Evaluating the Relationship Between Conditional Variance and Daily Stock Market Returns in Nigeria

Ike, Frank Chidiebere[1], Ejem, Chukwu A.[2], Ogbulu, Onyemachi M.[3] Onyegbule, Kenneth C.[4]

[1.] Federal Polytechnic, Ngodo Isuochi, Nigeria
[2. 3] and [4.] Department of Banking and Finance,
Abia State University, Uturu, Nigeria.
*Corresponding Author's email:
chukwu.ejem@abiastateuniversity.edu.ng
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Abstract
This study examined the relationship between volatility and daily stock market returns in Nigeria using Exponential Generalized Autoregressive Conditional Heteroskedasticity, EGARCH model. Daily closing price data from the Nigerian Exchange Group (NGX) was analyzed to assess volatility persistence, clustering, and asymmetric responses to economic shocks. Findings showed that high volatility persistence and significant asymmetry, with negative shocks exerting a stronger impact on volatility than positive shocks. The EGARCH model is a sufficient model in capturing these dynamics, underscoring the Nigerian stock market's heightened sensitivity to adverse economic and political events. These results have practical implications for investors and policymakers, underscoring the importance of robust risk management strategies and stability-focused policies. This study contributed to the literature on emerging market volatility and lays a foundation for further research on volatility patterns in other African financial markets.

Keywords: *Conditional Variance, Nigerian stock market, EGARCH, volatility clustering.*

1.1 Introduction

The volatility of stock markets has become an area of significant interest to both investors and policymakers, especially in emerging markets like Nigeria. Stock market returns are inherently volatile, influenced by various factors such as macroeconomic variables, political events, and global economic shifts (Ajao & Osayuwu, 2012). The Nigerian stock market, in particular, exhibits high levels of volatility, which has implications for economic growth, investor confidence, and overall financial stability (Olowe, 2009). Modeling this volatility is essential for understanding the behavior of stock prices and for helping investors make informed decisions. Approaches such as the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model and its variations are commonly used to capture and analyze such fluctuations, offering insights into the risk and return profile of Nigerian stocks (Ogum et al., 2005). By investigating daily stock market returns and volatility patterns, researchers and stakeholders can better understand market dynamics and develop strategies for risk management in Nigeria's financial markets (Omorokunwa & Okonofua, 2019).

The stock market is one of the most important segments of a nation's financial system. It is the market available to companies for meeting their requirements of the long-term funds or assets that is, shares and debentures. In other words, it is concerned with the raising of money capital for purposes of making long-term investments (Ibenta, 2005; Ezirim, 2005). These securities are regularly transacted, that is sold and purchased at prices which are supposed to reflect all the information relating to the issuing company. To understand why good financial decisions are reflected in positive share prices adjustment as well as how the securities are valued or price in the market, it is necessary to understand the efficiency of the market (Ogbulu, 2016; Onyele & Nwadike, 2021). Efficiency of the market is a concept underlying investment analysis. Ibenta (2005) is of the opinion that the efficiency of stock markets is the key to optimal allocation of resources. That it is necessary to have an efficient stock market to ensure that the investor is involved in a fair game. This is anchored on the efficient market hypothesis (EMH) which was developed from the Random Walk Theory. The EMH argues that the market is always efficient meaning that share price instantly reflects available or knowable information in the market (Fama, 1970). The market is efficient when the market price is a good and correct guide for share selection. It can also mean that all known information is immediately discounted by all investors and reflected in share prices in the stock market. No investor has information advantage to make abnormal profit. (Bhalla, 2011; Marobbe & Pastory, 2019). The effectiveness of a nation's stock market is dependent but not limited to the extent of economic advancement and the existence of both monetary and fiscal policies. The reason is that fund is required to propel the engine of the expansion and as well enhance output, and advancement in the economy. This fund in focus is supplied to the economy through various channels: varying from banks and non-bank finance institutions like insurance companies, mortgage banks, finance houses etc. The funds provided could be in many forms or variants like equity, preferred shares, bonds, or direct loans on short-, medium- or long-term basis. However, in all these capital movements listed, there is a pre-determined or conscious attempt to create a financial intermediation process between the surplus units or lenders of funds and the users of funds (Okpara, 2012; Alanya-Beltra, 2022).

Stock markets are inherently volatile, with returns influenced by economic, political, and global factors. This volatility poses a considerable challenge, especially in emerging markets like Nigeria, where daily stock market returns can fluctuate unpredictably. The Nigerian stock market, one of the largest in Africa, plays a vital role in the country's economic growth and development. However, the volatility in returns raises concerns for investors, analysts, and policymakers, as high volatility implies increased risk, leading to investor uncertainty and reduced investment inflows (Ewetan & Okodua, 2013). Volatile stock markets often experience rapid price swings, which, when not well-understood, can discourage investment and affect the financial stability needed to foster economic development (Asaolu & Ogunmuyiwa, 2011).

In Nigeria, the determinants of stock market volatility are multifaceted, ranging from macroeconomic variables, like inflation and exchange rates, to global events that influence both local and international investment sentiment (Adekunle & Sunday, 2010). Political instability and economic policies also add to the unpredictability of daily returns (Olowe, 2009). To capture this volatility, researchers often employ econometric models, such as the Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) models, which can effectively model time-dependent changes in volatility. These models provide insights into the structure of returns and help identify volatility clusters, a characteristic feature of emerging markets, where periods of high volatility tend to follow each other closely (Emenike, 2010).

A clear understanding of volatility dynamics is essential for improving market efficiency and investor confidence. However, most existing studies focus on developed markets, leaving gaps in research specific to emerging economies like Nigeria (Ajao & Osayuwu, 2012). While advanced volatility models are frequently applied in established markets, there is a shortage of research applying these tools to the Nigerian market context (Ajayi, 2011). This research gap makes it difficult for investors to accurately assess risk and for policymakers to make informed regulatory decisions. Modeling volatility in the Nigerian stock market is not just a statistical exercise; it is a necessary step in developing risk management strategies and stabilizing the market for long-term economic growth (Ogum et al., 2005).

However, bad news will accelerate returns volatility more than good news which may be interpreted by investors as higher risk-return tradeoff. Since returns on financial assets is a function of the market risk, risk takers are expected to receive a rate of return that will compensate for the risk taken in making such long-term funds (such as, debentures, common share, bond, and mortgage loan) available to economic units (Ejem & Ogbonna, 2020). This explains the long age maxim of Efficient Market Hypothesis (EMH) that all available information is correctly reflected in stock prices and thus stock prices rapidly react to any novel information that reaches the market participants (Brealey & Meyers, 2003). This informational fundamental comprises changes to firms' operations, modifications in macroeconomic policies, twist in the level of investors' risk-return preference, financial integration, natural disaster, etc. (Sansa, 2020).

Therefore, this study is conceived to add to the knowledge about the relationship between stock market volatility in Africa by investigating all stock markets in Africa and this investigation will be anchored on the efficient market hypothesis (EMH).

Given the importance of understanding volatility, this study aims to apply EGARCH models to analyze daily stock returns in Nigeria. By doing so, it seeks to provide a framework for predicting market behavior, managing risk, and guiding policy decisions. Understanding these volatility patterns will also aid in mitigating the risks associated with speculative bubbles and market crashes, thus creating a more robust investment environment in Nigeria (Omorokunwa & Okonofua, 2019).

1.2 Statement of Problem

Volatility in the Nigerian stock market not only impacts investor confidence but also affects broader economic growth by influencing investment levels and capital flows (Ewah et al., 2009). This instability is exacerbated by economic shocks, political uncertainties, and global market trends, which further contribute to the unpredictability of stock performance (Olowe, 2009). The Nigerian stock market is noted for its substantial return potential but is highly susceptible to extreme volatility, posing risks for investors and complicating effective portfolio management. As one of Africa's largest markets, the Nigerian Exchange Group (NGX) is influenced by complex internal and external factors that cause significant fluctuations in daily stock returns (Adekunle & Sunday, 2010). A major issue arises from the limited application of advanced volatility models that accurately capture the unique behaviour of stock returns in emerging markets like Nigeria (Omorokunwa & Okonofua, 2019). Most volatility studies in Nigeria rely on basic descriptive models or conventional econometric methods, which may not fully reflect the asymmetry and clustering effects typical of daily stock returns (Ologunde et al., 2006). These gaps in research create a need for models, such as the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH), which can better capture time-varying volatility and provide more

reliable forecasts for risk assessment (Ajao & Osayuwu, 2012). Understanding these volatility patterns is crucial, as they impact investor decision-making, regulatory policies, and the stability of Nigeria's financial sector (Emenike, 2010).

Moreover, without a clear understanding of volatility patterns and their causes, the Nigerian stock market remains vulnerable to speculative bubbles and sudden crashes, undermining its attractiveness as a safe investment destination (Ajayi, 2011). Addressing these issues through detailed volatility modeling could contribute to stabilizing market performance, thus creating an environment more conducive to sustainable economic growth and attracting both local and international investors.

2. Review of Related Literature

2.1.1 Stock Market

Equity securities or stocks represent the ownership of companies. Holding a stock of a company means that the stockholder has the partial ownership of that company and entitled to receive the profit from the company's operation. Stocks comprise two kinds, the preferred and common stocks. Preferred stocks holders are entitled to a fixed dividend but don't have voting right. Wherefore, stock or equity securities mostly refers to common stocks. The holder of common stocks has the right of voting and getting dividend. Company issues stocks to collect long term funds and investors, individual and financial institutions, buy those stocks as a long-term investment. Investors can buy new stocks from primary market existing securities from secondary market. Brokerage firms help investors as a financial intermediary to buy and sell existing stocks in secondary market. These secondary market transactions can be performed in the over the counter (OTC) market if the stocks are not listed on an exchange. Organized exchange is an established platform for secondary market trading of listed stocks. In Nigeria, transactions in stock exchanges are strictly monitored and regulated by the Securities and Exchange Commission (SEC) and considered safer than OTC transactions (Ezirim, 2005; Ibenta, 2005; Okpara, 2012; Ogbulu, 2019).

The concept of stock market volatility refers to the degree of variation in stock prices over time, reflecting the level of risk associated with the market. Volatility is generally viewed as a double-edged sword, as it represents both opportunities for high returns and the potential for significant financial losses (Schwert, 1990). In emerging markets like Nigeria, volatility tends to be higher due to less mature market structures, lower liquidity, and vulnerability to external economic shocks, making volatility a critical component of financial risk analysis (Ewetan & Okodua, 2013). Modeling volatility is essential for understanding risk-return dynamics, as it helps predict future price movements and supports better investment decision-making (Ajao & Osayuwu, 2012).

The Nigerian stock market is particularly prone to high volatility due to several structural and economic factors, including regulatory changes, political instability, and dependence on oil revenue, which makes it susceptible to fluctuations in global oil prices (Olowe, 2009). The concept of "volatility clustering" is the tendency for high-volatility periods to be followed by similar periods is a notable feature in Nigerian stock returns and is well-documented in the literature on financial markets (Mandelbrot, 1963).

2.1.2 Volatility Modeling and Stock returns

Modeling and forecasting volatility inherent in stock market has over the decades occupied empirical and theoretical investigations by finance and economic experts. This academic excursion has a lot of motivations due to the prime place taken by volatility in the field of finance. Brooks

(2008) sees volatility as measured by the standard deviation or variance of returns, is sometimes applied as a crude measure of the total risk of financial assets. However, volatility models for evaluating market risk need the estimations or forecast of volatility parameters. From previous study the mostly used stationarity models are original Autoregressive Conditional Heteroskedastic (ARCH) presented by Engle (1982) permits the conditional variance to change over time as a function of past errors leaving the unconditional variance constant. Furthermore, Engle et al (1987) introduced the ARCH-M model, an extension of ARCH model which allows the conditional variance to be determining factor of the mean. Engle et al model was applied to three different data sets of bond yields; hence came out to opine that risks are not time invariant; instead risks vary systematically with the assumptions of underlying uncertainty. Other models are improvement of ARCH model, such as Generalized Autoregressive Conditional Heteroskedasticity (GARCH), introduced by Bollerslev (1986). This generalized ARCH model allows for a longer memory and a more permissible and flexible lag structure at the same time. It provides a relatively long lag in the conditional variance equation and negates the problems associated with negative variance parameters in a fixed lag structure. The difference between the ARCH and GARCH is that in ARCH model, the conditional variance is specified as a linear function of past sample variance only, while the GARCH process permits lagged conditional variances to also enter in the model. ARCH and GARCH family models is to provide a volatility measure applied in financial decisions with about risk analysis, portfolio selection and derivative pricing (Bollerslev 1986, Engle & Ng, 1993; Bera & Higgins, 1993). Another is the Exponential GARCH (EGARCH) model which according to Brook (2008) is an improvement of the GARCH which imposes a non-negativity constant on market variable and permits for conditional variance to respond asymmetrically to returns innovations of different signs. The EGARCH used to describe the behavior of return volatilities by Nelson (1991) was proposed to test the hypothesis that the variance of return was affected differently by positive and negative excess returns, and that excess returns were negatively related to stock market variance.

2.2: Theoretical Review

Various theoretical frameworks have been developed to explain and model stock market volatility, with the Efficient Market Hypothesis (EMH) and Behavioral Finance Theory serving as foundational theories. According to the EMH, stock prices fully reflect all available information, and therefore, price changes are unpredictable and follow a random walk (Fama, 1970). However, empirical findings challenge this hypothesis, especially in emerging markets, where information asymmetry, lower liquidity, and market inefficiencies are more pronounced (Ologunde et al., 2006). This gap highlights the need for volatility models that account for these unique market characteristics. The Autoregressive Conditional Heteroskedasticity (ARCH) model by Engle (1982) and its generalized form, the GARCH model, developed by Bollerslev (1986), provide robust methods for capturing time-varying volatility in stock returns. These models account for the "clustering" phenomenon and have been widely used in finance to model returns volatility in various markets, including Nigeria's. Extensions of the GARCH model, such as the Exponential GARCH (EGARCH) and Threshold GARCH (TGARCH) models, incorporate asymmetries in volatility, which is essential for capturing the stylized fact that negative shocks have a larger impact on volatility than positive ones (Nelson, 1991). Behavioral theories, such as prospect theory, also contribute to understanding volatility, as they suggest that investor overreaction to news can exacerbate price swings, particularly in less regulated markets (Kahneman & Tversky, 1979).

2.2.1 The Efficient Markets Hypothesis

The efficient market hypothesis (EMH) remains a topic for debate. The EMH states that the market price for shares incorporates all the known information about that stock. This means that the stock is accurately valued until a future event change that valuation. Because the future is uncertain, an adherent to EMH is far better off owning a wide swath of stocks and profiting from the general rise of the market. Studies on stock returns volatility are often anchored on the Efficient Market Hypothesis (EMH) which was developed by Fama (1970). The EMH explains why stock prices are seen to follow a random walk. Fama (1970), an efficient market is one in which all available information are reflected in the stock prices. According to the EMH, the intrinsic value of shares and other financial assets is defined by the future discounted value of cash flows accruing to investors (Fauzel & Fauzel, 2016). Hence, if the stock market is efficient, all available information must be reflected in stock prices. This is needful for the assessment of a firm's performance in the future; therefore, the intrinsic and market value of a share should be equal (Lo & MacKinlay, 1988). Hence, an information that may alter firm's profitability in the future must be reflected in the share price immediately, else any delay in information diffusion to price would lead to irrationality as availability of some information could be exploited to predict or forecast profitability (Bohl & Henke, 2003). As such, in an efficient market, it is assumed that changes in share prices are unpredictable since there is random arrival of information. There are three levels of efficient markets among which is the weak-form efficiency whereby the information content of interest is historical prices (Fama, 1970). The weak form efficiency suggests that current stock prices reflect all information of previous prices and that investors cannot apply technical analysis of any form in their investment decisions (to determined undervalued or overvalued stocks) but can research firm's financial statements to boost their chances of gaining returns higher than that of the market. On the other hand, the semi-strong form is hinged on the notion that investors cannot use either fundamental or technical analysis to obtain higher returns in the market since all publicly available information is used in the computation of current stock prices and that only information that is not available to the public (private information) can aid investors boost their returns above that of the market (Ogege et al, 2015). The advocates of the strong form version states that all available information (both public and nonpublic) is completely reflected in the current stock prices, that is, there is no type of information that can make an investor make returns higher than the market, not even insider knowledge give investors a predictive edge over the entire market. The building block of this study is the weak form of market efficiency (Rossi & Guardi, 2018).

2.1.2: Behavioural finance theory

This is an innovation in the field of finance, a departure from the efficient market hypothesis. This theory believes that the pattern of behaviour, whether overconfidence, overreactions, over representation, perceptions of investors are the same, hence such attitude do heavily influence share price from reflecting the economic fundamentals or beliefs or assumptions. It borders on how psychology influences investment decision-making process and financial markets, hence deviation of investors from traditional economic assumptions (Kumar, 2017). Contrary to the EMH that sees investors as trying to outsmart each other in the market to make abnormal profit thereby making prices of securities return to equilibrium market value, also does not see all investors to be rational, rather assume that markets make unbiased forecast for future (Copur, 2015; Kumar, 2017; Ogbulu, 2019), the behavioural finance theory adjudges investors as both rational and exhibit behavioural biasness while evaluating and pricing securities.

2.3 Empirical Review

Ibe and Uche (2019) looked at the asymmetric volatility and the Nigerian stock market using EGARCH model. The results indicated that negative shocks had a more substantial impact on volatility than positive shocks, confirming the presence of leverage effects in the Nigerian stock market. The study highlighted the importance of considering asymmetry in volatility modeling to provide better risk assessment tools for investors. Omorokunwa and Okonofua (2019), examines the Modeling Stock Market Volatility in Nigeria: A Comparative Analysis of GARCH and EGARCH Models applying GARCH and EGARCH models. The EGARCH model outperformed the GARCH model in terms of model fit and capturing the asymmetric effects of volatility. The study concluded that incorporating asymmetry into volatility models provides a more accurate representation of market dynamics in Nigeria, aiding investors in risk management. Alagidede, and Panagiotidis (2009) studied Volatility Transmission in the Nigerian Stock Market: Evidence from GARCH Models with GARCH and VAR models. The study found significant volatility transmission from global markets to the Nigerian stock market, suggesting that international factors play a crucial role in shaping domestic volatility. This interdependence implies that Nigerian investors need to consider global market trends when assessing risks.

Adebiyi and Adebayo (2019), investigated the Stock Market Returns and Volatility in Nigeria using GARCH model. The results indicated that stock returns in Nigeria exhibit volatility clustering, and past volatility significantly influences current returns. The study concluded that understanding this relationship is essential for developing effective trading strategies in the Nigerian stock market. Onyele and Nwadike (2021) established the relationship between stock returns volatility and asymmetric new effects around the world. The study employed GARCH, GARCH-M (1,1), TGARCH to examine daily S&P Global 1200 index from September 1,2010 to September 30, 2020. The S&P Global 200 index stood for free float weighed stock market index of global equities taken care of 7 regional stock market indices and close to 70% of the global market capitalization. The analysis of GARCH-M and TGARCH models have explosive volatility persistence strong asymmetric news effect in the global stock market.

In another study, Musa, Adamu, and Dauran (2020) applied PGARCH and revealed that volatility persistence in the Nigerian Stock Market reduced significantly after unexpected shocks between 1987 and 2019. Bello (2020) used GARCH (1,1) and daily data from 2008-2018 to analyze stock returns volatility and found high volatility persistence in the Nigerian Stock Market. Ejem and Ogbonna (2020) used EGARCH and showed evidence of returns volatility persistence and asymmetric news effect in the Nigerian Stock Market.

While Marobbe and Pastory (2019) used the GARCH models to model stock market volatility in Dar es Salaam stock exchange with daily closing stock price indices from January 2, 2012, to November 22, 2018, with GARCH, GARCH (1,1), EGARCH (1,1) and PGARCH. It was established that all three models were significant to forecast stock returns volatility at DSE. It was also established that the magnitude of stocks volatility is higher with good news as opposed to bad news. EGARCH models showed evidence of leverage effects associated with the stock returns which can be hazardous to the trading companies' capital structure. Also, PGARCH was found to be more accurate in predicting stock returns based on both Root Mean Square Error (RMSE) and Theil Inequality Coefficient (TIC).

Adewale, Olufemi, and Oseko (2016) investigated shock persistence and asymmetry in Nigerian stock market by incorporating structural breaks using monthly stock returns for the period from January 1985 to December 2014. They segmented the study period into pre-structural break period

and after break period having identified breakpoints in the series. Result from the basic GARCH model showed higher shock persistence during pre-break sub-period than the post break sub-period. No evidence of asymmetry or leverage effect was found in the asymmetric GARCH model with or without incorporating the breakpoints in Nigerian stock market.

Ogege (2016) investigated the nature of Nigerian stock Exchange (NSE) employing mainly stock indices in the period January 2003 to December 2014. The study employed GARCH (1,1) model to evaluate stock returns and found strong evidence of volatility clustering in the series and volatility persistence for the stock returns data.

Dikko et al. (2015) modeled abrupt shift in time series using dummy variable by employing both symmetric and asymmetric GARCH models with and without sudden shifts in variance. They used daily quotations of 10 insurance stocks of the Nigerian stock exchange from 02/01/2006 to 26/05/2014. They found significant reduction in shock persistence in volatility of most insurance stock returns when the regime shifts were incorporated into the models.

Bala and Asemota (2013) employed GARCH models with and without breaks to examine the volatility of exchange rate of naira against US Dollar, British Pounds and European Euro using monthly exchange rate data. There was high persistence of shocks in all the models, although the introduction of structural breakpoints improved the volatility estimates by reducing shock persistence in most of the estimated models. Asymmetric property was not evidenced in most estimated models. Onakoya (2013) conducted an empirical investigation on the trade-off between stock market volatility and economic growth in Nigeria over the period 1980-2013 using Exponential Generalized Autoregressive Conditionally Heteroskedastic (EGARCH) technique. It was documented that there is tendency for volatility to be persistent thereby distorting growth on the long run. Applying EGARCH, Nwezeaku and Okpara (2009) examined volatility clustering in Nigerian stock market. They found that volatility clustering is not quite persistent but there existed asymmetric effect in the Nigerian stock market. They concluded that unexpected drop in price (bad news), increases predictable volatility more than unexpected increase in price (good news) of similar magnitude in Nigeria.

3 Methodology

3.1 Sources of Data

This study employed time series data (daily stock return historical data) spanning from June 30, 2015, to October 25, 2024 obtained from Nigerian Exchange Group (NGX) All share Index (ASI) historical data

3.2 Techniques for Data Analysis

The study employed EGARCH model.

3.2.1 Description of tools to be employed in this study.

Auto-Regressive conditional heteroscedasticity (ARCH), Exponential Generalize Auto-Regressive conditional heteroscedasticity (EGARCH) models with associated mathematical formulations are seen below.

3.2.1.1 Methodology for ARCH model

In the words of Hojatallah et al (2010), the ARCH model is seen as a diagnostic model that examines the ARCH effects and autocorrelation of financial data. It remains the veritable model

that is used to test in a volatility model the presence of ARCH effects and autocorrelation and where a model of no ARCH effects is a good model. Here, two pertinent tests must be carried out for ARCH model: test of stationarity with unit roots test in the residuals, and ARCH effects test. Already discussed, unit root in a time series is checked using Augmented Dickey- Fuller test (ADF), which incorporates regressing the first difference of the series against the series lagged k times (Brooks, 2008; Gujarati, 2013). Here, the series is assumed to be stationary if the ADF test rejects the null hypothesis of a unit root in the return series. Furthermore, Engle (1982) gave a process of testing for the presence of ARCH effects in a residual as seen below.

$LM = n.\ R^2 \sim \chi^2_{(p)}$

Where, n = sample size and $R^2$is arrived by regressing $\varepsilon_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \ldots + \alpha_p\varepsilon_{t-p}^2 + u_t$

Whenever the sample is seen to be large nR^2 follows the Chi-square distribution with *df* equal to the number of autoregressive terms in the auxiliary regression model. Here, whenever there is non-rejection of the null hypothesis, it shows no volatility clustering, and the rejection of same null hypothesis indicates the presence of ARCH effects. According to Engel (1982), to evaluate heteroscedasticity, the linear ARCH (q) model for heteroscedasticity is used.

$h_t^2 = \beta_0 + \sum_{i=1}^{q}\beta_1\varepsilon_{t-p}^2$

If $\beta_1 = 0$, then there is no volatility clustering. The AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) are applied to determine the ARCH model order (the value of q) where the model with the minimum value of information criterion is to be preferred.

3.2.1.2 Methodology for GARCH family

Here, some of the models in GARCH family to be considered are GARCH, EGARCH and TGARCH. As already stated, GARCH (p,q) specifies the conditional variance to represent linear combination of (q) lags of the squared residuals $\varepsilon_t^2$from the conditional return equation and (p) lags from the conditional variance σ_{t-j}^2. This GARCH (p,q) conditional variance is expressed as;

$\sigma_t^2 = \omega + \sum_{i=1}^{p}\alpha_i\varepsilon_{t-i}^2 + \sum_{j=1}^{q}\beta_j\sigma_{t-j}^2$

This is estimated under the constraints; $\alpha_1\beta > 0$ and $(\alpha + \beta) < 1$. It's (GARCH model) adequacy is examined by standardized residual $\frac{\varepsilon}{\sigma}$. Where (σ) = conditional standard deviation, arrived by the GARCH (p, q) model.

(ε) = residuals of the conditional return equation, and the standardized residuals are assumed to be independently and identically distributed (IID). To test for independence of the error term, a two-step is needed: Ljung and Box (1978), calculate the Liung-Box statistics on the squared observation of the raw data. This test is normally applied to test for the remaining serial correlation in the mean equation; if the mean equation is correctly specified; all Q-statistics is expected not to be significant. Second, is a diagnostic test, also known as post hoc analysis step; it examines the specification of the variance equation. It involves the calculation of the Q- statistics of squared standardized residuals, again if the variance equation correctly specified, all Q-statistics should not be significant. It is a Chi-square statistic, χ^2_{m-p-q}. Here the rejection of null hypothesis signifies that there are no autocorrelation and that the series under examination signposts volatility clustering. Moreso, the adequacy of the GARCH model and selection criteria are examined or evaluated using the same method as of the ARCH model. For that, since the standard GARCH model cannot take account of leverage effects and does not permit for any direct feedback between the conditional variance and the conditional mean, hence the postulations of two popular GARCH models; Threshold GARCH (TGARCH) model or according to Glosten, Jagannathan and Runkle

in1993 called GJR model, and the Exponential GARCH (EGARCH) model (Nelson, 1991). Meanwhile, the TGARCH or GJR model is a simple extension of GARCH with additional features or terms to account for possible asymmetries. Here, the conditional variance is given below as.

$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \gamma\varepsilon_{t-1}^2 d_{t-1} + \beta\sigma_{t-1}^2$

Where $d_{t-1} = 1$, if $\varepsilon_{t-1} < 0$, $= 0$, otherwise. However, the conditional variance of the basic GARCH model is simply extended to include a threshold term, $\varepsilon_{t-1}^2 d_{t-1}$. In this model, $d_l = 1$, if $\varepsilon < 0$, and 0 otherwise. For leverage effect, γ should be greater than zero, and for non-negativity, the following should be: $\alpha_0 > 0$, $\alpha_1 > 0$, $\beta \geq 0$, and $\alpha_1 + \gamma \geq 0$

Therefore, the model is still admissible, even if $\gamma < 0$, given that $\alpha_1 + \gamma \geq 0$.

Decision Rule

If $\propto_t + \beta$ is approximately 1, it shows high persistence in volatility clustering. However, the GARCH model neither considers the asymmetric property of return that is negative relationship between return and conditional volatility nor the leverage effect. This therefore necessitates the use of EGARCH model which accommodates the asymmetric and leverage property.

Brooks (2008), for EGARCH, model, the conditional covariance is given by:

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha\left(\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right)$$

Where, ω, β, α, γ are constant parameters, Log (σ_t^2) = the one period ahead volatility forecast, ω = the mean level, β = persistence parameter, α = volatility clustering coefficient, Log (σ_{t-1}^2) = the past variance, γ = the leverage effect.

The above model ensures that even when the parameters are negative, σ_t^2 will be positive and the asymmetry or the leverage effect measure, γ, will be negative even when the relationship between volatility and log returns is negative. The EGARCH is symmetric when = 0, when $\gamma < 0$ then positive shocks (good news) generate less volatility than bad news (negative shocks); in other way round, bad news or negative shocks magnify more volatility than good news or positive shock of the same magnitude. When $\gamma > 0$, it implies that positive innovations or shocks are more destabilizing than negative innovations or shocks (Black, 1976; Christie, 1982). In other words, negative value of γ is called the 'sign effect'. The choice of EGARCH framework is to accommodate examination of conditional variance (volatility), asymmetric effect and volatility persistence. The $'\propto'$ parameter represents the symmetric effect of the model, if $\propto$ is positive, then the conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller), hence magnitude effect'. The GARCH effect β measures the persistence in conditional volatility. When β is relatively large, then volatility takes a long time to fizzle out or decay or die out following mayhem in the market or economy in general. Succinctly, the EGARCH model has a good number of advantages over the normal GARCH specification. First, since the log (σ_t^2) is modeled, then even the parameters σ_t^2 will be positive. There is thus no need to artificially impose non-negativity constraints on the model parameters. Second, asymmetries are allowed for under the EGARCH formulation, since if the relationship between volatility and returns is negative, γ, will be negative (Brooks, 2008).

Decision Rule

If the expected variance can be used to predict expected returns in eqn (1), then the value of b_2 should be positive and significant for a risk averse investor. That is to say that the higher the risk of an investment, the higher the reward accruable for having undertaken such a risky investment. The EGARCH-M model, a refinement of the GARCH imposes a non-negativity constant on market variable, and allows for conditional variance to respond asymmetrically to returns innovations of different signs. If γ is negative, leverage effect exists. That is unexpected drop in price (bad news) increases predictable volatility more than an unexpected increase in price (good news) of similar magnitude (Black, 1976; Christe, 1982). In other words, negative value of γ is called the 'sign effect'. If $\propto$ is positive, then the conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller). $\propto$ is called the 'magnitude effect'.

3.4 Determination of Expected Returns

The price data is converted into compound returns by taking logarithms:

$R_t = \ln(p_t/p_{t-1})$

where R_t, is the current market returns, p_t is the current market index price, p_{t-1} is the previous market index price.

3.5 Diagnostic and Model Validation Tests

After estimating the models, diagnostic tests, including the Ljung-Box Q-statistic and ARCH-LM test, will be performed to verify model adequacy and to ensure that there is no remaining serial correlation or ARCH effect in the residuals (Engle, 1982). The Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) will be used for model selection, allowing for comparison of model fit and parsimony (Tsay, 2010).

4. Data Presentation, Analysis, and Interpretation of Results

This section deals with acquiring and formulating the solution (analysis and interpretation of data collection of the study) data analysis consists of examining, categorizing, tabulating or otherwise re-combining the evidence to address initial proposition of the study.

4.1: Data

This section made use of data presented in the appendix which are computed returns spanning from June 30, 2015, to October 25, 2024 obtained from NGX.

4.2. Test of ARCH Effect

Table 4.1 ARCH Effect Test

Heteroskedasticity Test: ARCH

F-statistic	212582.8	Prob. F(1,1423)	0.0000
Obs*R-squared	1415.525	Prob. Chi-Square(1)	0.0000

Table 4.1 above shows that the F-version is significant, indicating presence of ARCH effects in the returns.

4.3 Test of Volatility Clustering

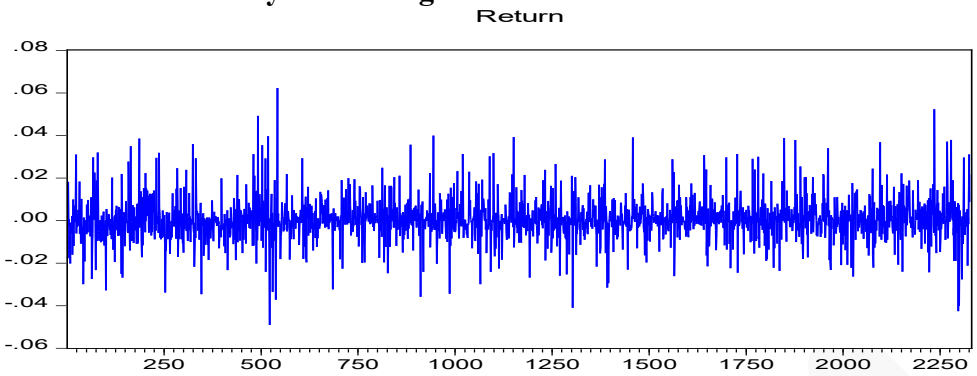


Figure 1: Volatility clustering test

A close look at figures 1 revealed that Nigeria stock market exhibited wide swings for almost all the period under study suggesting that periods of high volatility are followed by the same magnitude of volatility for a prolonged period. The implication of the above movements is that all the stock market under study exhibited property of stock returns distribution called volatility clustering. This means that volatility shocks at the current period influence the expectation of volatility in some periods in the future.

Table 4.2 Estimation of models using EGARCH.

Parameter Estimates	Values
Mean Eqn	
b_2	26.55717 *0.3292
μ	0.012226 *0.5449
Variance Eqn	
ω	-0.001875 *00.4323
α	-8.468733 *0.0000
γ	-0.115831 *0.0001
β	0.038215 *0.0751
Log likelihood	7566.364
Dw Stat	2.001715
AIC	-6.491510
SIC	-6.474219
ARCH LM Test	*0.8402

*Probability values

The findings from Exponential GARCH (EGARCH) model in table 4.2, provide a comprehensive overview of volatility dynamics in Nigeria's stock market. Data from the Nigerian Exchange Group (NGX) from June 30, 2015, to October 25, 2024 was analyzed. The estimated parameters for each model, including coefficients for lagged returns and variance, significance levels, and the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) for model selection, were compiled and compared. These indicators help determine the best-fitting model to capture the characteristics of the Nigerian stock market's daily returns volatility.

The EGARCH model provided further insights by capturing the asymmetric effects of positive and negative shocks on volatility. The coefficient for leverage effect, 'γ', was negative and statistically significant, indicating that negative shocks (such as economic or political instability) have a more substantial impact on volatility than positive shocks (Nelson, 1991). This asymmetric response is essential for modeling the Nigerian market, where political and economic events disproportionately influence investor sentiment. The EGARCH model's superior performance, based on the AIC and SIC values, suggests that it is better suited for capturing these asymmetrical volatility effects compared to the symmetric GARCH model (Engle, 1982).

This corroborates the leverage effect theory which states that the effect of bad news on volatility is higher than the effect of good news of the same magnitude. Furthermore, the persistent parameter β are positive and significant at 10%, also are relatively large for all the market under study indicating that the Nigeria market is various capital market volatility is persistent, confirming that volatility takes a long time to die following the crisis. Magnitude effect ($\propto$) (volatility clustering) coefficient of EGARCH is positive and significant. That means the conditional volatility will rise or fall when the absolute value of the standardized residual is larger (smaller). It is also found that the ARCH- LM tests for the serial correlation is insignificant at 5% critical level, suggesting that the asymmetry models are sufficient in modeling the serial correlation structure in the conditional mean and variance. This indicates there is no further ARCH effect in the estimated EGARCH model, as well as suggesting that the model is correctly specified. The AIC and SIC were found to maintain small criterion value for EGARCH, affirming the suitability of the models, hence are best fit models

4.5 Discussion of Findings

The findings reveal critical insights into the volatility patterns of Nigeria's stock market, supporting existing literature on emerging market volatility. The persistence of volatility, as indicated by the EGARCH model, is consistent with earlier studies, such as those by Emenike (2010) and Olowe (2009), which show that Nigerian market volatility is impacted by a combination of internal and external economic factors. The persistence of variance and clustering effect align with emerging market behavior, where investor sentiment is more easily swayed by both local and global economic developments (Ajao & Osayuwu, 2012). The asymmetric impact of shocks on volatility observed in the EGARCH model suggests that negative news or economic downturns have a disproportionate effect on Nigerian stock returns, amplifying volatility significantly more than positive news does. This aligns with findings by Omorokunwa and Okonofua (2019), who concluded that the Nigerian stock market's volatility is sensitive to both global economic crises and domestic political instability. As in other emerging markets, where information flows are imperfect, this asymmetry can lead to increased risk aversion among investors (Ologunde et al., 2006).

These findings underscore the importance of accounting for asymmetric effects in volatility modeling, particularly in less stable markets like Nigeria. The asymmetric model (EGARCH) provides a more accurate representation of real-world market behaviour, as evidenced by their superior performance metrics. This has important implications for investors, as understanding volatility dynamics can inform risk management strategies and investment decisions. The use of advanced GARCH model can also aid policymakers in developing strategies to improve market stability by addressing the structural factors contributing to volatility.

4.6 Implications for Investors and Policymakers

For investors, the findings indicate the necessity of monitoring volatility closely, particularly during periods of economic or political uncertainty. Understanding the asymmetric impact of negative news on volatility can help investors make better-informed decisions about portfolio risk management. For policymakers, the results underscore the need to develop economic policies that foster stability and minimize the likelihood of negative shocks that could lead to elevated market volatility. This may involve structural reforms and policies that reduce reliance on volatile economic sectors, such as oil (Adekunle & Sunday, 2010).

5. Conclusion and Recommendations

This study contributes to the understanding of volatility modeling in emerging markets, specifically Nigeria. The results demonstrate the effectiveness of asymmetric GARCH model (EGARCH) in capturing the volatility dynamics of the Nigerian stock market, with implications for investors and policymakers. These findings suggest that further research on volatility dynamics in other African markets could provide a broader perspective on the unique factors driving volatility in emerging economies. This study investigated the volatility dynamics of daily stock market returns in Nigeria using advanced econometric model, EGARCH model. Daily closing price data from the Nigerian Exchange Group (NGX), spanning from June 30, 2015, to October 25, 2024, was analyzed. The findings revealed high volatility persistence and clustering, typical of emerging markets, along with asymmetric volatility responses. The EGARCH model indicated that negative news has a more significant impact on volatility than positive news, highlighting the sensitivity of the Nigerian stock market to economic and political events. These results align with earlier studies and contribute valuable insights into understanding the risk profile of Nigerian stocks, which has implications for investors and policymakers alike.

The findings of this study underscore the importance of using asymmetric GARCH model to capture the unique characteristics of volatility in the Nigerian stock market. The high persistence of volatility and the pronounced asymmetric response to negative shocks suggest that investors in Nigeria are highly reactive to adverse information, contributing to volatility clustering. This behavior underscores the relevance of political and economic stability in managing investor sentiment and stock market fluctuations. The study reaffirms that advanced econometric models, such as EGARCH, is essential for accurately modeling volatility in emerging markets where conventional symmetric models may fall short. By capturing these volatility patterns, this study provides valuable insights for market participants and policymakers aiming to understand, predict, and manage stock market risk in Nigeria.

Therefore, the following recommendations are offered:

i. **For Investors:** Investors should be cautious of the high volatility and asymmetric response of the Nigerian stock market to negative events. Risk management strategies, such as portfolio diversification and the use of hedging instruments, should be prioritized to mitigate potential losses due to volatility spikes.

ii. **For Policymakers:** The government and regulatory authorities should aim to improve economic and political stability, as these factors play a crucial role in controlling market volatility. Policies focused on enhancing investor confidence, transparency, and market infrastructure can help reduce sensitivity to shocks.

iii. **For Financial Analysts and Portfolio Managers:** The use of advanced GARCH models, especially those capturing asymmetry (EGARCH, should be integrated into volatility analysis and forecasting. These models enable better predictions of risk and return, which can lead to more effective investment decisions.

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