African J. of Economic and Sustainable Development

ISSN online: 2046-4789 - ISSN print: 2046-4770
https://www.inderscience.com/ajesd

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DOI: 10.1504/AJESD.2023.10056490

Article History:

Received:	02 April 2020
Last revised:	28 July 2021
Accepted:	30 October 2022
Published online:	15 January 2024

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Abstract: This study examined the effect of inter-bank rates (IBR) and prime lending rates (PLR) on stock market return volatility in Nigeria from January 2002 to December 2016. Descriptive statistics, unit root test (URT), heteroscedasticity, autocorrelation and GARCH (1.1) models were used to examine stock market returns volatility. A diagnostic test was conducted to ascertain the robustness of the estimated GARCH model. It was found that volatility clustering persists in the Nigerian stock market, suggesting that volatility shocks from the previous period will not disappear in the current period for a long time. Consequently, the government should establish a mechanism for monitoring banks' foreign exchange activities to reduce the high cost of borrowing among banks and reduce their liquidity pressures. A reduction in prime lending rates by banks to their customers/investors will encourage them to borrow more.

Keywords: stock returns; volatility; inter-bank rate; IBR; prime lending rate; PLR; Nigeria; all share index; ASI; unit root test; URT.

Reference to this paper should be made as follows: Aleke, S.F., Irem, C.O., Ugwoke, C.J. and Eunice, O.C. (2024) 'Response of stock return volatility to money market rates in Nigeria', *African J. Economic and Sustainable Development*, Vol. 9, No. 3, pp.219–238.

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This paper is a revised and expanded version of a paper entitled 'Response of stock returns volatility to money market rates in Nigeria' presented at the International Conference on Accelerating Sustainable Development in Nigeria, Faculty of Management and Social Sciences, Alex Ekwueme Federal University Ndufu Alike, Ebonyi State, Nigeria, 25–27 June 2019.

1 Introduction

The link between macroeconomic variables and stock returns volatility has been a debatable issue over the years among economists, researchers and financial analysts (see for example, George-Anokwuru, 2017; Elly and Oriwo, 2013; Olowe, 2011; Makua and Antanda, 2009; Karolyi, 200l). This correlation has been observed in a selection of models and empirical evidence has revealed that the relationship varies overtime. However, the motivation for most of these previous studies were in response to the fact that the unpredictability in macroeconomic factors such as short-tenure interest rates are

essential illustrative variables that could give rise to volatility (see also Olweny and Omondi, 2011; Engle and Rangel, 2005).

The volatility of stock return reveals the variability of stock price changes within a chosen period (Schwert, 1989; Choudry, 1996). As a way of measuring risk, extreme volatility according to investors undermines the value of stock price which shows at all times the essential worth of the firm. Collaborating this, Campbell and Hentschel (1992) cited in Emenike and Aleke (2012) observed that volatility is a measure of risk hence increased volatility will bring about a higher risk as well as a higher future expected risk and investors will require higher returns to bear this risk and thus are motivated to pay less for the relevant equity.

The stock market is an important economic institution which plays major role of enhancing efficient capital formation and allocation for productive investment. The stock market returns as pointed out by Asaolu and Ogunmuyiwa (2010) cited in Kirui et al. (2014), are usually influenced by some basic macroeconomic variables and/or indicators such as inter-bank call rate, prime lending rate (PLR) and others, as they are connected with macroeconomic behaviour in both developed, emerging and/or developing economies. Stock market behaviour and effective macroeconomics policies has a very strong link; since asset prices to Xu (2007) are the essential tools people use to convey their confidence about the situation of the economy. Macroeconomic variables could explain further stock returns volatility in any economy, as their uncertainties causes' slight change in investor's belief and cause them to shift their investment and thus, make stock market returns to be more unpredictable. Similarly, volatility is believed to be reasonably high for the period of economic recession and this increase tends to be connected with fragile economic conditions thus affecting macroeconomic variables.

Equally, economic volatility is linked to fluctuations in risk aversion since investors tend to avoid risk more during economic decline. The stock market has become one of the popular investment avenues in the recent past due to its high returns on investment. Pilinkus (2010) state that stock market as an institution, is a major component of the financial system as it allows redistributions of financial resources to separate economic entities. Also, it has become the major component of the global economy, as such; fluctuations in the market will produce negative effect on the economic health of such country (Uzuke et al., 2016). Further they pointed out that the negative outcome of stock market forecast is marked more than its positive outcome. This is because the stock market in their views reflects the judgment and/or investor's expectation on market efficiency. Hence, rational investors react to every available information in the market and adjust their investment accordingly consequently upon this investor's attention has been shifted from investing in investments that are risk free. Stock market forecast and accurate predictions is of great importance in a dynamic global economy (Uzuke et al., 2016). It is assumed that Stock market returns are influenced by some macroeconomic factors. That is why investors rely on market prediction to compare specific investment returns (Kirui et al., 2014).

Despite the theoretical assertion that macro-economic factors and/or indicators are expected to affect stock returns. The observed pattern and/or magnitude, of the effect of these market indicators is still not clear in Nigeria, hence, the need to investigate the effects of money market indicators on stock market returns volatility in Nigeria.

Nwokoye and Otu (2018) identified that stock market has become a major source of income and savings which plays indispensable role in accumulating investment capital.

Thus stock market development, affects the economy globally through its influence on the real economic activities such as savings and investment and this brings about appreciable level of economic growth and development (Uchendu, 1993). Banks through their intermediary roles, channel credit from the net savers to the Net borrowers each time they accept deposits from the surplus sectors of the economy and lend out to the deficit sectors of the economy that needs such found for investment. Macroeconomic variables can influence to large extent investment since favourable macroeconomic policies attracts investment in the stock market and vice versa. Acha and Acha (2001) observed that interest rate has the fundamental implications for any economy as it affects the cost of capital and influences the credit available for savings and investment.

The Nigerian financial environment was deregulated when the structural adjustment programme (SAP) was introduced in 1996. This brought increased competition between banks and inters-bank markets. With this, the economy was restructured to clear those factors that distorts price, improve production and consumption pattern such that economic diversification could be achieved. The apex bank ensures that banks maintains a definite lending rate with their customers and to encourage investments in other sectors; such as the agricultural, solid minerals, entertainment, service as well as the production sectors of the economy. Kanu and Nwali (2019) pointed out that the SAP programme was implemented to help checkmate the negative influence of financial instability, liberalise the financial sector that has remained inconsistent (see also Reinhart and Tokatlidis, 2003; Kanu and Nwali, 2019). Sadly, all these government laudable efforts yielded no appreciable results as her economy still cannot be ranked among the world best economies.

Monetary policy rate (MPR) is among the key variables that relates to stock returns globally. It is one of the key variables that affect equity prices through its influence on interest rate with the level of money supply and the prospect of the market participants about the future direction of the economy (Samate, 2016). Furthermore, any adjustment and/or alteration by the monetary authorities on its rates could have serious effect on the economy since stock prices at all-time have investment and consumption spending implications. Matenilola, Bayariffin and Muhter (2014) found that any shift in the policy rate will influence the interest rate charged on loans and overdraft which bank extends to their customer. PLR and stock prices are very important factors in any economy. Ngugi (2014) argues that when banks offer high interest rates on customers 'deposits, the customers may be encouraged to invest more in the banks and thus reducing share prices. On the contrary, a lower interest rate on customers' deposits would produce opposite reactions of higher demand for stock investment, causing an increase in the share prices.

Empirical literatures on the effects of money market on stock return in Nigeria are growing but very scanty. This study as one of the very few studies in this area contributes to the existing literatures, considering the variables used, the period covered and the methodology adopted to examine the response of stock return volatility to money market rates in Nigeria. This help to validate some of the findings of the previous studies and equally bring new issues on volatility for further studies. Accordingly, this study investigates the response of stock return volatility on money market rates in Nigeria. Specifically, this study examines the effects of inter-bank rate (IBR) on all share index (ASI) in Nigeria and evaluate the extent to which PLR affect ASI in Nigeria. The remainder of the paper is as follows, Section 2 handled the theoretical and empirical review, Section 3 presents the data sources and discusses the econometric methodology

employed, Section 4 presents the empirical results and discussions, and Section 5 concludes the paper with policy implications.

2 Theoretical review

The study adopted the modern portfolio theory, and the efficient market hypothesis (EMH) model. The modern portfolio theory was developed by Markowitz (1991). The theory assumes that investors are risk averse and that when given two portfolios that offers the equal anticipated returns, investors will at all times choose the less risky one. Thus, an investor will always invest in a portfolio with a more favourable risk expected return. Equally financial volatility is linked to fluctuations in risk aversion this is because investors tend to be more risk averse during economic recession, such fluctuations in money market indicators, increases the volatility of stock return giving rise to risk and investors may think of shifting their investment to portfolios with a reduced amount of risk (Kirui et al., 2014). The theory is a portfolio choice that allows investors to analyse risk relative to their expected returns. Markowitz (1991) argues that modern portfolio theory is an investment theory which attempts to maximise portfolio risk for a particular anticipated return by chosen proportions of various assets. The theory was a mathematical formulated concept of diversification in investment with the aim of selecting a collection of investment assets.

Equally, the EMH was an investment theory propounded by Fama (1965). The theory asserts that in an efficient market, prices always reflect totally all accessible information that is germane to their valuation (Fama, 1965). In this way, stock prices at any time are fair reflection of all accessible information on the security's anticipated future cash flow and the risk inherent owning such a security. This means simply that investors can anticipate receiving only risk-adjusted return from all investment as prices move immediately and at random to any new information.

The EMH is among the key theories that gave explanation of stock price changes and information and every normal investor respond immediately to the new information made public and adjust their investments accordingly. The main goal that investors tend to pursue is to maximise wealth with lowest risk. Given that money market indicators, such as treasury bills, IBR, MPR, PLR and other interest rates, are believed to have significant impact on the returns volatility, investors are expected to take them into account in pricing of stocks.

2.1 Empirical review

Mubarak and Javid (2018) in Pakistan examined the impact of macroeconomic volatility on stock market return volatility for the 50 stocks listed at the Karachi Stock Exchange using monthly data from July 1998 to June 2014. The study adopted rational valuation formula (RVM) and macroeconomic variables used in the investigation are; market return, industrial production, and interbank call money rate, term structure of interest rate, money supply, exchange rate and inflation rate. The result of significant auto regressive process suggests existence of volatility persistence. The industrial production shows evidence of harmful effect on stock market returns volatility in Pakistan. Equally the volatility of exchange rate captures the external sector volatility and show evidence of

positive effect on stock return volatility. The increased variation in money supply and inflation makes stock returns more volatile and on unexpected change in call money retard the term structure of interest rate has the opposite effect on stock return volatility. They concluded that stock prices fluctuations in Pakistan are influenced by financial and economic variable's uncertainty.

Nauyen (2016) tested the robustness of vector autoregressive (VAR) generalised autoregressive conditional heteroskedasticity (GARCH) framework for Vietnam, using an updated data set of 161 monthly observations collected for the period beginning from august 2000 to December 2013, the author established a unique equation that represents the linkage among variables of interest. Also a wide range of techniques, together with unit roof test Johansen co-integration tests Granger causality tests, dynamic analysis (impulse response function and variance decomposition) were employed. The study's result demonstrates that VN-index corresponds to long-run and also short run, path of preferred macroeconomic variables. The study took volatility clustering into account, GARCH (I,1) models used revealed that the predictability of stock market volatilities using previous shocks (i.e., those originating from GDP, CPI and EX) rather than the previous volatility itself. The study's discussion of empirical findings has additionally been substantiated and corroborated the views of expert in the Vietnam's Stock Market.

Using US and EU data, Alikhanov (2013) investigated the mean and volatility spillover effects involving US and EU stock markets, also from the oil market down to eight European stock markets. The author applied G.TR-GARCH model and the result provides strong evidence of volatility transmission, mostly US-global, EU-regional and global factors towards the nationalised stock markets of eight European countries. Despite the fact that both mean and volatility spread from the USA are found to be significant, the degree of volatility spill-over, is found to be negligible. The paper also computed the variance ratios and the results draws to attention that the individual emerging countries stock returns are mostly influenced by US volatility spill-over rather than EU or oil markets. The paper equally examined global and regional stock markets and confirms evidence of US spillover transmissions. Also, the paper carried asymmetric test on stock returns of some EU markets; the stock market returns of Hungary, Poland, Russia and the Ukraine and found that the markets reacts asymmetrically to negative and positive shocks in the US stock returns. The paper found a weak support of asymmetric effects with regards to oil markets shocks. Only in the case of Russia and the quantified variance ratios, indicates that presence of oil market shocks is reasonably higher for Russia. Furthermore, a model with dummy variable confirms the effect of European Union enlargement on stock returns only for Romanian.

Using Indian data, Surbhi and Bhanumurthy (2005) examined the rising progress of capital flows, mostly short term capitals into domestic financial markets, in the post-1991 period by using monthly-data of call money rates, 91-day treasury bill rates (TBR), Indian Rupee/US dollar exchange rates and the London Interbank Offer Rate (LIBOR). Using multiple co-integration approach, they found that there is a strong incorporation of the domestic call money with the I. IBOR. Although the study found that there is a long-term co-movement between domestic foreign exchange rate and LIBOR, it is not robust. This could be as a result of frequent government participation through the Apex Bank in the foreign exchange market. Since the government securities in India is still on the rise; integrating with internationals market.

Turkyilmaz and Babbey (2013) examined the spread of volatility spillovers and shocks among some key macroeconomic variables, such as stock exchange prices, exchange rates and interest rates using the Baba-Engle-Krayt-Kroner and multivirate GARCH BEEK-MGARCH Model approach on monthly data from 2002 to 2009 for Turkey. The authors result shows a considerable spread of shocks and volatility among the variables used. However, the anticipated coefficient from the equations of the conditional mean return implies that all variables are significantly incorporated to news that affects not only mean returns but their volatility as well. Furthermore, the degree and persistence of the coefficient of the variance equations indicates that all variables show evidence of strong ARCH and ARCH effects, implying that current and old news have significant impacts on conditional volatility.

For Kenya, Otieno et al. (2017) examined in their study the stochastic properties of the macroeconomic variables, stock market returns with their co-integrating residuals in Kenya, they employed an autoregressive fractionally integrated moving average (ARFIMA) model and investigated Granger causality involving the two measures of interest rate with stock market returns in Kenya. The authors use monthly data from 1st January 1993 to 31st December 2015. Their results show that the three-month treasury bills rate, lending rate and stock market returns are fractionally integrated which implies that shocks to the variables persist but eventually disappear. Their results also reveal that the co integrating residuals are fractionally incorporated, suggesting establishment of a new and damaging long-run equilibrium when each of the measures of interest rate is driven away from stock market returns.

Using Nigeria data, Ufoeze et al. (2018) assessed the impact of monetary policy on economic growth in Nigeria over the period of 1986 to 2016 using ordinary least square and co-integration tests. They also used the natural log of the GDP as the dependent variables against the explanatory monetary policy variables: MPR, money supply exchange rate, lending rate and investment. The study shown that a long run connection exists among the variables. Similarly, the study showed that MPR, interest rate, and investment have insignificant positive effect on economic growth in Nigeria. Money supply however has significant positive effect on growth in Nigeria. Exchange rate has significant negative effect on GDP in Nigeria. Money supply and investment Granger cause economic growth, while economic growth causes interest rate in Nigeria. The study affirmed that monetary policy can be adequately used to control Nigerian economy and thus as an important mechanism towards price stability.

Afolabi et al. (2018) examined the link between monetary policy instruments and deposit money banks loans and advances in Nigeria from 1981–2016. Using Toda and Yamamoto Granger non-causality model, they found revealed that structural changes in monetary policy system exerted positive significant impact on loan and advances of deposit money banks in Nigeria. Their results also revealed bi-directional relationship existing between MPR and loan and advances of deposit money banks in Nigeria. Specially, MPR Granger causes loans and advances in Nigeria. The other explanatory variables; broad money supply (LM2), liquidity ratio (LR), inflation rate (IFR) and cash reserve ratio (CRR) does not Granger cause loan and advances of financial institutions in Nigeria within the examined period. They concluded that the structural change in monetary policy system and MPR will impact significantly on loan and advances of financial institutions in Nigeria.

Babajide et al. (2016) used EGARCH estimation technique to investigate the impact of the systematic risk on stock market volatility based on monthly data sourced from 1985 to 2013 on the Nigerian Economy. The authors' results show that all the macroeconomic variables examined exerts on stock market pricing and is generally influenced by exchange rate volatility.

Onyeke (2016) investigated the impact of monetary policy on stock market returns in Nigeria over period from 2003 to 2014. The author in his study conducted his empirical investigation using a six variable standard VAR model with six lags which comprises; consumer price index (CPI), Interbank Rate (UBR), open buy-back (OBB), TBR, exchange rate, (XGR) and ASI. The dynamic interactions among the variables are based on variance decompositions and impulse response functions generated from the VAR. The estimated results of the study revealed that monetary policy variables did not have a significant impact on the prices of stock in Nigerian equity market. This implies that the Nigerian equities market do not significantly absorb the monetary policy impulse and as such cannot be taken as being a good transmission channel yet for implanting monetary policy in Nigeria.

Nwakoby and Alajekwu (2016) employed Jahansen co-integration technique, ordinary least square technique and Granger causality test to investigate the effect of monetary policies on stock market performance in Nigeria for the period from 1986–2013. ASI was used as the indicator of stock market performance (ASI) while the explanatory variables included MPR, TBR, lending interest rates (INT), LR and deposit rates (DR). The co-integration result indicates evidence of long run relationship between monetary policy and stock market performance in Nigeria. The OLS regression result showed that monetary policy significantly explains 53% of changes stock market performances in Nigeria. However, MPR showed insignificant positive effect on ASI while lending rate (INT) has significant positive effect on ASI. Equally, TBR and LR have insignificant negative effect on ASI in Nigeria; and DR has significant negative effect on ASI in Nigeria. The Granger causality analyses showed that ASI has no causal relationship with MPR, TBR, and LR in Nigeria. However, ASI has causal relationship with lending and DR in Nigeria. This indicates that monetary policy has the potential to influence the stock market, but the causality analyses showed that monetary policy cannot influence stock market performance nevertheless stock market performance has influenced the direction of monetary policy in Nigeria through lending and DR.

Emenike (2015) examined the character and/or nature of volatility transmission involving money market and stock market using Nigeria data. The result of the Bivariate BEKK-GARCH (I,I) model used by the author, shows strong proof of ARCH and GARCH effect on stock return for both market. The results also, indicated evidence of a unidirectional volatility spread from the stock market to the money market. The finding of the study provides implications for portfolio selection and diversification as well as financial market regulation.

Olokoyo et al. (2014) used comparative analysis to investigate the approach of investors to investments before and after the financial melt-down in Nigeria for the period 1961–2011. The authors used correlation, multivariable regression and t-test to analyse Secondary data sourced from the Nigerian Stock Exchange (NSE) for the period under review. They found that there was significant change in the attitude of investors before and after the financial crisis to investments, as investors switched funds from capital market securities in form of money market instruments which guaranteed fixed

interest income. The authors also observed that despite the fact that the capital market was progressively improving, investors still show low confidence in the market.

Akpan and Chukwudum (2014) examined impact of interest rate changes on the Nigerian stock market. The response of the NSE ASI to the changes in the central bank of Nigeria's (CBN) interest rate over a period from (1986–2011), was analysed using the bivariate and multivariate regression analysis models for periods of interest rate hikes and cuts The study finds that the ASI responded differently to interest rate hikes and cuts. Also, that the impact of interest rate is not significant when other variables affecting stock prices are controlled.

Onakaya (2013) examined relatively the contributions of stock market unpredictability on economic growth in Nigeria for the period 1980–2010 using exponential generalised autoregressive conditional heteroscedasticity (EGARCH). The study provides evidence that volatility surprise is quite persistent in Nigeria and is capable of distorting growth of the economy. The study therefore recommends for the stock market to be less volatile. Also Securities and Exchange Commission (SEC) itself should be strengthen its capacity building with special attention on independent research monitoring mechanism and prompt decision making in order to make the stock market more stable and reduce the vagaries of its performance and to facilitate an improved oversight function of the capital market and engender improved performance.

Olewe (2011) investigated the unpredictability of interbank call rates in Nigeria using GARCH(I,I), EGARCH(I,I), TS – GARCH(I,I) and PARCH (I,I) models during the stock market collapse and global economic meltdown. For the period, beginning from June, 2007 to May, 2009 to examine unpredictability and asymmetric properties in the Nigerian inter-bank call market. The author's result shows unpredictability persisting in the market, also evidence of clustering properties in the market, thus rejecting the hypothesis of asymmetry and leverage effect. The study's result also shows that stock market collapse and global economic meltdown have effect on interbank call rate return but not on its instability. The paper found that the augmented TS – GARCH (I, I) model to be the best and/or suitable model.

3 Data

Our secondary data were collected and analysed serially in harmony with the research objective of the study using the descriptive statistics which involved computation and analyses of mean, standard deviation, skewness, kurtosis, and Jarque-Bera statistic for the monthly money market rates and stock indices of the Nigeria stock market. The population of the study consists of the monthly ASI of the NSE (ASI), IBR and PLR for the period from January, 2002 to December, 2016. The data for this study were sourced from the Central Bank of Nigeria Statistical Bulletin and the Nigerian Securities and Exchange Commission (NSEC) data.

3.1 Econometric methodology

To investigate the effect of money rates on stock market return volatility in Nigeria, we adopted generalised autoregressive conditional heteroscedasticity (GARCH 1,1)-X Model This model is apt because financial time series, such as stock prices, has been stylised to

show the occurrence of volatility crowding episodes to an extended period of relative calm (Gujarati, 2003). The GARCH-X (1,1) model is a suitable model as it permits explanatory variable to be added to the GARCH equation. This involved estimating the following equation in accordance with Lee (1994) and Emenike and Odili (2014):

$$\begin{aligned} &Rt = \theta + mt \\ &m \sim (0, \partial 2t) \end{aligned} \tag{1}$$

$$\partial 2t = \alpha 0 + \alpha 1 m 2t - 1 + \beta 1 \partial 2t - 1 + \nwarrow (\text{Money Market Rates})t - 1 \tag{2}$$

where

Rt in equation (1) = the stock market return

mt the error term

$\sigma 2t$ the conditional variance

$\alpha 0$ the constant variance that agrees with the long run average

$\alpha 1$ the first order ARCH term which transmits volatility news from the previous period

$\beta 1$ the first order GARCH term, is the new information that was not presented when the earlier prediction was made (Engle, 2003; Emenike, 2010).

λ the variable that measures the effect of money market rates on stock market returns volatility.

The equation (2) is an extension of standard GARCH (1,1) model to estimate the impact of money market rates (IBR and PLR) on stock market returns volatility in Nigeria. The estimate of λ measures the extent to which these money market rates affect stock returns volatility in Nigeria. Positive and statistically significant lambda coefficient, for example, would show that money market indicates a positive effect on stock markets returns volatility in Nigeria. Conversely, statistically insignificant lambda coefficient would indicate absence of any impact.

However, the linear function of the above notation is hereby modified and estimated in line with variables of the study as follows:

$$\begin{aligned} &ASIt = F(IBR, PLR) \\ &ASIt = \beta 0 + \beta 1 IBRt + \beta 2 PLRt + \mu t \end{aligned} \tag{3}$$

where

ASI ASI (dependent variable)

IBR inter bank rate

PLR prime lending rate

T time series (monthly) values

$B0$ represents the constant or intercept

$\beta 1 \ldots \beta 2$ are the regression coefficients to be estimated

μt error or disturbance term.

The assumption of the GARCH-X (1,1) is the error term is serially uncorrected with absence of heteroscedasticity.

3.1.1 Stationarity tests

The stationarity tests are aimed at determining whether the variables have dependable means and variances. Its needs were clearly highlighted in Granger and Newbold (1974). They argued for a spurious or nonsense result which regression analysis between two non-stationary time series could produce. This means that one could find statistically significant relationship whereas *a priori* there should be none. Stationary time series are so important, according to Gujarati (2003, p.798), the reason is that if a time series is non-stationary; its behaviour can only be investigated for the time period under consideration. However, each set of time series data will therefore be for a particular period. As a result, it is not promising to generalise it to other periods. Therefore, the prediction of such (non-stationary) time series may be of little practical value. It is therefore necessary to ascertain that the markets return series are stationary using the Augmented Dickey Fuller (ADF) unit root test (URT) and Phillips-Perron (PP) test (Dickey and Fuller, 1979; 1981; Phillips and Perron, 1988).

However, to evaluate adequacy of the GARCH-X (1,1) model, we evaluated how well it fits the data. In addition to providing good fit, the estimated standardised residuals should be serially uncorrelated and should not display any remaining conditional volatility (Engle and Paton, 2001). The adequacy of the GARCH-X model that will be fitted to the Nigeria financial markets return series will be evaluated by testing the standardised residuals for independence. If the mean model is adequate, the standardised residuals will be uncorrelated. Similarly, a good variance model has uncorrelated squared standardised residuals (Emenike, 2015).

4 Descriptive analysis

Tables 1 and 2 presents the descriptive statistics of the level series of the monthly ASI, interbank call rate and PLR in Nigeria. Notice from Table 1 that the average monthly ASI of the NSE is 28,680. The mean monthly interbank call rate is 12% and the PLR is 17.8%. Equally, Table 2 shows the descriptive statistics of the return series of the monthly ASI, interbank call rate and PLR in Nigeria. Observe that the monthly mean returns of the ASI, interbank call rate and PLR in Nigeria are 0.5%, –0.4% and –0.2% respectively.

The null hypothesis of normal distribution of skewness is 0. The skewness value for the ASI, interbank call rate and PLR in Nigeria are –0.563, 0.018 and –0.738, respectively. These show that the ASI and PLR are negatively skewed, while interbank call rates are not skewed. In a normally distributed series, skewness is 0 and kurtosis is 3. Positive or negative skewness indicate asymmetry in the time series under study and kurtosis coefficient greater than or less than 3 suggest peakedness or flatness of the data (Emenike, 2015). In a normally distributed series, excess kurtosis is 0. Positive or negative excess kurtosis suggests peakedness or flatness of the data.

The kurtosis coefficients for all the series show evidence of leptokurtosis. The implication of leptokurtosis is that, for a large part of the time, extreme observations are

much more likely to occur. Leptokurtic stock returns, for example, implies that investors can make very high returns and as well lose large amount of their investments (see Emenike, 2015). Jarque-Bera statistics also show absence of non-normal distribution in all the series.

Table 1 Descriptive statistics for money market rates and stock market level series

	SMR	*IBR*	*PLR*
Mean	28,680.73	12.00	17.86
Min.	10,581.90	0.77	14.58
Max.	65,652.38	36.42	26.38
Std. dev.	11,340.06	6.72	2.40
Skewness	1.01	10.1	1.92
	(0.00)	(0.00)	(0.00)
Kurtosis	0.98	1.57	3.92
	(0.00)	(0.00)	(0.00)
J-B Stat.	38.07	49.39	226.86
	(0.000)	(0.00)	(0.00)

Notes: *P*-values are displayed as (.). All the tests are conducted at 5% significant level.

Source: Author's computation (2018) using RATS Version 9.0

Table 2 Descriptive statistic for money market rates and stock market returns series

	SMR	*IBR*	*PLR*
Mean	0.005	–0.004	–0.002
Min.	–0.365	–2.010	–0.175
Max.	0.323	1.935	0.118
Std. dev.	0.072	0.537	0.026
Skewness	–0.563	0.018	–0.728
	(0.002)	(0.919)	(0.000)
Kurtosis	5.376	3.682	12.594
	(0.000)	(0.000)	(0.000)
J-B Stat.	225.037	101.156	1,198.820
	(0.000)	(0.000)	(0.000)
McL (26)	3.261	0.178	8.967
	(0.180)	(0.858)	(0.999)
LB-Q (26)	2.73	2.323	24.180
	(0.244)	(0.098)	(0.565)

Notes: *P*-values are displayed as (.). All the tests are conducted at 5% significant level.

Source: RATS Version 9.0 computer package (2018)

The heteroscedasticity in Table 2 was verified using McLeod-Li test and serial correlation test was done using Ljung-Box Q, The lag length of the tests of both the McLeod-Li and Ljung-Box Q were selected using Bayesian information criterion (BIC), Estimates from lags 26 of the BIC show absence of heteroscedasticity and serial

correlation in the residual of the stock returns and money market indicator series. Hence series are apt for volatility analyses.

4.1 Time series graphs of money market indicators and stock market series in Nigeria

Figures 1 to 3 present plots of log-level and return series of the ASI, interbank call rate and PLR in Nigeria for the study period.

Figure 1 Time graph of level and returns for stock market index in Nigeria January 2002 to December 2016 (see online version for colours)

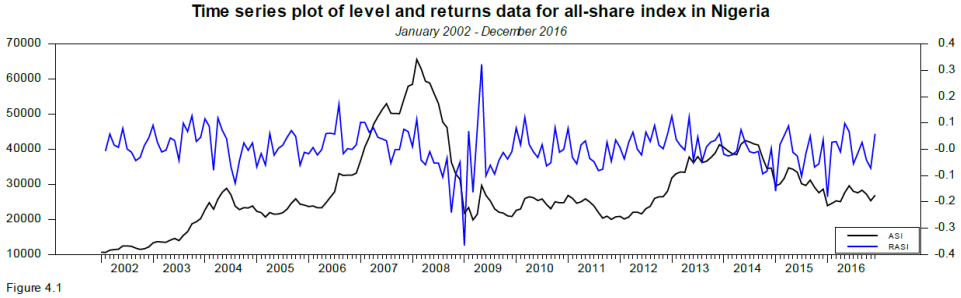

Figure 4.1

Notice from Figure 1, that the log-level series was trending upward till the first quarter of 2008, when it started a downward trend as a results global financial crisis. This implies that the log-level series may not be stationary. Towards the first quarter of 2012, the series regained its upward movement. This is an indication that Nigeria stock may have regained investors' confidence. The return series, on the other hand, appear to be mean reverting, which is an indication that the series appear stationary. Notice also large downward and upward spike in the 2008 and 2009 period, which correspond with the era of the global financial crisis.

Figure 2 Time graph of level and returns data for interbank call rate in Nigeria January 2002 to December.2016 (see online version for colours)

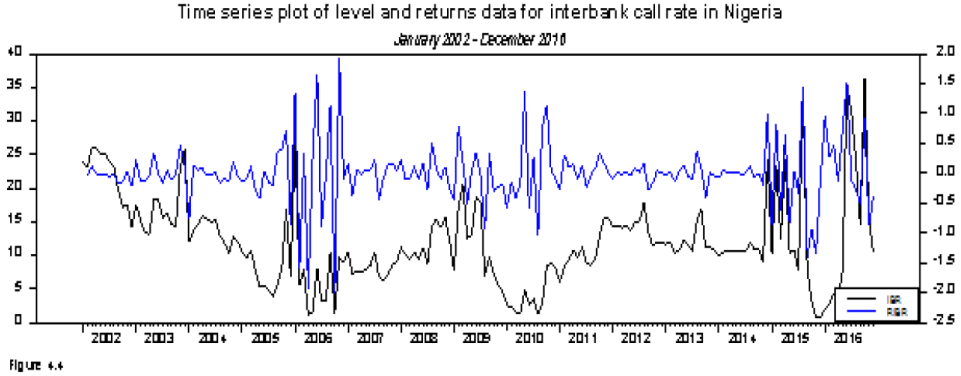

Figure 4.4

Figure 2 presents the graphic behaviour of the log-level and return series of the interbank call rate in Nigeria for January 2000 to December 2016 study period. Observe from the graph that the level and return series have many fluctuations. This indicates the nature of money market interbank.

Figure 3 Time graph of level and returns data for PLR in Nigeria January 2002 to December 2016 (see online version for colours)

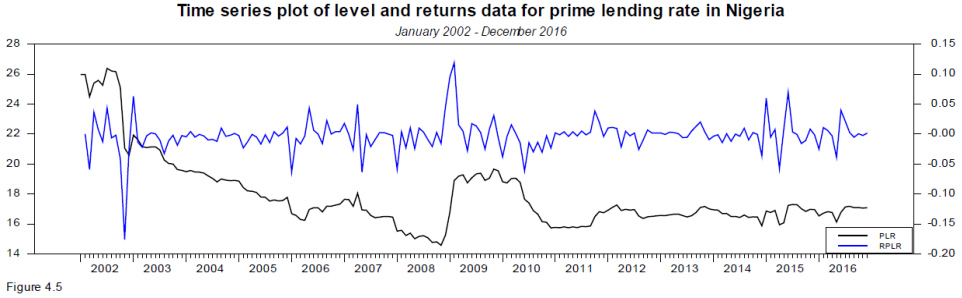

Figure 3 present the graphic behaviour of the log-level and return series of the PLR in Nigeria for January 2000 to December 2016. Observe from the graph that the level series is trending downwards, although with minor fluctuations. The return series however shows wide fluctuations, with mean reversion tendency.

4.2 URTs for money market indicators and stock market series in Nigeria

Tables 3 and 4 present the results of URTs conducted on the log-level and first difference series of the stock market indices, treasury bills rate, interbank call rate, MPR, and PLR. The URTs were conducted using ADF and PP tests. The ADF and PP tests were conducted at 5% level of significance in order not to accept a false null hypothesis.

Table 3 Results of URT for money market indicators and stock market level series in Nigeria

	ADF results		*Phillip-Perron results*	
	5% critical value	*Computed value*	*5% critical value*	*Computed value*
SMR	–3.435	–1.823	–3.435	–2.036
IBR	–3.435	–4.069**	–3.435	–5.441**
PLR	–3.435	–3.031	–3.435	–2.820

Note: **refers to 5% statistical significance levels.

As we can see from Table 3, the money market indicators and stock market series are not stationary at their levels, except for interbank call rate series. This is evidenced in the computed ADF coefficients being less than theoretical values in absolute terms. Similar results were obtained from PP tests except, also, for the interbank call rate series.

In their first differences, however, the absolute values of the computed ADF coefficients exceed the critical values at 5% significance level. Table 4 shows that the computed ADF coefficients –11.560, –1, –18.881 and –11.553 for the stock market, interbank call rate and PLR respectively are greater than the theoretical value (–3.435) at 5% significance level. These imply that money market indicators and stock market series

require first differencing to become stationary. These results are supported by the PP test. However, in their first differences the absolute values of the computed ADF coefficients exceed the critical values at 5% significance level.

Table 4 Results of URT for money market indicators and stock market return series in Nigeria

	ADF results		*Phillip-Perron results*	
	5% critical value	*Computed value*	*5% critical value*	*Computed value*
SMR	–3.435	–11.560**	–3.435	–11.815**
IBR	–3.435	–18.881**	–3.435	–19.597**
PLR	–3.435	–11.553**	–3.435	–11.594**

Source: RATS Version 9.0 computer package (2018)

4.3 GARCH-X results of the effect of money market indicators and stock market return volatility in Nigeria

In this section we present results of the GARCH models estimated to evaluate the effect of money market rates on stock market returns volatility in Nigeria. The GARCH-X (1,1) model is appropriate model because it allows explanatory variable to be added to the GARCH equation (Lee, 1994; Emenike and Odili, 2014).

Table 5 Estimates of GARCH (1,1) benchmark model for stock return volatility in Nigeria

Parameters	*Coefficient*	*T-statistics*	*Significance*
Constant	0.012	2.341	0.019
α_0	0.0005	2.376	0.017
α_1	0.204	2.609	0.009
β_1	0.690	9.205	0.000
$\alpha_1 + \beta_1$	0.894		
Q(6)	11.332	0.078	
ARCH-LM (6)	13.612	0.074	

Source: RATS Version 9.0 computer package (2018)

Table 6 Results for GARCH-X model for effect of money market indicators on stock return volatility

Parameters	*Coefficient*	*T-statistics*	*Significance*
Constant	0.014	23.792	0.000
α_0	0.002	30.840	0.000
α_1	0.042	12.995	0.000
β_1	0.468	72.461	0.000
$\alpha_1 + \beta_1$	0.610		
λ_{IBR}	0.012	1.442	0.149
λ_{PLR}	–0.218	–1.110	0.226

Source: RATS Version 9.0 computer package (2018)

Notice from the GARCH (1,1) benchmark model estimates presented in Table 5 that there is volatility clustering in the Nigeria stock market returns. This is evident in the statistical significance (0.00) of the GARCH parameter (β_1). Notice also that the volatility of the Nigeria stock market is persistent, as shown by the sum $\alpha_1 + \beta_1$ (0.89) being close to 1.

Observe from Table 6, also that the results of the GARCH-X (1,1) model show that money market indicators have no effect on stock market returns volatility in Nigeria at the 5% significance level. Specifically, the coefficient of the interbank call rate and PLR, however, are not significant the 5% significance level (0.05).

Table 7 Diagnostic test results for GARCH-X model for effect of money market indicators on stock return volatility

Parameter	*Statistic*	*Significance level (χ^2)*
Q(6)	11.066	0.086
Q2(6)	9.215	0.161
ARCH-LM (6)	10.107	0.120

Source: RATS Version 9.0 computer package (2018)

The results of diagnostic tests conducted to ascertain robustness of the estimated ARDL model are displayed in Table 7. Notice that the Ljung-Box Q-statistic for the model residuals is not significant. This indicates that there is no autocorrelation in the residuals. In a like manner, the ARCH-LM diagnostic test result shows that there is no heteroscedasticity in the residuals at 5% significance level. Therefore, the outcomes reported are serially uncorrelated and homoscedastic. Hence, the results reported are valid for reliable interpretation.

Table 8 GARCH result of the effect of interbank rate on ASI in Nigeria

Parameter	*Coefficient*	*T-statistics*	*Significance*
Λ_{IBR}	0.012	1.442	0.149

Source: RATS Version 9.0 computer package (2018)

Notice from Table 8 shows that interbank call rates do not significantly affect ASI in Nigeria at the 5% significance level. This is evident in the *t*-statistic of the coefficient of interbank call rate (1.44) being less than the theoretical *t*-statistic (1.96), and the *p*-value (0.149) being above the significance level (0.05). The above discussed findings that the calculated *t*-statistic (1.44) of the interbank rate coefficient is less than the critical *t*-statistic at the 5% significance level (±1.960). Similarly, *p*-value of the effect of changes in interbank bank call rate on ASI (0.149) is greater than the significance level (0.05), and thus indicates evidence in support of the interbank call rate insignificant effect on ASI in Nigeria. This indicates that changes in interbank call rate have no significant effect on ASI in Nigeria.

Table 9 GARCH results of the effect of PLR on ASI in Nigeria

Parameter	*Coefficient*	*T-statistics*	*Significance*
Λ_{PLR}	–0.218	–1.110	0.226

Source: Author's computation, 2018 derived from Table 7

Notice from Table 9 that PLR do not significantly affect ASI in Nigeria at the 5% significance level. This is evident in the insignificance of the *t*-statistic (–1.110) being less than the theoretical *t*-statistic (–1.96) and the *p*-value (0.226) being greater than the significance level (0.05). The above stated findings shows that the calculated *t*-statistic (–1.110) of the PLR parameter is greater than the critical *t*-statistic at the 5% significance level (±1.960). Similarly, *p*-value of the coefficient of the effect of PLR on stock market returns volatility (0.22) is greater than the significance level (0.05). This indicates that changes in PLR do not have significant positive effect on stock market returns volatility in Nigeria.

5 Conclusions and recommendations

The study investigated the effect of money market indicators on stock market return volatility in Nigeria. A bench mark GARCH –X (1, 1) model was estimated as a basis to evaluate the effect of money market indicators which were used as research variables. We also estimated and included the results of heteroscedasticity and serial correlation in the preliminary analysis. The heteroscedasticity was verified using McLeod-Li test and serial correlation test was done using Ljung-Box Q, The lag length of the tests of both the McLeod-Li and Ljung-Box Q were selected using BIC, estimates from lags 26 of the BIC show absence of heteroscedasticity and serial correlation in the residual of the stock returns and money market indicator series. Hence series are apt for volatility analyses.

However, the result of the GARCH-x (1,1) model estimate provided evidence of volatility clustering in the Nigerian stock market returns and it is persistent. The result equally indicated evidence to show that money market indicators investigated, have significant effect on stock market returns volatility in Nigeria. This implies that it will take relatively long time for the impact of volatility shock in the previous period to disappear. Finally, the study concludes that changes in interbank call rates and PLR, do not have significant effect on stock returns volatility in Nigeria. The study recommends that government through its agents should put in place mechanism for proper monitoring of banks foreign exchange activities to reduce high cost of borrowing among banks and reduce pressure on banks liquidity. Equally Central banks should ensure a reduction in the PLR by banks to their customers/investors to encourage them to borrow more and increase investment

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