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VOLATILITY PERSISTENCE AND ASYMMETRIC RISK IN THE NIGERIAN STOCK MARKET: EVIDENCE FROM GARCH AND E-GARCH MODELS

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ABSTRACT

This paper examines the behavior of stock prices and market returns on the Nigerian Stock Exchange between 2012 and 2024, with a focus on volatility dynamics, using both GARCH(1,1) and E-GARCH models. The analysis shows a general rise in stock prices, with a notable and significant spike in 2015 and peaking in 2021-2022. Nonetheless, the returns are highly volatile, with steep changes, especially during periods of economic downturns or when the market is undergoing corrections. The results from the GARCH(1,1) model show that the market has a high volatility persistence, although the average return is not statistically significant. The E-GARCH model further emphasizes the presence of volatility asymmetry, where negative shocks increase volatility more than positive shocks of the same magnitude, reflecting the leverage effect. The findings suggest that the Nigerian stock market is prone to prolonged periods of high volatility following significant shocks, with important implications for risk management and investment strategies. Understanding these volatility dynamics is crucial for investors seeking to steer the complexities of the Nigerian financial market.

Keywords: Volatility Dynamics, Risk Assessment, Nigerian Stock Market, GARCH Models, E-GARCH, Value at risk (VaR)

1. INTRODUCTION

The study of stock market volatility has emerged as an important area of policy and academic research aimed at understanding stock market behavior and making informed investment decisions. Volatility, defined as the degree of variation in market prices over time, plays a crucial role in determining the risk associated with investing in financial markets. While a body of organized literature has developed and dedicated to analyzing volatility in developed economies, there remains a significant gap in the literature of economics and finance regarding emerging markets, and African economies in particular. The Nigerian stock market, as one of the largest and most active stock exchanges on the continent (Yaya, Adenikinju, & Olayinka, 2024; Dibiah, & Mojekwu, 2023; Prochniak, et.al. 2023; Schiereck, et.al. 2018; Osinubi, & Amaghionyeodiwe, 2003), presents a unique and important case study for understanding volatility dynamics and risk assessment in emerging economies.

The Nigerian Stock Exchange (NSE) has evolved considerably over the past few decades, reflecting the broader economic transformations occurring in Nigeria. This growth has been accompanied by periods of heightened volatility, influenced by various factors such as political instability, macroeconomic fluctuations, and external economic shocks. The Nigerian market, heavily

influenced by the country's reliance on oil exports, has been particularly susceptible to global oil price fluctuations (Ojumu, & Osho, 2023; Wang, Zhang, & Xu, 2023; Bamaiyi, 2024). This dependence creates a volatile economic environment that can significantly impact stock market performance, making it a critical area of study for both investors and policymakers. This is especially motivated as the global economy is experiencing one of the worst uncertainties due to U.S. - Isreal with Iran war, and thus there is even greater need to study past behaviour of the market in order to understand the dynamics of the market and, more importantly, to make long-term decisions about stock market investment. Our important assumption is that financial markets are classified into rising and falling faces, well known in the literature as bull and bear phases (see, for instance, Yaya and Gil-Alana 2014). Each of these phases is driven by certain market forces with well documented implication for the stock markets of advanced economies.

Although prior Nigerian studies such as Emenike (2010), Atoi (2014), and Ndubuisi et al. (2023) have documented volatility persistence and leverage effects in the Nigerian stock market, important gaps remain. First, many earlier studies relied on shorter sample periods that excluded major recent episodes such as the COVID-19 pandemic, exchange rate reforms, oil price instability, and post-2021 market recovery. Second, relatively few studies have combined standard GARCH and asymmetric E-GARCH frameworks with additional robustness checks using alternative data frequencies and Log-GARCH specifications. This study, therefore, contributes to the literature by extending the sample period to 2024, incorporating recent macroeconomic disruptions, and providing robustness evidence on volatility persistence and asymmetry in the Nigerian stock market.

Volatility in financial markets is often characterized by sudden and significant price changes, which can be both unpredictable and frequent. In the context of emerging markets like Nigeria, these fluctuations can be exacerbated by various factors, including economic policy changes, political events, and global market trends. For instance, Nigeria's political environment has seen frequent changes and instability, which can lead to sudden shifts in market sentiment and increased volatility. Similarly, global economic events, such as changes in oil prices or international financial crises (Dhingra, 2024), can have a pronounced impact on the Nigerian market due to its reliance on oil exports and its integration into the global economy.

The importance of understanding volatility dynamics in the Nigerian stock market cannot be overstated. For investors, volatility represents both a challenge and an opportunity (Umar et.al. 2024; Salisu, Ndako, & Vo, 2023). High volatility can lead to significant gains, but it also increases the risk of substantial losses (Dhingra, 2024; Abdullah, et.al. 2023; Salisu, Ndako, & Vo, 2023). Effective risk management strategies require a deep understanding of volatility patterns and their underlying causes. By analyzing historical volatility data and employing advanced time series models, this study aims to provide a clearer picture of the extent to which past values of volatility drive market fluctuations and their implications for market risk.

This study uses time series analysis to investigate the volatility dynamics of the Nigerian stock market. Time series models, such as Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and its variants, are employed to analyze the historical volatility patterns and assess the persistence of volatility over time. These models are particularly useful for capturing the clustering of volatility and the presence of leverage effects, where negative shocks have a more pronounced impact on volatility than positive shocks of the same magnitude.

The significance of this study extends beyond the academic realm, offering practical implications for market participants and regulators. For investors, understanding volatility dynamics can lead to more informed decision-making and better risk management strategies. For policymakers, insights into market volatility can help in designing interventions that promote market stability and reduce the impact of external shocks. By contributing to the existing body of knowledge on market volatility, this study aims to enhance the understanding of financial market behavior in emerging economies and provide a foundation for future research in this area.

The rest of the paper proceeds as follows: Section 2 provides a review of the relevant literature, highlighting key studies and theoretical frameworks related to stock market volatility. Section 3 outlines the methodology used in this study, including data sources, analytical techniques, and research design. Section 4 presents the

empirical findings and discussion of results. Finally, Section 5 concludes the paper and suggests areas for future research.

2. LITERATURE REVIEW

Conceptually, volatility in the literature of economics and finance refers to the degree of variation in the price of a financial asset over time, typically measured by the standard deviation or variance of returns (Ndubuisi, Ebere, & Wilfred, 2023). In the analysis of stock market prices and behaviour, volatility is a key measure of risk and uncertainty (Ndubuisi, Ebere, and Wilfred, 2023; Uyabo, Atoi and Usman, 2015), which affects investor behavior, portfolio management, and policy decisions. Volatility persistence and asymmetry are two other important concepts associated with volatility, which are important in the study of market dynamics.

Volatility persistence refers to the tendency of high or low levels of volatility to remain in the market for extended periods. This means that once volatility increases or decreases, it tends to continue in the same direction for some time. The concept of volatility persistence is closely associated with the phenomenon of "volatility clustering," where large changes in asset prices are followed by large changes, and small changes are followed by small changes. Volatility persistence is critical because it implies that shocks to the market have long-lasting effects, influencing future price movements and risk levels. This persistence can be captured and analyzed using models like the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, which allows for the conditional variance to depend on past information, effectively modeling the duration of volatility shocks.

Volatility persistence is the propensity of high or low volatility to stay in the market over a long period (Conrad, Kleen, and Lönn, 2025). This implies that when volatility is rising or falling, it is likely to persist in the same direction in the short term. Volatility persistence is closely related to the so-called volatility clustering, in which large changes in asset prices are succeeded by large changes, and small changes are succeeded by small changes. The importance of volatility persistence is that it suggests that market shocks have long-term impacts, which affect future price changes and risk levels. This persistence may be modeled and studied with the help of such models as the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, where the conditional variance may be conditioned by the past information, which is useful to model the persistence of volatility shocks (Kayani, et.al. 2024).

Asymmetry in volatility is the fact that negative and positive shocks of equal magnitude do not affect the market volatility in the same way (Ormos, and Timotity, 2024). In general, negative news or events are more likely to cause volatility than positive news- a phenomenon referred to as the leverage effect (Dahlvid, and Granberg, 2017). This asymmetry is important in stock markets as it implies that investors respond more to bad news than to good news, which increases risk in bad times (Yaya and Gil-Alana 2014). Models like the Exponential GARCH (E-GARCH) model can be used to capture asymmetric volatility because it allows the varying effects of positive and negative shocks on volatility (Epaphra, 2016).

In the emerging markets such as Nigeria, it is important to know the volatility persistence and asymmetry because of the greater market inefficiency, economic instability, and vulnerability to external shocks. Nigerian stock market is a relatively low liquidity, low market depth and high regulatory change environment, which tends to be highly volatile and thus market participants and policymakers need to know these dynamics to manage risks and make effective policies.

In theory, the volatility dynamics in financial markets are entrenched in several financial and economic theories. These dynamics are critical in understanding how asset prices and returns behave, and in the development of strategies to manage risks, formulate policies, and make investment decisions. Therefore, this study will be guided by the following theories and models. The first is the Efficient Market Hypothesis (EMH) that assumes that the price of assets is the complete reflection of all the available information at a particular time (Gimba, 2012), which means that the price changes are unpredictable and follow a random walk. Nevertheless, the existence of volatility persistence and asymmetry contradicts this hypothesis, especially in emerging markets such as Nigeria, where the flow of information might be less efficient, and the market response to news might be stronger. The deviations from EMH in such markets make it necessary to use advanced econometric models to understand price behavior and volatility.

Second is the Autoregressive Conditional Heteroskedasticity (ARCH) models, introduced by Engle (1982), and their extensions, such as GARCH (Bollerslev, 1986), are fundamental in modeling financial time series with volatility clustering. These models presume that the present volatility is a function of the past errors and past volatility, which reflects the persistence of volatility. GARCH models are popular in financial econometrics to study the time-varying volatility and to predict future volatility. Third is the Leverage Effect and Asymmetric Volatility. The leverage effect, initially noted by Black (1976), is a theory that the equity of a firm is riskier as the stock price declines, and thus the volatility increases. This is the key idea behind asymmetric volatility, in which negative returns have a greater volatility effect than equal positive returns. E-GARCH models, which were proposed by Nelson (1991), are especially effective in explaining these asymmetries since they can be used to model the various effects of positive and negative shocks on volatility.

Fourth is the behavioral finance theories. Behavioral finance can further explain volatility asymmetry, implying that the leverage effect is due to psychological biases of investors (Ait-Sahalia, Fan, & Li, 2013), including loss aversion and overreaction to bad news. These theories question the rationality of behavior and market efficiency, and offer a better insight into the volatility dynamics, particularly in markets where institutional participation is lower and retail investors are more influential, as it is in Nigeria. Fifth is the market microstructure theory. The market microstructure theory studies the mechanisms and the results of trading assets under certain trading regulations (Muranaga, & Shimizu, 1999). It offers a model of the effect of information asymmetry, order flow, and liquidity on volatility. Microstructure theories can be used to explain the persistence and asymmetries in volatility observed in the Nigerian stock market where market microstructure is affected by trading restrictions, low liquidity, and informational inefficiencies.

Empirically, a number of studies have come out in an attempt to comprehend volatility in the Nigerian stock markets and other emerging financial markets, but the evidence has been inconclusive. The study of stock market volatility has been on the rise in the Nigerian context since the early 2000s, but the results are still inconclusive, especially on the asymmetric impacts and persistence of volatility. Some studies have observed leverage effects in the region of asymmetric effects, with negative news having a stronger effect on volatility than positive news. As an example, Emenike (2010) with GARCH and GJR-GARCH models on monthly data 1985-2008 and Okpara (2011) with an EGARCH-in-mean model found leverage effects in the Nigerian stock market. Similarly, Atoi (2014) employed GARCH, TGARCH, EGARCH, and PGARCH models on daily data from 2008 to 2013 and found evidence of leverage effects, highlighting the significance of using non-Gaussian processes for better modeling. Agwu and Ogbonna (2020) also documented leverage effects with TGARCH on daily data between 1999 and 2016.

Other studies have however not found any significant leverage effect. As an example, Emenike and Aleke (2012) used EGARCH and GJR-GARCH models on daily data between 1996 and 2011 but did not find any leverage effect. Likewise, Osazevbaru (2014) with TGARCH on 1995-2011 data, and Uyaebo, Atoi, and Usman (2013) with panel data on 2000-2013, did not find any leverage effects in the Nigerian stock market. The evidence on volatility persistence is also mixed. While some studies like Olowe (2009), Emenike and Aleke (2012), and Herbert, Ugwuanyi, and Nwaocha (2019) found strong evidence of volatility persistence, others like Agwu and Ogbonna (2020) did not find significant evidence of this phenomenon. These studies typically employed either GJR-GARCH or EGARCH models, with varying results depending on the sample period and the models used.

The results in the Nigerian setting are consistent with the results in other emerging markets, where the evidence on leverage effects and volatility persistence is also mixed. Market research in markets such as India, China and the Asian region in general has revealed the existence and non-existence of leverage effects and volatility persistence, which suggests that these effects can be very context-specific. For example, Kaur (2004) found a greater impact of negative news on volatility in the Bombay Stock Exchange, while Mun, Sundaram, and Yin (2008) found no evidence of leverage effects in the Bursa Malaysia. These conflicting results demonstrate the intricacies of volatility modeling in emerging markets and the significance of choosing the right models and data frequencies. The daily data and non-Gaussian processes used in some of the more recent studies seem to give more accurate and reliable results,

which are essential in making informed policy-making and investment decisions.

Although the literature on stock market volatility in Nigeria is increasing, there is still a lot of inconsistency in the results, especially on the existence and magnitude of leverage effects and volatility persistence. Although leverage effects and strong volatility persistence have been found in some studies, others have found little or no evidence of these effects, in large part because of variations in data frequencies, sample periods, and modeling. Moreover, the majority of the current studies are based on the traditional GARCH models, and little has been done to investigate more sophisticated models such as E-GARCH that can be more effective in capturing asymmetries in volatility. This gap highlights the necessity of additional research on the volatility dynamics of the Nigerian stock market with the help of both GARCH and E-GARCH models to offer more robust and context-specific information on volatility persistence and asymmetry.

3. METHODOLOGY

This section outlines the methodological approach employed in analyzing the volatility dynamics and risk assessment in the Nigerian stock market, with a focus on the use of GARCH models. The methodology is designed to capture the essential characteristics of stock price behavior, returns, and volatility persistence within the context of the Nigerian market.

3.1 Model Specification

To analyze the volatility dynamics and risk assessment, the study employs two primary models: the GARCH(1,1) model and the Exponential GARCH (E-GARCH) model. These models are selected due to their ability to capture the time-varying volatility and asymmetric effects often observed in financial markets.

3.1.1 The GARCH(1,1) Model

The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model introduced by Bollerslev (1986) is used to model the conditional variance of stock returns. The GARCH(1,1) model is specified as follows:

$$R_t = \mu + \varepsilon_t \text{ ----------Eqn1}$$

Eqn1 represents the mean equation, where R_t, μ, and ε_t denotes the return at time t, mean return, the error term or shock at time t respectively.

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \text{ ----------Eqn2}$$

The σ_t^2 and α_0 **in the variance Eqn2 denotes** the conditional variance at time t and the constant term in the variance equation respectively. While α_1 is the coefficient of the lagged squared residuals (ε_{t-1}^2) representing the ARCH effect, β_1 is the coefficient of the lagged conditional variance (σ_{t-1}^2), representing the GARCH effect. The GARCH(1,1) model captures volatility persistence by modeling the variance as a function of past squared shocks and past variances.

3.1.2 The E-GARCH Model

The Exponential GARCH (E-GARCH) model, developed by Nelson (1991), is employed to capture the asymmetric effects of shocks on volatility. The E-GARCH(1,1) model is specified as follows:

$$R_t = \mu + \varepsilon_t \text{ ----------Eqn3}$$

Eqn3 is the mean equation of the E-GARCH model and the parameters are as defined in Eqn1 above

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_1 \frac{\varepsilon_{t-1}^2}{\sigma_{t-1}} + \gamma \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \beta_1 \ln(\sigma_{t-1}^2) \text{ ------}$$

------Eqn4

Where γ is captures the leverage effect, indicating the asymmetry in the response of volatility to positive and negative shocks. The E-GARCH model allows for the possibility that negative shocks (bad news) may have a different impact on volatility compared to positive shocks (good news) of the same magnitude, thereby accounting for the leverage effect.

3.2 Estimation Techniques

The parameters of the GARCH(1,1) and E-GARCH models are estimated using the maximum likelihood estimation (MLE) method. This approach maximizes the likelihood function under the assumption that the errors (ε_t) follow a conditional normal distribution. The estimation is conducted using EViews econometric software which provides robust tools for modeling and analyzing financial time series data.

3.3 Stationarity Testing

Before estimating the GARCH models, the stationarity of the stock returns series is tested using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Both tests check for the presence of a unit root in the returns series, with the null hypothesis being that the series has a unit root (i.e., it is non-stationary). The rejection of the null hypothesis would indicate that the series is stationary, which is a prerequisite for reliable GARCH model estimation.

3.4 Data and Preliminary Analysis

The data used in this study consists of daily stock prices from the Nigerian Stock Exchange (NSE) for the period from 30th January 2012 to 16th August 2024. The data was obtained from investing.com. The dataset includes 3,106 observations for stock prices and 3,105 observations for stock returns. Following the leads of Danladi & Sanusi (2024) and Ndubuisi, Ebere, & Wilfred, (2023), stock returns are calculated as:

$$\mathrm{Re}turns_t = \ln(\mathrm{Pr}ice_t / \mathrm{Pr}ice_{t-1})100 \text{ ------Eqn5}$$

Where $\mathrm{Re}turns_t$ represents the stock return at time t, $\mathrm{Pr}ice_t$ is the stock price at time t, and $\mathrm{Pr}ice_{t-1}$ is the stock price at time t-1. Based on this, the trend of both stock prices and the calculated returns are presented as Fig. 1. While the panel (a) on the left side of Fig. 1 illustrates the trend of stock prices, the panel (b) graph on the right side of the Fig. 1 displays the stock market returns for the same period, from January 2012 to August 2024. The data indicates that stock prices remained relatively positive until around 2014, fluctuating within a narrow range. Starting from 2014, however, there is a noticeable downward trend, with stock prices gradually decreasing. By 2015 the market rebound and exhibits an increasing trend. The peak in stock prices occurs in 2023, reaching the highest levels observed during the entire period. This upward trajectory suggests a period of growth in the market, possibly driven by positive economic conditions, increased investor confidence, or other favorable market dynamics.

Unlike the steady rise in stock prices, the returns exhibit significant volatility, with sharp fluctuations between positive and negative territory. The most pronounced volatility occurs between 2015 and 2016, where returns sharply dip into negative values, likely reflecting a market downturn or correction during this period. Despite these fluctuations, positive returns are also observed sporadically, indicating periods of recovery and growth. The sharp movements in returns could be influenced by various factors, including economic policies, external shocks, or changes in market sentiment. Notably, the contrast between the generally upward trend in stock prices and the volatility in returns highlights the inherent risks and opportunities in the Nigerian stock market, where investors could experience both significant gains and losses over short periods.

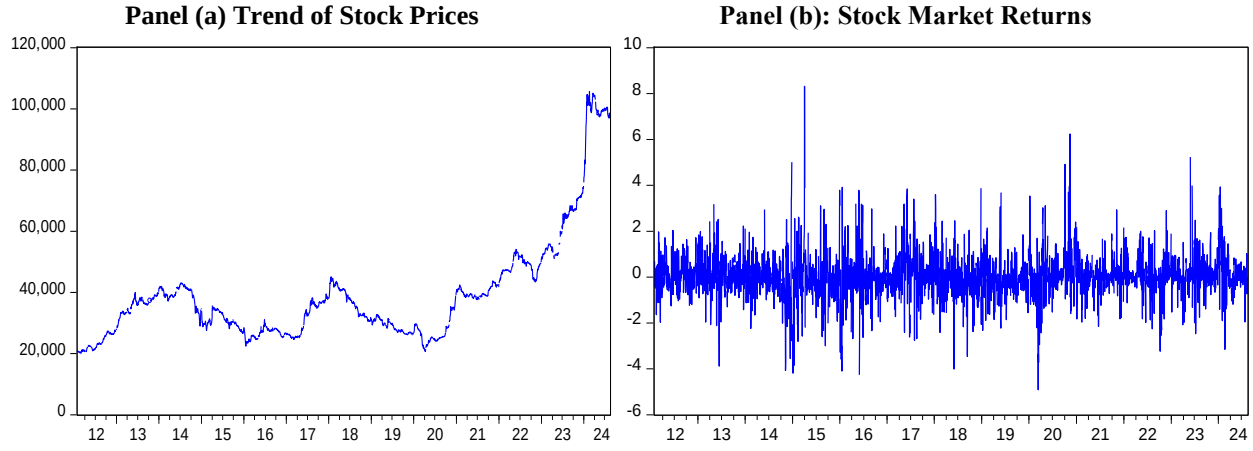


Figure 1: (a) Trend of Nigerian Stock Market Prices and (b) Stock Market Returns, January 2012–August 2024.

Panel (a) presents the evolution of stock prices in the Nigerian stock market over the sample period, while Panel (b) displays the corresponding daily returns. The figure highlights the long-run upward movement in stock prices alongside substantial fluctuations in returns, indicating periods of heightened market volatility. This

suggests that while the overall market has grown, the path has been marked by periods of significant gains and losses. Investors likely experienced both bullish and bearish phases, with the market recovering over time, contributing to the upward trajectory in prices. The volatile nature of returns indicates that investors in the Nigerian stock market would need to be prepared for both positive and negative performance, which could impact their investment strategies. The overall positive trend in stock prices, however, suggests that long-term investors may benefit from staying invested through the market's ups and downs.

These volatility episodes can be linked to specific economic developments in Nigeria during the study period. The heightened market fluctuations observed between 2015 and 2016 coincide with the collapse in global crude oil prices, foreign exchange shortages, and the economic recession experienced by Nigeria in 2016. Similarly, the sharp movements in returns around 2020 reflect the effects of the COVID-19 pandemic, which disrupted economic activity and heightened uncertainty in financial markets globally. More recent fluctuations during 2022–2024 may be associated with persistent inflationary pressures, exchange-rate reforms, fuel subsidy removal, and broader macroeconomic adjustments. These events likely affected investor expectations and market sentiment, thereby contributing to the volatility clustering observed in the Nigerian stock market.

Table 1 presents the descriptive statistics of stock prices and returns in the Nigerian stock market over a sample period with 3,106 observations for stock prices and 3,105 observations for returns. The statistics provide insights into the central tendency, dispersion, and distributional characteristics of the data. The descriptive statistics in Table 1 reveal key characteristics of the Nigerian stock market during the observed period. The high mean (39102.3) and standard deviation (17295.96) of stock prices indicate that the market experienced substantial growth alongside significant volatility. The positive skewness (2.162558) and high kurtosis (7.904445) suggest that the market is prone to extreme price movements, which could be driven by various economic or political factors. The kurtosis values of 7.90 for stock prices and 8.63 for returns are substantially higher than the benchmark value of 3 associated with a normal distribution.

This indicates that both series are leptokurtic and characterized by fat tails, implying a greater likelihood of extreme price and return movements than would be expected under normality. Such behaviour is common in financial markets and suggests the presence of heightened market risk and vulnerability to large shocks. The positive mean returns (0.049729), coupled with the significant volatility and indicated by standard deviation (0.959591), highlight the potential for both gains and losses, emphasizing the need for careful risk management by investors. The results of the Jarque-Bera test confirm that both stock prices and returns are not normally distributed, which has implications for statistical modeling and forecasting in this market.

Table 1: Descriptive Statistics

Variables	Price	Returns
Mean	39102.3	0.049729
Median	35095.04	0.010011
Maximum	105722.8	7.984833
Minimum	20123.51	-5.032939
Std. Dev.	17295.96	0.959591
Skewness	2.162558	0.361172
Kurtosis	7.904445	8.626067
Jarque-Bera	5533.883	4162.565
Probability	0.00	0.00
Observations	3106	3105

Table 2: Unit Root Test Results

Test	Test Statistics	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	P-Value
ADF Test	-40.96247	-3.432267	-2.862273	-2.567204	0.0000
PP Test	-41.61963	-3.432267	-2.862273	-2.567204	0.0000

Table 2 summarizes the results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for the RETURNS series. Both the ADF and PP tests indicate that the null hypothesis of a unit root in the RETURNS series can be rejected at all conventional levels of significance (1%, 5%, and 10%). The test

statistics for both tests are far below the critical values, and the associated p-values are 0.0000, providing strong evidence against the null hypothesis. This implies that the RETURNS series is stationary, meaning it does not have a unit root. Stationarity in the returns series is crucial for modeling and forecasting purposes, as it suggests that the series' mean and variance remain constant over time, and it is suitable for further time series analysis.

4. RESULTS AND DISCUSSION

4.1 Result of the GARCH and E-GARCH Model

Table 3 presents the estimated results from two different models: a GARCH(1,1) model and an E-GARCH model, both used to analyze the returns of the Nigerian stock market. Each model consists of a mean equation and a variance equation, which together help in understanding both the average return behavior and the volatility dynamics in the market. From the estimated GARCH model, the coefficient of the constant term (C) in the mean equation is 0.007656, but with a p-value of 0.6014, it is not statistically significant. This suggests that the average return over the sample period is not significantly different from zero. This finding is common in financial time series data, where the mean return is often less informative than the volatility.

On the other hand from the variance equation the C (Constant Term)**.** The constant term in the variance equation is 0.094506 and is highly statistically significant (p-value = 0.0000). This value represents the baseline level of volatility in the market, independent of past shocks. RESID(-1)^2 (ARCH Term): The coefficient of the lagged squared residuals (ARCH term) is 0.206726 and is also statistically significant (p-value = 0.0000). This indicates that past shocks have a significant impact on current volatility. The magnitude of this coefficient suggests that the market's volatility is sensitive to past shocks, with a strong influence from recent market events. GARCH(-1) (GARCH Term): The coefficient for the lagged conditional variance (GARCH term) is 0.695122, which is statistically significant (p-value = 0.0000). This high value indicates a high degree of volatility persistence, meaning that once volatility increases, it is likely to remain elevated for some time. This persistence is a key characteristic of financial markets, where periods of high volatility tend to cluster together.

Table 3: Estimated Results

Variable	Coefficient	Std. Error	z-Statistics	Prob.
		GARCH(1,1)		
Mean Equation				
C	0.007656	0.014656	0.522407	0.6014
Variance Equation				
C	0.094506	0.005717	16.53076	0.0000
RESID(-1)^2	0.206726	0.011446	18.06121	0.0000
GARCH(-1)	0.695122	0.013050	53.26603	0.0000
		E-GARCH		
Mean Equation				
C	0.027992	0.012193	2.295824	0.0217
Variance Equation				
C(2)	-0.293665	0.013291	-22.09443	0.0000
C(3)	0.360483	0.017109	21.06975	0.0000
C(4)	0.040112	0.009164	4.377169	0.0000
C(5)	0.871157	0.008238	105.7458	0.0000

A useful measure of volatility persistence is the sum of the ARCH and GARCH coefficients ($\alpha + \beta$). In this study, the estimated persistence parameter is 0.9018 (0.2067 + 0.6951), which is less than unity. This indicates that the conditional variance process is stationary and mean reverting. In practical terms,

although shocks to volatility persist for a considerable period, their effects gradually diminish over time rather than increasing indefinitely. The result, therefore, confirms the existence of strong but not explosive volatility persistence in the Nigerian stock market. Compared with Atoi (2014), who reported persistence parameters closer to 0.99, the present finding suggests a slightly faster rate of volatility adjustment while still indicating substantial persistence in market risk.

Furthermore, from the estimated E-GARCH model, the constant term (C) in the mean equation is 0.027992, and it is statistically significant with a p-value of 0.0217. This suggests that there is a small but statistically significant positive average return over the sample period. This finding indicates that, despite the volatility, the Nigerian stock market has experienced a slight upward trend in returns over time. Additionally, the variance equation of the E-GARCH model provides important insights into the asymmetric behaviour of volatility in the Nigerian stock market. The coefficient of C(2), which captures the asymmetry effect, is -0.293665 and is highly statistically significant (p-value = 0.0000). The negative sign indicates that negative shocks (bad news) increase market volatility more strongly than positive shocks (good news) of the same magnitude. This phenomenon is commonly referred to as the leverage effect and suggests that investors react more strongly to adverse information than to favourable information. Economically, the result implies that events such as economic downturns, policy uncertainty, inflationary pressures, or adverse external shocks are likely to generate disproportionately larger increases in market volatility.

Furthermore, the coefficient of C(3), which measures the impact of the magnitude of shocks on volatility, is 0.360483 and statistically significant (p-value = 0.0000). This finding indicates that larger shocks, irrespective of their direction, contribute to higher levels of current volatility. The coefficient of C(4) is 0.040112 and statistically significant (p-value = 0.0000), further confirming that past innovations continue to influence current volatility dynamics. Finally, the volatility persistence parameter, C(5), is estimated at 0.871157 and is highly significant (p-value = 0.0000), indicating that volatility shocks dissipate slowly over time. This finding suggests that periods of heightened uncertainty in the Nigerian stock market tend to persist, exposing investors to prolonged periods of elevated risk following major market disturbances.

In summary, the results from both the GARCH (1, 1) and E-GARCH models suggest that the Nigerian stock market exhibits high volatility persistence, meaning that periods of high volatility are likely to continue once they occur. The E-GARCH model, in particular, reveals an asymmetric response to shocks, where negative news increases volatility more than positive news, a critical insight for risk management and investment strategies. These findings highlight the importance of monitoring volatility closely and developing strategies to manage periods of heightened market instability.

4.1.1 Diagnostic Tests of Model Adequacy

To assess the adequacy of the estimated GARCH(1,1) model, post-estimation diagnostic tests were conducted on the standardized residuals. Specifically, the Ljung-Box Q-statistics were employed to examine residual serial correlation, while the ARCH-LM test was used to determine whether any remaining ARCH effects persisted after model estimation.

Table 4: Diagnostic Tests for the GARCH(1,1) Model

Test	Statistic	Probability	Decision
Ljung-Box Q(1)	1.9302	0.1650	Fail to reject H_0
ARCH-LM (Obs*R^2)	2.0029	0.1570	Fail to reject H_0

Note: H_0 for the Ljung-Box test states that there is no serial correlation in the standardized residuals. H_0 for the ARCH-LM test states that there are no remaining ARCH effects.

The diagnostic results indicate that the estimated volatility model adequately captures the dynamics of the return series. The Ljung-Box Q-statistic at the first lag is statistically insignificant (p-value = 0.1650), suggesting the absence of significant serial correlation in the standardized residuals. Similarly, the ARCH-LM test yields a p-value of 0.1570, implying that the null hypothesis of no remaining ARCH effects cannot be rejected. This result confirms that the GARCH(1,1) specification successfully captures the conditional

heteroskedasticity and volatility clustering present in the Nigerian stock market returns. Consequently, the estimated model is considered adequate and reliable for analysing volatility persistence and asymmetric volatility behaviour in the Nigerian stock market.

4.2 Additional Analysis

The findings of this study are robust to alternative data frequency and technique of estimation reported in Table 5. The results obtained using monthly data and Log-GARCH is intuitively the same as the baseline model results of GARCH (1, 1) and E-GARCH reported as Table 3. For example the standard GARCH model shows that the lagged GARCH (-1) term is highly significant (p-value = 0.0001), which is consistent with the main GARCH (1, 1) model's findings, indicating strong volatility persistence. Similarly, in the Log-GARCH model, the lagged log-volatility term (C (5)) is also significant (p-value = 0.0000), reaffirming the persistence of volatility across different model specifications.

Table 5: Additional Analysis Results using Monthly Data

Variable	Coefficient	Std. Error	z-Statistics	Prob.
		GARCH(1,1)		
Mean Equation				
C	0.900602	0.541096	1.664403	0.0960
Variance Equation				
C	10.57604	6.141499	1.722061	0.0851
RESID(-1)^2	0.123374	0.066042	1.868107	0.0617
GARCH(-1)	0.672726	0.176189	3.818218	0.0001
		E-GARCH		
Mean Equation				
C	0.934459	0.538724	1.734577	0.0828
Variance Equation				
C(2)	0.495609	0.310816	1.594542	0.1108
C(3)	0.092945	0.105890	0.877745	0.3801
C(4)	-0.115794	0.047205	-2.453004	0.0142
C(5)	0.852537	0.091190	9.348968	0.0000

While the RESID(-1)^2 term in the standard GARCH model is marginally significant and slightly less significant than in the main GARCH(1,1) model, the result still indicates that past shocks are relevant. The Log-GARCH model includes an asymmetry term (C(4)), which is significantly negative (p-value = 0.0142). This indicates that negative shocks tend to increase volatility more than positive ones, a finding consistent with the main E-GARCH model. The presence of significant asymmetry in both the Log-GARCH and E-GARCH models suggests that asymmetry is a robust feature of the volatility process in the dataset.

The robustness checks using the Standard GARCH and Log-GARCH models generally confirm the key findings from the main GARCH(1,1) and E-GARCH models. Volatility persistence is strong across all models, while the impact of past shocks and the presence of asymmetry vary slightly depending on the model specification. Overall, these results reinforce the reliability of the conclusions drawn from the main analysis, highlighting the robustness of the observed volatility dynamics in the Nigerian stock market.

4.3 Discussion of Results

According to the Efficient Market Hypothesis (EMH), in its weak form, past prices and returns should not predict future prices and returns, as all available information is already reflected in asset prices. However, the persistence of volatility, as indicated by the GARCH and E-GARCH models, suggests that the Nigerian stock market may not fully adhere to the weak form of the EMH. This persistence implies that past volatility influences future volatility, indicating potential inefficiencies in the market. This finding challenges the EMH and aligns more with behavioral finance theories that suggest markets can be inefficient due to factors such as investor psychology, herding behavior, or the slow diffusion of information. The prolonged periods of high volatility could be attributed to these behavioral factors, as well as structural inefficiencies within the market. The ARCH effect found, which refers to the impact of past shocks on current volatility, is consistent with the concept of volatility clustering in financial markets. This concept is supported by the theory of *GARCH models* (Generalized Autoregressive Conditional Heteroskedasticity), where

periods of high volatility tend to be followed by further high volatility, and low volatility periods by low volatility. This empirical finding aligns with the theoretical foundation of GARCH models, which are designed to capture such clustering. It also resonates with the broader financial theory that markets exhibit time-varying volatility due to the influence of past information. This could also be linked to *Mandelbrot's Fractal Market Hypothesis (FMH)*, which suggests that financial markets exhibit patterns and clusters in volatility due to underlying fractal structures in the data.

The insignificance of mean returns documented suggests that predicting future returns based on historical averages may not be reliable. This finding is consistent with the *Random Walk Theory*, which posits that stock prices evolve randomly and are unpredictable. The result supports the idea that, over time, returns may follow a random walk and that the focus should shift from return prediction to risk management, as suggested by modern portfolio theory. This also reinforces the EMH, particularly in its strong form, where prices incorporate all information, and thus, average returns may not be significantly different from zero. The asymmetry in volatility, where negative shocks lead to greater increases in volatility than positive shocks, is a manifestation of the *leverage effect* theorized by Black (1976). The leverage effect suggests that a decrease in a company's equity value increases its leverage, leading to higher perceived risk and, consequently, greater volatility. This finding aligns with the leverage effect theory and is also consistent with *prospect theory* from behavioral finance, which posits that investors react more strongly to losses than gains. This asymmetry could also be explained by the *Credit Risk Theory*, which suggests that as firms experience losses, their financial stability diminishes, leading to higher risk premiums and volatility.

This findings is consistent with the findings of Ndubuisi, Ebere, & Wilfred, (2023) who found that volatility is more responsive to good news compared to bad news. The significant impact of the magnitude of past shocks on current volatility ties into the *Risk-Return Tradeoff*, a core concept in financial theory. This theory suggests that higher risk (volatility) is associated with higher potential returns, though your findings highlight that larger shocks tend to exacerbate risk, regardless of returns. This relationship can be seen in the context of *CAPM (Capital Asset Pricing Model)*, where risk is a crucial determinant of expected returns. However, the significant impact of large shocks, regardless of sign, challenges the linearity assumption of the risk-return tradeoff and suggests a more complex relationship, potentially aligning with *non-linear models* of risk and return.

The persistence of volatility identified in the Nigerian stock market may partly reflect the prolonged impact of macroeconomic shocks and policy uncertainties. In emerging markets such as Nigeria, information dissemination is often gradual, causing market participants to adjust expectations over time rather than instantaneously. Consequently, shocks arising from oil price movements, exchange-rate adjustments, monetary policy changes, and geopolitical developments may continue to influence market risk for extended periods, thereby contributing to volatility persistence.

4.4 Implications of Findings

The findings from this study have significant implications for both investors and market regulators in the Nigerian stock market. The high persistence of volatility, as evidenced by the GARCH and E-GARCH models, suggests that investors need to adopt strategies that can effectively manage risk over the long term. The prolonged periods of high volatility following significant market shocks indicate that investors should be cautious during turbulent periods, as the market may remain unstable for an extended time. This behavior challenges the assumption that markets quickly revert to equilibrium and underscores the need for dynamic portfolio management strategies that are responsive to changes in market conditions. For market regulators, the presences of asymmetry in volatility-where negative shocks have a more substantial impact than positive ones-highlights the vulnerability of the Nigerian stock market to adverse events. This finding suggests that regulatory bodies should focus on strengthening market infrastructure to mitigate the effects of negative shocks, possibly through enhanced surveillance mechanisms and the implementation of circuit breakers to prevent panic selling. Additionally, the fact that average returns are not significantly different from zero shifts the emphasis toward risk management rather than solely seeking high returns. Regulators could consider policies that encourage transparency and stability, thereby fostering investor confidence and reducing the likelihood of extreme volatility.

More specifically, the evidence of volatility persistence suggests that shocks to the Nigerian stock market are not immediately absorbed but continue to influence market risk over time. Consequently, regulatory authorities should strengthen market surveillance during periods of heightened uncertainty and develop early-warning mechanisms capable of identifying emerging market stress. Furthermore, the significant leverage effect observed in the E-GARCH model indicates that negative news generates a stronger volatility response than positive news of similar magnitude. This underscores the importance of timely disclosure requirements, transparent policy communication, and effective information dissemination to reduce uncertainty and prevent excessive market reactions. For investors, the asymmetric nature of volatility implies that downside risks should receive greater attention in portfolio construction, hedging strategies, and risk assessment frameworks.

5. CONCLUSION AND RECOMMENDATIONS

This study provides a comprehensive analysis of the volatility dynamics in the Nigerian stock market, employing GARCH(1,1) and E-GARCH models to assess the behavior of stock prices and returns over the period from 30th January, 2012 to 16th August, 2024. The findings indicate that while the stock market has experienced an overall upward trend, it is characterized by significant volatility, particularly during periods of economic distress. The GARCH(1,1) model highlights the persistence of volatility, suggesting that once volatility spikes, it tends to remain elevated for extended periods. This persistence reflects the underlying risks and uncertainties in the market, which can have profound implications for investors and policymakers. The E-GARCH model reveals a pronounced asymmetry in the market's response to shocks, where negative news has a more substantial impact on volatility than positive news. This leverage effect underscores the market's sensitivity to adverse events, making it crucial for investors to develop strategies that can mitigate the risks associated with such volatility. The study's findings emphasize the importance of closely monitoring market conditions and adopting risk management practices that account for the unique characteristics of the Nigerian stock market.

Despite the valuable insights provided, this study has some limitations. First, the analysis is based on daily stock market data, which may not fully capture intraday price movements and high-frequency volatility dynamics. Second, the study employs a univariate GARCH framework and does not explicitly incorporate exogenous factors such as oil prices, exchange rates, inflation, or other macroeconomic variables that may influence stock market volatility. Third, the findings are specific to the Nigerian stock market and may not be directly generalizable to other African markets due to differences in market microstructure, liquidity conditions, regulatory environments, and levels of financial development. Future research could address these limitations by utilizing intraday data, incorporating relevant macroeconomic and financial variables into multivariate volatility models, and conducting comparative studies across African stock markets.

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