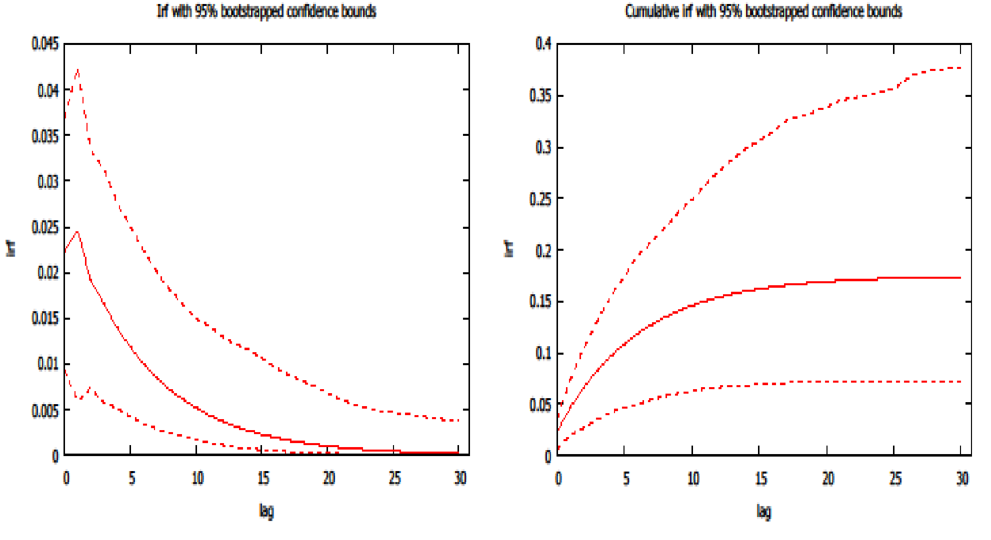


Table 11 shows the mean lag and the median lag of the estimated ARDL for VOL corresponding to each endogenous variables. The mean lag length reveals that it will take VOL 5.7 months, 7.1 months and 5.3 months to adjust back to equilibrium if there is interest rate shock, m1 shock and m2 shock respectively. The median lag shows that it will take 4 months, 4months and 3months for the first half or 50% of the total response of VOL following a percentage unit shock in INT, M1 and M2 respectively.

Table 11. ARDL Mean and median LAG Result

Varible	Mean Lag	Median Lag
INT	5.6972	4.0000
M1	7.1382	4.0000
M2	5.3489	3.0000

Source: Authors' computation using E-views 9.5, 2017

The null hypothesis is that, there is no autocorrelation in the error terms versus it alternative hypothesis of serial dependence among the error terms. The probability of the chi-square statistics in the result of the autocorrelation test has a value of 0.1486 (14.86%) which is greater than 5% level of significance, hence the null hypothesis of no autocorrelation is accepted and we conclude that the result of this analysis is reliable and free from serial error correlation. The null hypothesis is that, there is homoscedasticity of variance against its alternative of heteroscedasticity of variance. The probability of the chi-square statistics in the result of the ARCH heteroscedasticity test has a value of 0.8162 (81.62%) which is greater than 5% level of significance, hence the null hypothesis of homoscedasticity is accepted, therefore the result of this analysis is reliable and free non constant variance.

Table 12. Breusch-Godfrey Serial Correlation LM Test Result

F-statistic	1.924997	Prob. F(2,196)	0.1486
Obs*R-squared	3.987734	Prob. Chi-Square(2)	0.1362

Source: Authors' computation using E-views 9.5, 2017.

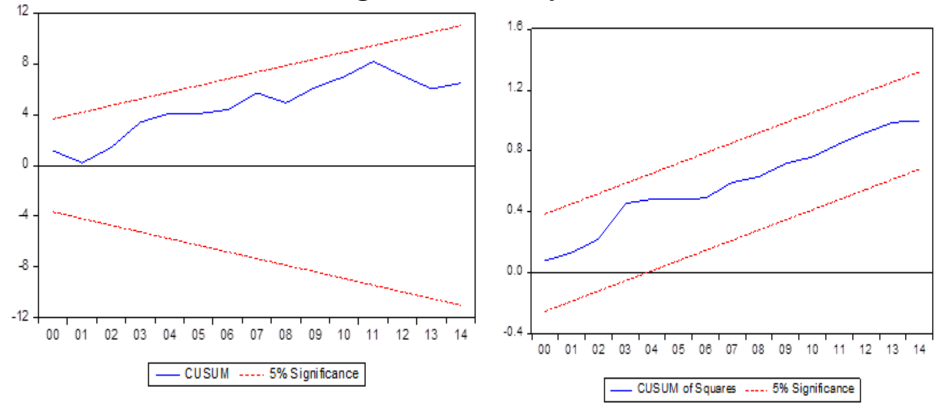
Table 13. Heteroscedasticity Test (ARCH) Result

F-statistic	0.053489	Prob. F(1,204)	0.8173
Obs*R-squared	0.053999	Prob. Chi-Square(1)	0.8162

Source: Authors' computation using E-views 9.5, 2017.

The null hypothesis is that, the regression model fit the data well versus its alternative hypothesis of invalid regression model. In Figure 10, the smooth line shows the cumulative sum of recursive residual errors and the cumulative sum of square of recursive residual errors. The dotted lines indicate 5% Bartlett standard error bound. Since the blue line did not move outside the bound, the null hypothesis that the regression model fit the data well is accepted and the parameter estimate in this model are stable over time.

Figure 10. Stability Test



The impact of monetary policy shocks on ASI volatility is investigated directly through exponential garch (EGARCH) methodology. The monetary policy shocks (INTSHOCK, M1SHOCK and M2SHOCK) which are generated earlier are integrated into the stock market variance equation in order to know whether they in anyway contribute to stock market volatility. The table 14 reveals that, only interest rate shock (INTSHOCK) and M1SHOCK contribute to the stock market volatility as their parameter estimates are significant at 5% and 1% conventional level. The variance equation reveals that there is no sign of asymmetry in stock market volatility.

Table 14. AR(1)-EGARCH Result

Dependent variable: ASI

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	0.108758	0.078941	1.377726	0.1683
ASI(-1)	0.990573	0.007860	126.0266	0.0000***
Variance equation				
C	-7.522558	1.030109	-7.302681	0.0000***
ABS(RESID(-1)/@SQRT(GARCH(-1)))	0.230515	0.174716	1.319370	0.1870
ABS(RESID(-2)/@SQRT(GARCH(-2)))	0.396533	0.184818	2.145531	0.0319**
RESID(-1) /@SQRT(GARCH(-1))	0.007929	0.098729	0.080312	0.9360
LOG(GARCH(-1))	-0.262513	0.170403	-1.540536	0.1234
INTSHOCK	7.466812	2.903835	2.571363	0.0101**
M1SHOCK	-11.20361	3.632642	-3.084150	0.0020***
M2SHOCK	5.183281	4.516099	1.147734	0.2511

Source: Authors' computation using E-views 9.5, 2017.

Table 10 shows the Mcloed-Li test result for 12 months (a year). This test is conducted to show whether volatility still persist in ASI after accounting for the monetary policy shocks (M1SHOCK, M2SHOCK and INTSHOCK). The probability of the test for the lags shows the absence of volatility in ASI because the monetary policy shocks are able to account for the volatility of ASI. The major drivers of this situation are the INT shock and the M1SHOCK as suggested by the ARDL dynamic response result.

Table 15. Mcloed-Li Test Result

Lags	Mcloed-Li coefficient	Mcloed-Li stat	Probability
1	0.016	0.0551	0.814
2	0.017	0.1156	0.944
3	0.092	1.9303	0.587
4	0.154	6.9835	0.137
5	0.074	8.1573	0.148
6	-0.040	8.5098	0.203
7	0.112	11.259	0.128
8	0.061	12.067	0.148
9	-0.024	12.191	0.203
10	0.040	12.539	0.251
11	0.111	15.261	0.171
12	0.013	15.299	0.225

Source: Author's computation using E-views 9.5, 2017.

The results of the empirical analysis have shown that there is a significant relationship between monetary policy shocks and stock market prices volatility. In the short run, stock market prices volatility is explained jointly by M1 shocks and interest rate shocks, while in the long run, it is explained by interest rate shocks. This implies that, the quest to control stock market prices volatility in the short run can be achieved using the M1 and interest rate. However, reducing the volatility of stock market in the long run requires the manipulation of interest rate in achieving the targeted objective.

5. Conclusion and Recommendation

It can be concluded from the finding that, there is a strong and positive relationship between monetary policy shocks and stock market prices volatility in Nigeria. The study has proven beyond reasonable doubt that the interest rate variable is the major variable explaining the stock market prices volatility in both the short and long run, while M1 was significant only in the short run. It then implies that the Central Bank might be able to influence stock market volatility and the efficiency in the stock market through better communication or increased transparency. This finding is in line with other studies in the literature (Bernanke and Kenneth, 2003; Qayyum and Anwar, 2011; Adeniji, 2014; Adeniji, 2015 and Babajide, et. al., 2016).

It could also be deduced from the findings that volatility in Nigeria is not persistent as opposed to the conclusion of Aliyu (2011) on the persistent level of volatility in the country. We therefore recommend that monetary policy decision should be an all-round engagement and not a periodic activity, so as to ensure immediate response to prevailing economic situations for prompt corrective measures. The government should further ensure that these responsibilities are put in the hands of professionals with the required expertise.

The major limitation of this study is the non-availability of some data. Monetary policy rate (MPR) data was not available to cover the period of study. However, this does not affect the power of the study as interest rate is used as one of the important monetary policy variables that causes volatility in the stock market. Also, given the role played by oil in the Nigerian economy, it is suggested that, further studies should consider the impact of oil price shocks in the relationship between monetary policy shocks and stock market prices volatility.

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