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COVID-19 Crisis and Stock Market Volatility in Nigeria: A GARCH Model Approach

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Abstract

The economic downturns locally and internationally due to the COVID-19 crisis were the main motivation for this study. However, rather than broadly examining economic indices, this paper focused on the reaction of the Nigerian stock market in terms of volatility to the crisis. The specific objectives of the study were to identify differences in market performance due to the COVID crisis, determine volatility persistence and ascertain the leverage effects of the news on stocks on the stock exchange floor. Adopting an ex-post facto research design, monthly time-series All-Share Index data were analyzed using descriptive statistics, GARCH(1,1), and EGARCH models. It was found that volatility existed in the market during the COVID-19 crisis however volatility persistence was low. EGARCH results showed asymmetric parameters did not exist revealing the form of leverage effect COVID-19 posed to the market. The market thus had identical responses to both bad and good news of COVID-19 announcements of the same magnitude. It was recommended that regulatory authorities and policymakers be proactive in their approach to forecasting market performance to reduce the negative effects of bad news on market indices.

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1 Introduction

The stock market is one of the powerhouses of the financial sector in any economy. This owes to the ability of firms to raise capital, especially for large and long-term funding. The market comprises different institutions dealing in securities that span longer than a year (Maxwell et al., 2018). The Nigerian Stock Exchange (NSE) is the major player in the Nigerian capital market with its trading on secondary securities. Transactions take place daily in the stock market with companies making gains, losses, and break even. Like other institutions in the financial sector and the economy in general, the NSE is influenced by external factors that have bearing on the economic climate of the nation. This is because investors who are players in the stock market receive signals from such events or occurrences and Bello (2020), states that they make investment decisions based on current or predictable changes. These changes in financial markets parlance are referred to as volatility. The influence of volatility behavior of stocks on investment decisions and stock market health has made it a long-time aspect of study with different models formulated to ensure proper explanation and fair prediction of the volatility of stocks for optimal investment and portfolio decisions on one hand; and economic policies for overall economic growth and governance on the other (Ekong & Onye, 2017). While the idea is to stabilize these forms of assets, reality does not present such perfect situations and thus stock market volatility is continuously monitored for optimum forecasting, Onuorah & Chigbu (2016).

Towards the end of 2019, in December precisely, there was a viral disease with flu-like symptoms that erupted from Wuhan, China referred to as the Coronavirus disease (acronym- COVID-19). The disease fast spread to different nations of the world and was officially declared a pandemic on 11th March of 2020 by the World Health Organisation. The novelty of the disease and the news of the contagion rate and death cases caused a level of panic globally. Nations and regions took measures to slow down the contagion rate that cut across aggressive sensitization and lockdowns in different cities in partial and total intensities. Measures are taken to slow down the number of reported cases met with economic challenges as several citizens were not able to adequately receive income and had to be supported with aids from the government and other non-governmental organizations Onuorah (2018). Businesses faced turbulent times leading to economic downturns in certain regions with stock markets being affected with an attendant estimation of business growth challenges, Ehiedu et al. (2020).

For Nigeria, the first case of coronavirus disease was in March 2020. This was followed by total and partial lockdown directives in different parts of the country. Businesses had to seek other ways such as remote working and streamlined attendance to conduct activities to remain afloat, Onuorah & Friday (2016). The economy was affected as revealed by a drop in GDP figures within the period, Ehiedu & Toria (2022). We opine that Nigeria was quite hit by the pandemic in terms of economic reactions because the country did not possess sufficient requisite infrastructure for non-traditional patterns of carrying out economic activities.

Statement of problem

COVID-19, which is a direct health challenge can be said to have had an economic impact even in Nigeria. Reactions such as a decline in aggregate consumption, disruption of supply chain activities, expansionary government expenditure in the health sector, and a fall in the value of assets such as stock were recorded in the period. Like other factors influencing the economy, it can be hypothetically stated that the pandemic should have impacted institutions in the financial sector inclusive of the NSE. More specifically, the NSE had the least All-Share Index of 21,300.47 points in March 2020 after over 97 months- the next least being in March 2012 with 20,652.47 points. This could be traced to COVID arbitrarily. However, it is noticed that ASI had already started to dwindle before the COVID crisis came into play with an ASI of 44,343.65 points in January 2018 with a gradual reduction through the year and extending till November 2019 with 27,002.15 points- before COVID was reported in China in December 2019. As a result of this twist amongst others, this study seeks to provide empirical evidence to back up the hypothetical assumption that the stock market in terms of volatility of stocks was affected by COVID 19 (Liu & Hung, 2010; Agnolucci, 2009; Barra Novoa, 2021).

Objective of the study

The study was undertaken to determine the volatility of the stock market and the level of persistence in response to the COVID-19 pandemic using the GARCH approach. Specifically, the study sought to:

1) Identify the movement of transactions on the Nigerian Stock Exchange pre and post-peak COVID crisis

2) Determine the volatility of stocks during the peak COVID-19 period
3) Ascertain the leverage effect of COVID-19 news on stock behaviour on the Nigerian Stock Exchange

Research questions

Hypotheses were not formulated for this study because it is assumed that the study used a modeling approach to achieve objectives. P values which are important for hypotheses testing did not also have a direct impact on the findings. Thus, research questions alone were formulated thus:

1) What form of movement was noticed in the Nigerian Stock market pre and post-peak COVID crisis?
2) What was the level of volatility persistence of stocks during the peak COVID-19 period?
3) What is the leverage effect of COVID-19 news on stock behavior in the Nigerian stock market?

2 Literature Review

The Nigerian stock market- all share index

The Nigerian stock market is synonymous with the Nigerian capital market in this literature. It represents the broad market for medium and long-term financing. All financial institutions not in the money market are in the capital market. The role of the Nigerian capital market in the economy cannot be overstated. Obiakor et al. (2021), opines that aside from financing which he believes is the major role of the market, the capital market has also improved the standard of living of investors.

The stock market is a subset of the capital market. It deals in stocks which are bulk of unit shares that represent an ownership interest in privately and publicly listed companies. Stocks could be primary when it is just introduced into the capital market or secondary when it already exists in the capital market, Ehiedu (2014). The study concentrates on the Nigerian Stock Exchange as it deals in secondary and publicly traded stocks with publications released periodically. The country's Stock Exchange commenced operations in 1961 with eight stocks and equities. There was a total of 300,000 shares worth N1.5 million across 334 deals which by 1970 had grown to N16.6m across 634 deals (CBN, 2007). By 1972 and 1977, the Promotion decree of both years had permitted large public participation in the market. The Securities and Exchange Commission (SEC) is the apex authority of the Nigerian capital market and controls the activities of the market. The market was deregulated in 1995 and had since recorded various improvements in its operations such as the establishment of the Central Security Clearing System in 1997, the e-business platform in 2002, the Automated Trading System (ATS) for trading activities in the market, Investors Protection Fund in 2007 and introduction of other products such as asset-backed securities, mortgage-backed securities, exchange-traded funds, and derivatives. Okafor & Arowoshegbe (2011), state that currently, the Nigerian stock market contributes to economic development through risk diversification, securitization, long term financing among others.

Stocks and volatility

Volatility simply means a change of a continuous nature. Emenogu et al. (2020) describe it in investment terms as a measure of the dispersion of returns for an identified market index or security. They affirm that statistical dispersion tools such as variance or standard deviation are worthy measures of volatility in market or stock indices. Volatility is given much attention in the dealing of securities and other market transactions and instruments because it is directly proportional to the risk associated with such an instrument. It is far from reality that stock prices remain the same over some time. This is because ceteris paribus, the market is to be controlled by the forces of demand and supply in a globalised economy. Demand in this case is the interest of investors in certain stocks. Investors as humans are influenced by certain signals from information, predictions, the performance of stocks, and other factors that affect their market decisions. As a result, the value of stocks fluctuates. The extent of this fluctuation and the adjoining risks is what economists measure in form of volatility persistence and value at risk. The study uses the All-Share Index (ASI) as the parameter to represent the health or performance of the Nigerian stock market (Palm, 1996; Tully & Lucey, 2007; Katsiampa, 2017).

All share index (ASI)

NSE (2017) defines the ASI as a numerical index that measures changes in variables based on another, usually time-based. It is used to measure the market's trends and overall performance. ASI is expected to enhance the activities of market participants such as brokers and investors as the index serves as the investor's benchmark to evaluate the performance of individual portfolios.

COVID-19 and stock markets

He et al. (2020) describe the coronavirus pandemic as a black-swan event because it caused panic and shock, and raised fear in social and economic circles. The welfare of individuals was threatened with a projected welfare loss of between 7 and 10 percent as well as a decline in economic growth which World Bank predicted to be about -5.9 percent in Sub-Saharan Africa (World Bank, 2020 as cited in Takyi & Bentum-Ennin, 2021). As the news reeled out several new cases and deaths confirmed by WHO and other local health agencies, Authors have stated that investors reacted with sentiments to their activities in the stock market.

From existing literature, it is gathered that when investors' perception of the stock market is one of low risk and rising market trends, reactions are usually more optimistic. Vice versa, a high-risk perception of stock and falling market trends would elicit more pessimistic responses from investors because they would want to delay entry into the market till trends show evidence of a boom again (Lu & Lai, 2012). COVID 19 as a challenge, could have thus elicited pessimistic responses on the part of investors in the stock market for the majority of stocks. Takyi & Bentum-Ennin (2021), support this by making reference to the global financial meltdown of 2008 to predict the impact COVID-19 could have had on stock markets. They opined that COVID-19 must have led to an overreaction of investors in the short run and caused fear in pricing on stock floors. However, it is difficult to be absolute about the reactions of stocks as statistics showed that certain businesses and stocks thrived within this period.

Theoretical framework

Generalized autoregressive conditional heteroskedasticity (GARCH) model

The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is a model that predicts changes (volatility) in conditional variance (heteroskedasticity) in a time series dataset. Usually, GARCH models [either decreasing or increasing] volatility that occurs due to time. Engle (1982), is credited with the first modeling of volatility using ARCH. The calculated variance of the dependent variable in a model is modeled as a function of past values (lags) of the dependent and independent variables (E-views, 2019). Bollerslev (1986), is said to have introduced GARCH which is an extension of ARCH. GARCH poses an advantage of reducing the cumbersomeness of determining the optimum lag length for a dataset that ARCH presents. The conditional variance is measured using lag values and squared lag values of the error or disturbance term (Atoi, 2014). However, the model is flawed for violating non-negativity constraints to parameters; weak results in highly stationary data; and the symmetric nature that causes non-sensitivity to asymmetric volatility shocks (Atoi, 2014).

The GARCH (1,1) model specifications are twain- the mean equation and the variance equation. The study adopts the model from E-Views help (2019) The mean equation for a conditional heteroskedasticity in a return series, yt, is given as:

$$y_t = E_{t-1}(y_t) + \varepsilon_t \quad \text{..... (i)}$$

Where: $E_{t-1} = expected\ value\ conditional\ on\ past\ values;$

$$\varepsilon_t = error\ in\ mean\ equation$$

The variance equation for a conditional heteroskedasticity is:

$$\sigma^2{}_t = w + \alpha_1 \alpha^2{}_{t-1} + \cdots + \alpha_p \alpha^2{}_{t-p} \quad \text{..... (ii)}$$

Where: $E_{t-1} = expected\ value\ conditional\ on\ past\ values;$

$$\varepsilon_t = error\ in\ mean\ equation$$

Exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model

To take care of asymmetric shocks, the EGARCH- Exponential GARCH model was also employed. Nelson (1991), pulled up this approach to cushion the weakness of symmetric GARCH in analyzing time series. In particular, to allow for asymmetric effects between positive and negative asset returns. The study adopts the model from Emenogu et al. (2020). The mean equation for a conditional heteroskedasticity in a return series is given as:

$$a_t = \sigma_t \varepsilon_t \quad \text{..... (iii)}$$

Where: where σ_t= standard deviation for t period; ε_t = error distribution

The variance equation for a conditional heteroskedasticity is:

$$\ln(\sigma_t^2) = \omega + \alpha([|a_{t-1}| - \mathrm{E}(|a_{t-1}|)]) + \theta a_{t-1} + \beta \ln(\sigma_{t-1}^2) \quad \text{..... (iv)}$$

Where: $\ln(\sigma_t^2) = \log of\ conditional\ variance$

$$ARCH\ term\ (effect\ of\ size) = \propto ([|a_{t-1}| - E|a_{t-1}|]) = ABS * \frac{residual\ in\ t-1\ period}{\sqrt{GARCH\ in\ t-1\ period}};$$

$$ARCH\ term\ (leverage\ effect) = \theta a_{t-1} = \frac{residual\ in\ t-1\ period}{\sqrt{GARCH\ in\ t-1\ period}};$$

$$GARCH\ term = \beta \ln(\sigma_{t-1}^2) = \log of\ GARCH\ term\ in\ t-1 period$$

Empirical review

Okpara & Nwezeaku (2009), relied on E-GARCH to investigate the impact of risk on data from 41 quoted Nigerian organizations for the 1996-2005 years. The output showed leverage effect is present and there is low volatility persistence in the NSE. The study concluded that negative shock from bad news cause higher volatility than positive shock from the good news of the same magnitude does. Atoi (2014), tested volatility in the Nigerian stock market using data relating to the All Share Index from 2nd January 2008 to 11th February 2013. The study used the asymmetric and first-order symmetric GARCH models. Findings revealed that volatility increases with higher magnitude when the bad news hits stocks than it does when good news does.

Olayungbo et al. (2020), employed non-linear and standard GARCH models to measure the volatility of stock price returns as a result of crude oil prices in Nigeria from December 2012 to April 2020. The NSE was found to dwindle by 15.53 percent or 4172 points. Raifu et al. (2021), conducted a study to determine how COVID-19 influenced the stock returns of 201 listed firms on the NSE. Using pooled regression and panel vector autoregressive models, it was found that stock market returns had higher negative responses to global COVID-19 havoc than they did for local news. Impulse response functions showed there were positive and negative responses within the period before convergence to equilibrium in the long run.

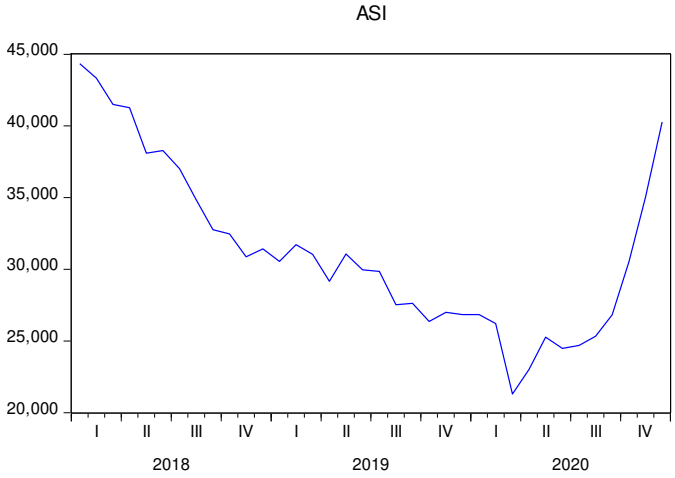
Emenogu et al. (2020), employed a case study approach to assess volatility in stock returns. Using the GARCH model and value-at-risk estimation, daily data for Total Nigeria Plc were analyzed. Stability was found in the persistence and convergence of the models. Value-at-risk estimation showed that high risks implied high returns in conformance with regular financial literature. Emenike (2010), examined the volatility persistence of stock returns in NSE using the GARCH model. All Share indices from January 1999 to December 2008 formed the dataset for the study. It was found that there was volatility clustering within the period and leverage effects also existed. Bello (2020), employed GARCH and ARCH models to examine the impact of persistent volatility on stock prices in Nigeria from 2008 to 2018. Volatility persistence was found to be high for stock prices within the period.

3 Materials and Methods

In terms of research design, the ex-post facto variant was adopted in the study as the study used historical data that could not be adjusted by the researcher. Time series data employed were monthly All Share Index data from December 2019 till December 2020 covering the COVID-19 period for which data is presently available. Data were retrieved from the 2020 Central Bank of Nigeria Statistical Bulletins (Financial Sector Statistics). This study employed the standard GARCH model to explain the volatility persistence in stocks on the Nigerian stock exchange (Franses & Ghijsels, 1999; Fakhfekh & Jeribi, 2020; Mandasari & Pratama, 2020).

4 Results and Discussions

Research Question 1: What form of movement was noticed in the Nigerian Stock market pre and post-peak COVID crisis?



Source: E-Views 10

ASI had already begun dwindling from January 2018 with 44,343.65 points. It became slightly stable between the 3rd quarter and 1st quarter of 2020, before a sharp decline in March 2020 of about 4915.99 points (-18.75%). The chart above also shows a steep rise from the third quarter to the fourth quarter of 2020 when business and the market had begun to adjust to COVID 19. Our findings are consistent with that of Olayungbo et al. (2020), that NSE dwindled by 15.53 percent or 4172 points for a study period of over seven years.

Table 1
Descriptive statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
ASI	27404.82	26524.11	40270.72	21300.47	4941.51	1.473980	4.560492

Source: E-Views 10

The average ASI for the period (November 2019- December 2020) was 27.404.82 points. Minimum ASI was in March 2020 when the first case of COVID-19 was reported in Nigeria. The standard deviation which measures the riskiness of stock (assets) was 4941.51. the standard deviation measures volatility in the stock market as higher values imply stronger volatility. Within the 12 months, the range of the distribution is found to be almost the same as the minimum value. Skewness and Kurtosis values of 1.47 and 4.56 show non-normality of ASI through the period as statistics are greater than 0 and 3 respectively. Dataset is positively skewed showing that ASI is rising in more recent months. This also implies that confidence is being renewed in the market (Awartani & Corradi, 2005; Donaldson & Kamstra, 1997).

Research Question 2: What was the level of volatility persistence of stocks during the peak COVID-19 period?

Table 2
GARCH estimation

Dependent Variable: ASI
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 11/15/21 Time: 13:29
Sample: 2019M11 2020M12
Included observations: 14
Failure to improve likelihood (non-zero gradients) after 128 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	24690.56	144.0615	171.3891	0.0000
	Variance Equation			
C	163414.3	317636.4	0.514470	0.6069
RESID(-1)^2	3.517572	2.761370	1.273850	0.2027
GARCH(-1)	-0.248680	0.026515	-9.378728	0.0000

R-squared	-0.324912	Mean dependent var	27404.82
Adjusted R-squared	-0.324912	S.D. dependent var	4941.510
S.E. of regression	5687.918	Akaike info criterion	18.41292
Sum squared resid	4.21E+08	Schwarz criterion	18.59551
Log-likelihood	-124.8904	Hannan-Quinn criter.	18.39602
Durbin-Watson stat	0.231343		

Source: E-Views 10

Table 2 contains the GARCH(1,1) estimation Mean equation for the GARCH model is:

m= 24690.56 + 144.06

The variance equation for the GARCH model is:

163414.3+ 3.5175 – 0.2486

Regression statistics are not applicable in this model as there are no regressors or predictor variables. Hence the negative r-squared values. To determine the persistence of volatility in the Nigerian stock market during the COVID-19 pandemic, the ARCH and GARCH coefficients are summed. 3.5175 + (-0.2486) = 3.269

Rule of thumb

A sum close to 1 shows persistence in volatility shocks (E-Views, 2019). Sum- 3.269; thus, volatility shocks had weak persistence in the stock market due to COVID-19. In contrast, Emenogu et al (2020) and Bello (2020) however found volatility persistence to be high in different analyses of the stock market. however, these studies do not directly target the COVID-19 crisis.

Research Question 3: What is the leverage effect of COVID-19 news on stock behavior in the Nigerian stock market?

Table 3
EGARCH estimation

Dependent Variable: ASI
Method: ML ARCH - Generalized error distribution (GED) (BFGS / Marquardt steps)
Date: 11/16/21 Time: 08:29
Sample: 2019M11 2020M12
Included observations: 14
Convergence not achieved after 10 iterations
Coefficient covariance computed using the outer product of gradients
Pre sample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	26841.94	62.86601	426.9706	0.0000
		Variance Equation		
C(2)	16.59828	29.34448	0.565635	0.5716
C(3)	0.513298	1.663598	0.308547	0.7577
C(4)	0.497014	1.382098	0.359608	0.7191
C(5)	-0.007223	1.761178	-0.004101	0.9967
GED PARAMETER	0.396623	0.182380	2.174702	0.0297

R-squared	-0.013973	Mean dependent var	27404.82
Adjusted R-squared	-0.013973	S.D. dependent var	4941.510
S.E. of regression	4975.915	Akaike info criterion	19.81345
Sum squared resid	3.22E+08	Schwarz criterion	20.08733
Log-likelihood	-132.6942	Hannan-Quinn criter.	19.78810
Durbin-Watson stat	0.302286		

Source: E-Views 10

C(5) is the GARCH term and shows volatility. To determine the persistence of volatility in the Nigerian stock market during the COVID 19 pandemic from the output of the EGARCH model, the ARCH and GARCH coefficients are summed. 0.5132 + 0.4970 + (-0.0072) = 1.003. A sum close to 1 shows persistence in volatility shocks (Eviews, 2019). Thus, volatility shocks are persistent in the stock market due to COVID 19 according to EGARCH. However, with the absence of asymmetry, the volatility persistence result of GARCH is adopted rather than that of EGARCH.

On leverage effects, the positive value of C(3) reveals a positive relationship between variance in the current period and that of the past period. C(4) is the indicator of volatility reactions to good and bad news- this is also referred to as the leverage effect. It has a positive value of 0.4970. the positive value indicates there is no asymmetric effect within the period. Thus, the bad news from the COVID-19 crisis did not increase volatility in a greater measure than the good news of pulling through COVID-19 did. Raifu et al. (2021), had findings consistent findings as they also found positive and negative responses of the stock market to COVID 19 news within the period. This is different from the regular findings of financial time series, however. Okpara & Nwezeaku (2009); Atoi (2014); Emenike (2010), are in line with popular findings where they all found volatility increases with a higher magnitude when the bad news hits stocks than it does when good news does.

5 Conclusion

The paper focused on the volatility of the stock market in Nigeria within a rather historic period in the world- the COVID-19 pandemic. The pandemic was found to affect economic activities as well as other aspects of living globally. Stocks that are financial assets are believed not to be left out in having a form of response to the signals brought about by news that filtered through the airwaves. All Share Index was found to have a drastic drop of 4915.99 points which is an 18.75% decline in March from February 2020. In line with previous economic literature, GARCH models have been used over time to measure conditional volatility of stocks and leverage effect on volatility as well. GARCH(1,1) model found that volatility existed within the market during the COVID-19 crisis however volatility persistence was low. EGARCH results showed an absence of asymmetry in data. The leverage effect found in the Nigerian stock market according to EGARCH shows that the market had identical responses to both bad news of COVID-19 announcements and the good news of the same magnitude that COVID-19 could be controlled.

Recommendations

Recommendations proffered based on study findings include:

1) Corporate NSE participants should have proper mechanisms in place to ensure performance is not adversely affected by challenging times.
2) Regulatory authorities and policymakers are expected to be proactive in their approach to forecasting market performance to reduce the negative effects of bad news on market indices.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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