The Effects of COVID-19 outbreak on the Nigerian Stock Exchange performance: Evidence from GARCH Models

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Abstract

The recent COVID-19 was first identified in Wuhan, China in December 2019 and now it has caused huge death and spread to almost all over the world. There are news that most of the world economy and financial markets would be affected due to protocols such as lockdown and social distancing. In Nigeria, the first case of COVID-19 was identified on 27th February 2020 and this present study examines the effect of COVID-19 outbreak on the performance of the Nigeria stock exchange using secondary data for the period of 2nd March 2015 to 16th April, 2020. Also the study considered the COVID-19 period of 2nd January 2020 to 16th April 2020, the results from GARCH models revealed a loss in stock returns and high volatility in stock returns under the COVID-19 period in Nigeria as against the non COVID-19 period. Also, the Quadratic GARCH (QGARCH) and Exponential GARCH (EGARCH) models with dummy variable were applied to the stock returns which shown that the COVID-19 has had negative effect on the stock returns in the Nigeria stock markets. The study therefore recommended that economic policy such as incentive to indigenous companies to create new employments, diversification of the economy to attract new investors, and flexible exchange rate regime that will aid business between Nigeria investors and the international market (trade) be implemented. Lastly, the government of Nigeria should ensure policy that ensures stable political environment and reduction in insecurity in the country.

Keywords: COVID-19, EGARCH, Financial Markets, Nigerian Stock Exchange (NSE), QGARCH

1.   Introduction

The recent COVID-19 can be regarded as a public health emergency of national and international concern. About approximately 15% of the cases comes from patients contracting the severe form of the disease (WHO, 2020). Older people and those with pre-existing medical conditions are likely to develop serious illness (Li et al. 2020). The Coronavirus disease 2019 (COVID-19) which first occurred in Wuhan, China in December 2019 has spread to almost all the world (Akanni and Gabriel, 2020). As

reported in Gralinski and Menachey (2020) the seafood market in Wuhan was closed down because of the incidence of this COVID-19 disease. Also Causing huge number of deaths (Al-qaness et al. 2020; https://www.worldometers.info/coronavirus/), falling global oil price and economic lockdown of major economy of the world such as USA (Ajami, 2020) of which Nigeria is not left out of the negative impact of the COVID-19 (Akanni and Gabriel, 2020). Igwe (2020) argued that the world economy faces worst-ever economic recession due to the outbreak of the COVID-19 which can lead to shock, increase volatility and negative impact on the financial system of any nation. African Union Report (2020) stated global equitable market has lost about 24 billion USD of which about 22 billion lost in United states GDP. In a recent study by Feinstein (2020) on Zombie outbreak which can be similar to COVID-a9, the study concluded a moderate zombie outbreak leaving 1 million people dead in major industrialized nation can lead to drop in GDP and Financial market by 23.44% and 29.30% respectively.

In Nigeria, COVID-19 case was officially identified on 27th February 2020 and few more cases were identified after then (Effiong, et al. 2020). The negative impact of COVID-19 on the Nigeria economy includes: economic lockdown which leads to economic loss, excessive withdraw of funds by investors from the market and also fall in oil prices (Ozili, 2020) and on the global economy, the impact of the COVID-19 cannot also be overemphasized (Mckibbin and Fernando, 2020) because it can lead to huge external debt of any country.

From the foregoing, if the negative impacts of COVID-19 on the economy and financial markets of any nation are not properly understood and managed, this virus has the potential to totally crash health sector or economy of any country such as Nigeria (Anjorin 2020; Feinstein 2020) especially in the absence of vaccine (Okhuese, 2020a) although study have shown that a recovered population may not be reinfected (Okhuese, 2020b).

1.1   Literature Review

The coronavirus pandemic is corona virus disease which has affected many, leading to deaths and have had great impact on Nigeria stock market, these have attracted a lot of scholars to investigate the pandemic. Ozili and Arun (2020) studied the impact of COVID-19 on the global economy reveal that COVID-19 has huge negative impact on Nigeria stock market in which the virus encouraged social distancing which led to a close of financial markets, corporate offices, businesses and events. The speed in which the virus spread exponentially can result to damage in consumption and investment among investors, consumers and trade partners. Similarly, Chukwuka and Ekeruche (2020) reported that Nigeria GDP in 2020 is expected to increase by 2.5% but unfortunately this has been truncated by the COVID-19 outbreak. The study is consistent with Oladeinde (2020) which examined Coronavirus and Nigeria Cuts Oil Benchmark to $30, Slashes Capital Budget By 20% which was discovered that Nigeria will make significant change in its 2020 budget to contain the effect of the outbreak of corona virus pandemic on the nation's economy. The bench mark for crude was placed at $57 per barrel is set to drop down from $57 per barrel to $30 per barrel, this shows that Nigeria economy may suffer because of her

overdependence on oil. The report of International Monetary Fund (IMF) also show global growth will fall by 0.5% in 2020 due to the covid-19 pandemic, the effects shows that there will be Stiffness of Demand and supply, sharp decrease in commodity and tourism arrivals. It was predicted that by the first half of the year, the global economy might enter into recessionn, as the result of huge inability to process raw material and respond to high demand of goods and services. Also, Akanni and Gabriel (2020) investigated the Implication of COVID-19 on the Nigerian Economy, it was discovered COVID-19 pandemic lead to disruption of activities and economy instability like the united trade and development agency has cost the outbreak of the pandemic to be at about $2trillion. It was seen that factors like social distancing, stay at home, limitation in spending and supply factor which include; cutting or stopping production and output have negative impact on economy growth. These have led to increasing poverty and unemployment rate, the National Bureau of Statistics (NBS) report 2020 placed Nigeria 21 among 181 counties with high unemployment rate of 23.1%, it is estimated that about 87million surviving with less than $2 a day benchmark.

Olufemi and Bolanle (2018) examined the diversification of International portfolio in the Nigerian stock market and the study was concluded using vector autoregressive granger causality test for relationship shows there is no relationship between Nigeria stock market and the five other developed countries. The study applied Generalized Method of Moments regression, the result shows during crisis and pre crisis period that developed stock markets impacted the Nigeria stock market especially during the crisis period. This was further concluded that Nigeria stock market is safe for investors before the COVID-19 crisis but this looming pandemic that shock the world economy has made it difficult to invest.

In Ndedi (2020), the aftermath of the Coronavirus in Selected African Economies was studied. The study concluded that countries such as Nigeria and Angola may feel the pain as they majorly depend on crude oil to have a stable economy and manufacturers of good and services, importation of foods have been tightened. It will further lead to African strong economic countries like Nigeria, South Africa, Angola, Egypt and Algeria will experience fiscal pressure due to sharp drop of commodity price. Lastly, John (2020) examined COVID-19 Pandemic, a War to be won and understanding its Economic Implications for Africa. The study concludes that the International Monetary Fund has called on creditors of all official bilateral to suspend all debt payment as forbearance is requested by International Development Association Countries to savage the economy instability, and further added that there will be substantial cost on the economy as the pandemic continue to spread which require strong will and action by the people and government to continue a war against it. The future impact of COVID-19 on the African economy cannot be determined immediately, but there will be more insight into it as situation unfolds.

Volatility of Nigerian stock exchange during COVID-19 is the focus of this study. The study employed the exponential GARCH (EGARCH) model which was proposed by Nelson (1991) because of the following advantages as: logarithmic specification; it support the relaxation of positive

constraints among parameters; it incorporates the asymmetric in stock returns volatilities and can successfully captures persistence of volatility shocks which is common to stocks in the Nigerian stock market. Abdulkareem, and Abdulkareem (2016) examined the macroeconomic and oil price volatility in Nigeria and their study revealed that the asymmetric models (such as TGARCH and EGARCH) was superior over the symmetric models (such as GARCH (1, 1) and GARCH – M). Kuhe, (2018) suggested that EGARCH (1,1) model with student-t innovation density was suitable for modelling Nigerian stock returns with structural breaks. In another study by Emenogu et al (2019) revealed ARMA(1,1)-eGARCH (2,2) model with student t distribution provides a suitable model for evaluating the GT bank stock returns in Nigeria. In other economy such as Egypt, Ezzat (2012) suggested the superiority of EGARCH model over other GARCH models considered. While in an empirical study by Alexander (2009) and Su (2010) suggested that EGARCH model fits better than GARCH model in modelling volatility of Chinese stock returns.

On the other hand, the Quadratic GARCH (QGARCH) is one of the popular conditional heteroscedastic models with leverage effects proposed by Engle and Ng (1993) and Sentata (1995) and it allows for asymmetric reactions to shocks such as EGARCH (Williams, 2011) . Some studies have shown that asymmetric model such as QGARCH have superior in-sample and out-sample fits than symmetric model such as standard GARCH (Franses and Van Dijk, 1996; Ulu, 2005). Yaya and Shittu (2010) used the QGARCH model to examine the Impact of Inflation and Exchange Rate on Conditional Stock Market Volatility in Nigeria. They reported that that previous exchange rates and inflation rates have significant effects on conditional stock market volatility in Nigeria. Lastly, QGARCH model has more advantages for financial market risk prediction, has the ability to reduce fluctuation of the model and can improve stability of risk value when combined with machine learning model as reported in Zheng, et al. (2019).

Therefore the goal of this paper examined the impact of the COVID-19 pandemic on the Nigerian Stock markets using Quadratic GARCH (QGARCH) and Exponential GARCH models because of the advantages of asymmetric models such as EGARCH and QGARCH as reviewed above.

The remaining parts paper is structured as follows: Section 2 describes the source of the datasets and presents the results of the descriptive statistics and unit root and Arch tests. Also Section 2 presents the framework for QGARCH and EGARCH approaches used. Section 3 presents the results, while Section 4 provides conclusion and some policy implications.

2.   Materials and Methods

2.1   Data and Descriptive Statistics

This research work adopted a secondary data collected from this website (www.investing.com). Daily All Share Price (ASP) of the Nigerian Stock Exchange (NSE) covering from 2nd March, 2015 to 16th April, 2020 (that gives a total of 1270) was collected from the website. The period was used to avoid the effect of the 2008 to 2009 global financial crisis. The returns of the daily stock prices were

calculated with the formula stated below:

$$r_t = \ln p_t - \ln p_{t-1}.$$ (1)

where r_t is the return at current time t; ln is refers to the natural logarithm; p_t is the price of the daily stock at current time t, while p_{t-1} is the price of daily stock price at the previous time $t-1$. The calculations of the returns have total observations of 1269.
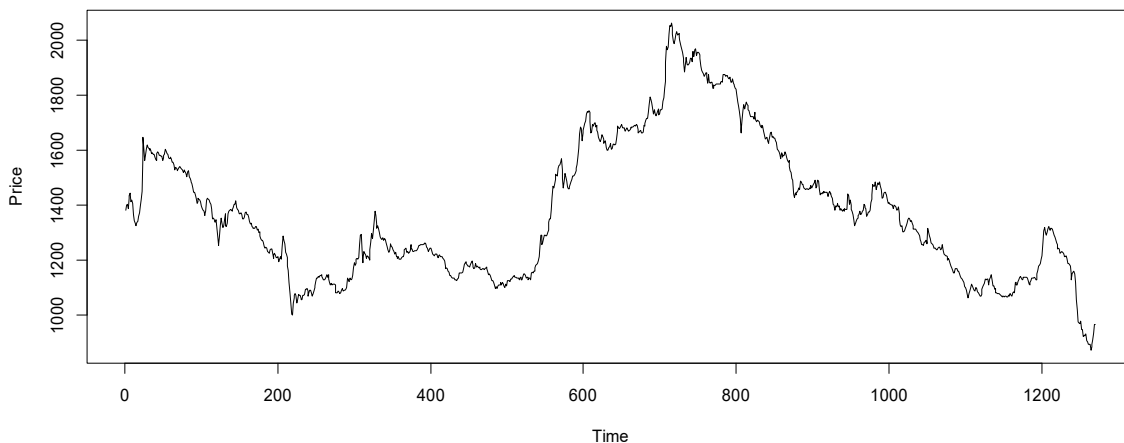

Fig. 1: Time Plot of NSE Stock Price

The All Share Price (ASP) of NSE got to its peak between data point of 600 and 800 but begins to drop from data point of 801 to 1100. While drop can be seen from data point of 1201 which are the COVID-19 period as shown in Fig. 1 above.
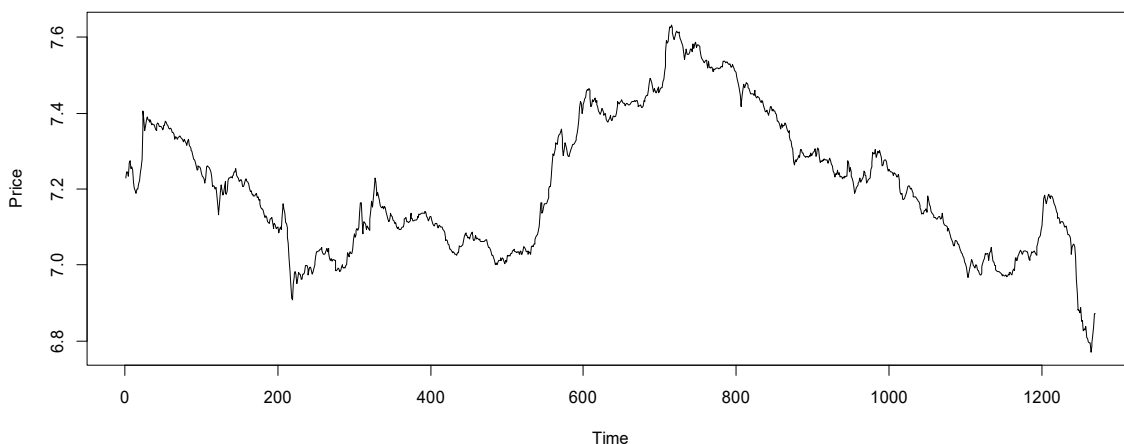

Fig 2: Time Plot of log Stock Prices of NSE

The log of All Share Price (ASP) of the NSE is presented in Fig. 2 above which also unveils

the information as shown in Fig. 1. Towards the end of the series one can observe sharp drop in the price of stock in Nigeria during the COVID-19 period.
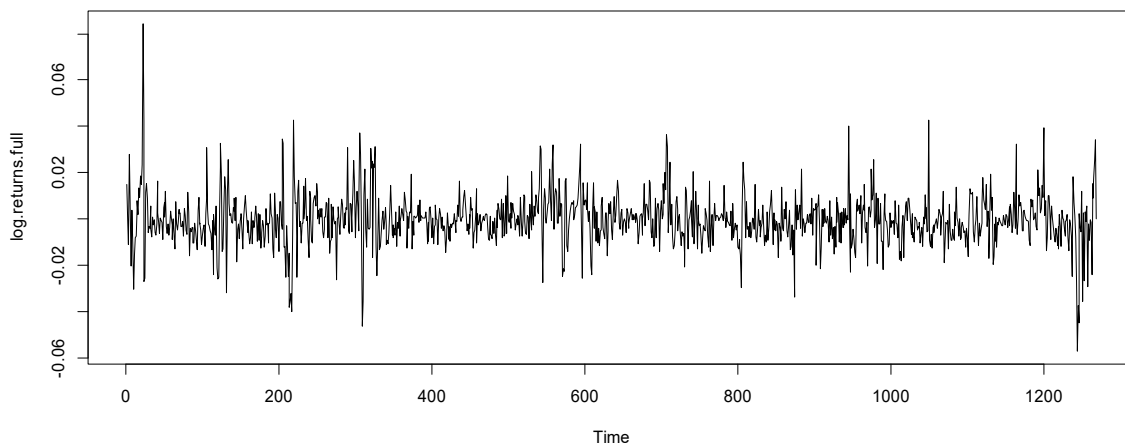

Fig. 3: Time Plot of NSE log Returns

In Fig. 3 presents the log returns of the ASP of the NSE for the period of 3rd March 2015 to 16th April 2020. Evidences of volatility are shown between data point of 600 and 800, 801 and 1100, and from data point 1201.
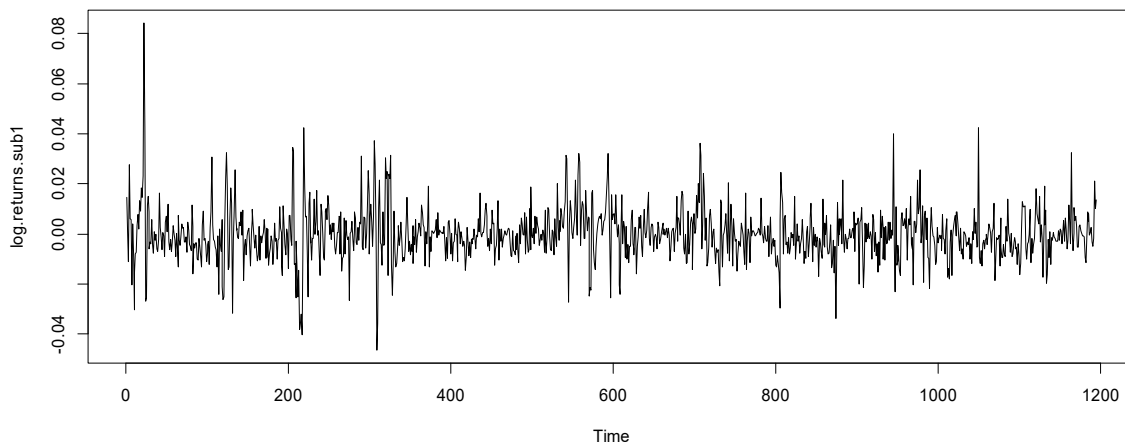

Fig 4: Time Plot for NSE log Returns for Non COVID-19 period

In Fig. 4 we presented the log returns of the NSE refer to as Non COVID-19 period from 3rd March 2015 to 31st December 2019. The Fig 4 shows volatility in the returns during the non COVID-19 and some clustering at the early part of the series from 0 to 200, and from data point 1000 to 1200.
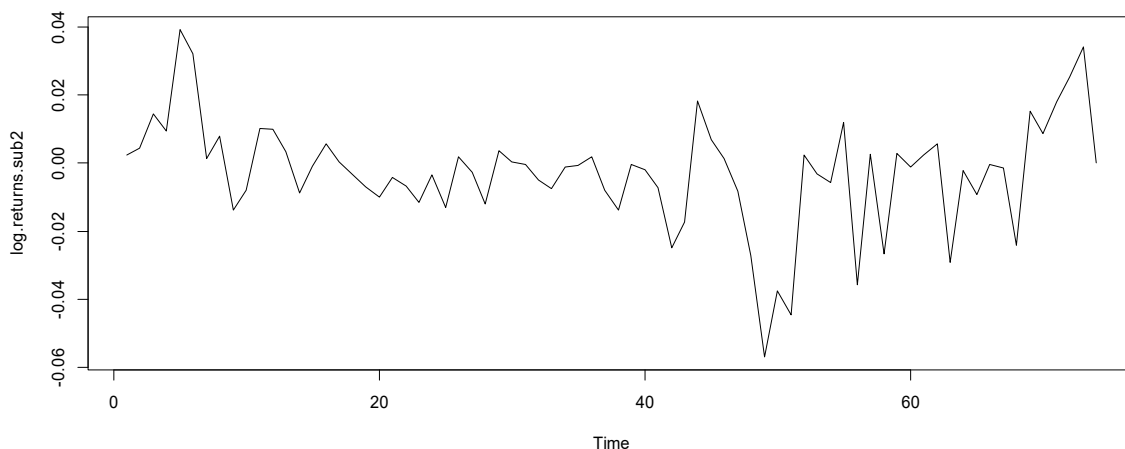
Fig 5: Time Plot for NSE log Returns for COVID-19 period

The Fig. 5 above, we presented the log returns of the NSE refer to as COVID-19 period from 2nd January 2019 to 16th April 2020. During this period of COVID-19 the market seems to be high volatile with high rate of fluctuation as depicted in Fig. 5 above.

In Table 1, we presented the descriptive statistics for the price and log returns for the full sample. The mean returns is negative which signifies a loss in stock, the returns is skewed and leptokurtic (highly peaked and fat tailed). Likewise the returns rate presented for the non COVID-19 and COVID-19 periods. While for the COVID-19 period, the returns exhibited high volatility as against the returns of the non COVID-19 period as shown in the Table 2. Lastly, returns for the full sample, non COVID-19 and COVID-19 periods revealed presence of Arch effects at lag 15 using the ARCH LM test, this provide the justification for using the GARCH models.

Table 1: Data Summary

Variables	Mean	Max.	Min.	SD	Skewness	Kurtosis	JB
Daily Stock Price (Full Sample)(2nd March 2015 to 16th April 2020)							
Price	1374.7440	2062.6100	871.2600	251.4658	0.6393	2.6062	JB=94.7172 P=0.0000
Changes in Prices (Log-Returns) (3rd March 2015 to 16th April 2020)							
Returns	-0.0003	0.0842	-0.0570	0.0108	0.4594	8.6564	JB=1736.3400 P=0.0000
ARCH LM-test: Chi-squared = 171.8900, df = 15, p-value < 2.2e-16							

Table 2: Data Summary for Non COVID-19 and COVID-19 periods

Variables	Mean	Max.	Min.	SD	Skewness	Kurtosis	JB
Changes in Prices (Sub Sample)(Non COVID-19 period)(3rd March 2015 to 31st December 2019)							
Returns	-0.0001	0.0842	-0.0463	0.0104	0.7288	8.8785	JB=1826.4000 p=0.0000
ARCH LM-test: Chi-squared = 149.8700, df = 15, p-value < 2.2e-16							
Changes in Prices (Sub Sample)(COVID- period)(2nd January 2020 to 16th April 2020)							
Returns	-0.0027	0.0393	-0.0570	0.0162	-0.5072	4.8894	JB=14.1808 p=0.0008
ARCH LM-test: Chi-squared = 28.3410, df = 15, p-value = 0.0195							

In Tables 3 and 4, we presented the unit root test using Augmented Dickey-Fuller (ADF), Dickey-Fuller Generalized least square (DF-GLS) and Phillips-Perron (PP) statistic for the price and log returns for the full sample at lag 22, log returns for non COVID-19 at lag 22 and COVID-19 periods at lag 5. The results shows that the price is not stationary while the log returns is stationary for full and sub samples.

Table 3: Results of classical Unit root tests for the full sample

Variables	ADF	DF-GLS	PP
Daily Stock Price (Full Sample)(2nd March 2015 to 16th April 2020)at lag 22			
Price	-1.2494 P=0.6548	-1.2458 Critical value=-1.9411	-1.0484 P=0.7440
Changes in Prices (Log-Returns) (2nd March 2015 to 16th April 2020) at lag 22			
Returns	-12.8724 P=0.0000	-1.6858 Critical value=-1.9411	-25.2988 P=0.0000

Table 4: Results of classical Unit root tests for non COVID-19 and COVID-19 periods

Variables	ADF	DF-GLS	PP
Changes in Prices (Sub Sample)(Non COVID-19 period)(3rd March 2015-31st December 2019)at lag 22			
Returns	-12.8996 p-value=0.0000	-1.3323 Critical value=-1.9411	-24.7113 p-value=0.0000
Changes in Prices (Sub Sample)(COVID-19 period)(2nd January 2020 to 16th April 2020) at lag 5			
Returns	-3.0038 p-value=0.0395	-2.6765 Critical value=-1.9456	-5.3681 p-value=0.0000

2.2. Methodology

2.2.1 The Exponential GARCH (EGARCH) Model

Exponential GARCH (EGARCH) model was first introduced by Nelson (1991) in other to overcome

some of the weaknesses of the standard GARCH model in analysing financial time series. One of the advantages of EGARCH is that it allows for asymmetric effects between positive and negative stock returns, the weighted innovation was considered by Nelson (1991) as follows:

$$g(\varepsilon_t) = \theta\varepsilon_t + \gamma[|\varepsilon_t| - \mathrm{E}(|\varepsilon_t|)] \tag{2}$$

where θ and γ are considered as constants. While both ε_t and $|\varepsilon_t| - \mathrm{E}(|\varepsilon_t|)$ are considered as zero-mean iid sequences with continuous distributions. With that, $E[g(\varepsilon_t)] = 0$. Therefore the asymmetry of $g(\varepsilon_t)$ can easily be written as

$$g(\varepsilon_t) = \begin{cases} (\theta + \gamma)\varepsilon_t - \gamma E(|\varepsilon_t|) \ if \ \varepsilon_t \geq 0, \\ (\theta - \gamma)\varepsilon_t - \gamma E(|\varepsilon_t|) \ if \ \varepsilon_t < 0. \end{cases} \tag{3}$$

An EGARCH(m,s) model can be written as be written as follows (Emenogu et al. 2020):

$$a_t = \sigma_t\varepsilon_t,$$

$$\ln(\sigma_t^2) = \omega + \sum_{i=1}^{s}\alpha_i \frac{|a_{t-i}| + \theta_i a_{t-i}}{\sigma_{t-i}} + \sum_{j=1}^{m}\beta_j \ln(\sigma_{t-i}^2) \tag{4}$$

which specifically results in EGARCH(1,1) being written as

$$a_t = \sigma_t\varepsilon_t$$

$$\ln(\sigma_t^2) = \omega + \alpha([|a_{t-1}| - \mathrm{E}(|a_{t-1}|)]) + \theta a_{t-1} + \beta\ln(\sigma_{t-1}^2) \tag{5}$$

where $|a_{t-1}| - \mathrm{E}(|a_{t-1}|)$ are considered to be iid with mean zero. When the EGARCH model assumed a Gaussian distribution of error term, $\mathrm{E}(|\varepsilon_t|) = \sqrt{2/\pi}$, which gives:

$$\ln(\sigma_t^2) = \omega + \alpha([|a_{t-1}| - \sqrt{2/\pi}]) + \theta a_{t-1} + \beta\ln(\sigma_{t-1}^2) \tag{6}$$

2.2.2   Quadratic GARCH (QGARCH)

Sentana (1995) first introduced Quadratic GARCH (QGARCH) model to cope with asymmetric effects of shocks on volatility. In addition, Quadratic-GARCH is an important time series model used mostly in econometrics and finance such as returns on stocks, foreign exchange rate with volatility variance with time. It is used to model asymmetric effects of positive and negative shocks, it is a very important time, adequately representation of volatility and risk and can easily be incorporated in multivariate models (Andersen and Bollerslev, (1998); Bou-Hamad and Jamali (2020); Hølleland and Karlsen (2020); Holý and Tomanová (2020)).

The QGARCH (1,1) can be specified as follows:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma\varepsilon_{t-1} \tag{7}$$

the term $\gamma\varepsilon_{t-1}$ often makes it possible for positive and negative shocks to have different effects on

conditional volatility (Yaya and Shittu, 2010).

2.2.3 Model Selection Criteria

The AIC, BIC, SBIC and HQIC are measure of goodness-of-fit of an estimated GARCH model and model with the lowest values of AIC, BIC, SBIC and HQIC is the preferred model among competing models. They are given as below:

$$AIC = -2\log(\hat{\sigma}^2) + 2(k) - 1 - \log(2\pi) \tag{8}$$

$$SBIC = -2\log(\hat{\sigma}^2) + (k) * \log(n) - 1 - \log(2\pi) \tag{9}$$

$$HQIC = -\log(\hat{\sigma}^2) + 2(k) * \log(\log(n)) - 1 - \log(2\pi) \tag{10}$$

Where is the estimated model error variance; k is the number of parameters in the model; n is the number of observation (Akaike, 1973; Schwarz, 1978; Hannan-Quinn, 1979; Javed and Mantalos, 2011).

3.   Results and Discussion

In Table 5, we presented the performances of the EGARCH and QGARCH models with Generalized Error Distribution (GED), Student t distribution (STD) and Skewed Student t distribution (SSTD) using Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Schwarz Bayesian Information Criteria (SBIC) and Hannan-Quinn Information Criteria (HQIC) to choose the best model among the competing GARCH models. Our choice of Generalized Error Distribution (GED), Student t distribution (STD) and Skewed Student t distribution (SSTD) is supported by Abdulkareem and Abdulkareem (2016) and Kuhe (2018) for modelling Nigeria stock returns. The choice of lag for the GARCH models adopted in this study is consistent with the work of Kuhe (2018) who found EGARCH (1,1) superior for modelling Nigeria stock returns in the presence of structural break. The result revealed EGARCH (1,1) with SSTD model emerged the best model with the least AIC, BIC, SBIC and HQIC values. Hence EGARCH(1,1) with SSTD was used to model the full sample incorporating dummy (non COVID-19 period is 0 and COVID-19 period as 1).

Table 5: Results of GARCH Models for Full Sample

Models	Distributions	AIC	BIC	SBIC	HQIC
Log returns Full Sample					
EGARCH(1,1)	GED	-6.5519	-6.5316	-6.5519	-6.5443
EGARCH(1,2)	GED	-6.5503	-6.5259	-6.5503	-6.5411
EGARCH(2,1)	GED	-6.5487	-6.5203	-6.5487	-6.5380
EGARCH(2,2)	GED	-6.5485	-6.5160	-6.5485	-6.5363
EGARCH(1,1)	STD	-6.5537	-6.5335	-6.5538	-6.5461
EGARCH(1,2)	STD	-6.5520	-6.5276	-6.5520	-6.5428
EGARCH(2,1)	STD	-6.5504	-6.5220	-6.5504	-6.5397
EGARCH(2,2)	STD	-6.5496	-6.5172	-6.5497	-6.5375

Model	Dist				
EGARCH(1,1)	**SSTD**	**-6.5554**	**-6.5311**	**-6.5555**	**-6.5463**
EGARCH(1,2)	SSTD	-6.5537	-6.5253	-6.5537	-6.5430
EGARCH(2,1)	SSTD	-6.5521	-6.5197	-6.5522	-6.5400
EGARCH(2,2)	SSTD	-6.5517	-6.5152	-6.5518	-6.5380
QGARCH(1,1)	GED	-6.5526		-6.5323	-6.5450
QGARCH(1,2)	GED	-6.5517		-6.5273	-6.5426
QGARCH(2,1)	GED	-6.5520		-6.5276	-6.5428
QGARCH(2,2,)	GED	-6.5506		-6.5222	-6.5399
QGARCH(1,1)	STD	-6.5552		-6.5349	-6.5476
QGARCH(1,2)	STD	-6.5541		-6.5298	-6.5450
QGARCH(2,1)	STD	-6.5542		-6.5299	-6.5451
QGARCH(2,2,)	STD	-6.5527		-6.5243	-6.5420

In Table 6, we presented the result of the EGARCH (1,1) with SSTD by incorporating the COVID-19 period. The result revealed a negative impact of COVID-19 on the performance of Nigeria stock exchange for the period under study. This result is consistent with the results of Ozili and Arun (2020) and Akanni and Gabriel (2020). The implication of these findings is that the news and impact of COVID-19 could lead to investors withdrawing their funds from the market thereby affecting investment in Nigeria, and possible lead to reduction of the Nigeria GDP and fall in standard of living of Nigeria, high inflation and unemployment rates during this pandemic.

Table 6: eGARCH(1,1) with Dummy Variable

Model	ω	α_1	β_1	γ_1	Covid 19	Skew	Shape
Optimal Parameters							
EGARCH(1,1)	-0.95100 (0.000593)	-0.20743 (0.000130)	0.90029 (0.000706))	0.59624 (0.000332)	-5.57650 (0.002064)	1.00000 (0.000895)	3.99777 (0.004000)
Persistence= 0.9002867; Half-life= 6.598761							

4.   Conclusion

This study employed EGARCH and QGARCH models with addition of dummy variable to allow for non COVID-19 and COVID-19 period. We found that EGARCH (1,1) with SSTD by incorporating the COVID-19 period emerged the best model among the competing models. The result revealed a negative impact of COVID-19 on the performance of stock returns in the Nigeria stock Exchange for the period under study.

The study therefore recommended that economic policy such as incentive to indigenous companies to create new employments, diversification of the economy to attract new investors, and flexible exchange rate regime that will aid business between Nigeria investors and the international market (trade) be implemented. Lastly, the government of Nigeria should ensure policy that ensures

stable political environment and reduction in insecurity in the country.

5.   Acknowledgements

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