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MODELLING THE IMPACT OF POST COVID-19 PANDEMIC ON THE PERFORMANCE OF NIGERIA STOCK EXCHANGE USING GARCH DISTRIBUTION

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ABSTRACT
The unprecedented COVID-19 epidemic has put the world in peril and shifted the global landscape in unanticipated ways. Using the GARCH distribution, this study investigates the impact of the post-COVID-19 pandemic on the performance of the Nigeria Stock Exchange (NSE) index return from January 2016 to April 2022. The ARCH effect statistic utilizing the ADF statistic reveals the presence of heteroscedasticity, while the stationarity statistic indicates that data is stationary without transformation. The volatility models were found to be statistically significant, with probability values of 0.01 for the distributions. The results reveal that GARCH (1, 1) with a normal error distributions outperforms other volatility models and error distributions, and has the lowest AIC. The normal error distribution outperforms the student t and generalized error distributions in term of best fit. Furthermore, the whole sample forecast reviews that the NSE return is stable but volatile. Volatility is likely to occur in the first four months of the year 2022, while the estimate on a smaller sample size is also stable with volatility slows toward April 2022.

KEYWORDS
COVID -19, Error distributions, Forecast, Stock exchange, Volatility models

1. Introduction

The unprecedented COVID-19 epidemic has put the world in peril and shifted the global landscape in unanticipated ways. COVID-19's entry into global space has resulted in a public health emergency as well as an economic crisis. Global and national health systems have been preoccupied with the virus's treatment, containment, and vaccine development as a public health emergency. Furthermore, the government's global lockdown to stop the virus from spreading has triggered an economic catastrophe due to supply and demand shocks. Thus, the labour market, global supply chains, consumer consumption, and stock market are all important routes through which the lockdown will impact the global economy. The Nigeria stock exchange and its volatility are key factors that influence economic and financial activities in Nigeria that is why stock exchange market fluctuation have always attracted favorable recognition in

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OLAYEMI, Michael Sunday, OLUBIYI, Adenike Oluwafunmilola & OLAJIDE, Oluwamayowa Opeyimika (2023). Modelling the Impact of Post Covid-19 Pandemic on the Performance of Nigeria Stock Exchange using Garch Distribution. *Journal of Econometrics and Statistics.* 4(1), 53-61.

both economic, financial and statistics literature. The need for modelling and forecasting volatility is because investors are not only interested in the average returns of a stock but also its risk. Therefore, market investors and speculators need information to analyze the profit or loss for the erratic behaviour of financial asset. However, analyzing volatility is helpful as it informs investors a measure of the risk involved in holding an asset The aim of this work is to model the impact of Post COVID -19 on the Nigeria stock exchange using GARCH, Exponential GARCH and GJR- GARCH Models while the objective is to forecast the volatility of the Nigeria stock exchange. Economic impacts of epidemics and pandemics have been examined in literature in forms of country-specific and global studies. However, COVID-19 has created an unprecedented global disruption which has necessitated several studies. Consequently, emphasis in this review will be on macroeconomic and financial market disruptions orchestrated by COVID-19 pandemic. (Oyelami et al.,2020) in their study investigates the dynamic interaction of COVID-19 incidence and stock market performance using daily time series data between April, 2020 and August, 2020 of All Share Index (ASI), COVID-19 pandemic confirmed cases, Nigeria's borrowing rate and exchange rate. It spans through the pre-lockdown, lockdown and post lockdown periods. Based on the assumption of endogeneity, vector autoregressive (VAR) model was employed for estimation. The result revealed that COVID19 confirmed cases have a significant negative effect on stock market performance proxy by stock market returns. (Adenomonet al.,2020) employed EGARCH and QGARCH models with addition of dummy variable to allow for non COVID-19 and COVID-19 period in their study on the effects of COVID-19 outbreak on the Nigerian Stock Exchange performance: evidence from GARCH Model they discovered 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 stock returns in Nigeria under the period under study. (Egunjobi, 2022) in his study explained that the financial market and consequently the economic climate have been severely impacted by the economic chaos caused by the pandemic. The consequences are reflected in the inability of the financial sector to perform its function of promoting development via income generation and reducing poverty and inequality. Even while stock market returns have been hurt more severely, especially in service delivery and reduction in turnover, the business environment is still very uncertain and unpredictable, though the study revealed that this has not really deterred investors or operations in the Nigerian financial sector. Thus, to achieve economic development, a sustainability appropriate policies and relief measures must be geared towards reducing the negative consequences arising from the pandemic. (Arashiet al., 2022) observed in their study that with the continuous development of economy in the society, a rapid rise has happened in emergence of capital markets in the world today. They concluded that investing in stock market forms an important part of the economy of the society. They modelled daily return series of stock index NASDAQ stock exchange using ARMA-GARCH model. (Olayemi et al., 2022) reflected three different models in their empirical work. They modelled the volatility in Nigeria crude oil price using the symmetric and asymmetric GARCH model that capture most common stylized facts about Crude oil price in Nigeria markets such as volatility clustering and leverage effects. It was discovered that GARCH (1,1) model outperformed EGARCH (1,1) and PGARCH (1,1) models because it has the least Akaike info Criterion (AIC)" Alzyadat& Asfoura (2021) observed that the descriptive statistics show that stock market returns and the number of COVID-19 infection cases recorded during the study period are volatile, and displays evidence of fluctuations in the variables over the study period.Based on the results of the impulse

response functions that shock market returns respond to COVID-19 negatively over the study period. Olayemi et al. (2021) "observed two different models in their paper work. Nigeria inflation rate was modelled by applying the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and Threshold GARCH models. Both symmetric and asymmetric models that capture most common stylized facts about the rate of inflation in Nigeria such as volatility clustering and leverage effects were studied. These models are GARCH (1,1) and TGARCH (1,1). The first model implies a symmetric effect of past shocks whereas TGARCH model allow capturing of asymmetric effects.

2. Methodology

The time-series data used for modelling volatility in this paper is the daily Nigeria stock Exchange (NSE) return of all index over the study period (January 2016 through April, 2022) obtained from the Nigeria Stock Exchange website. The GARCH, EGARCH and GJRGARCH volatility model were used in this study. The symmetric and asymmetric GARCH model was used as conditional variance equations. Computation of NSE Return. Let

$$r_t = \ln\left(\frac{v_t}{v_{t-1}}\right), \quad t = 1, 2, 3, \ldots n. \tag{1}$$

Where v_t and v_{t-1} are the present and previous prices at time t and rt is the returns series.

2.1. The ARCH model

The ARCH model is as presented below:

$$\sigma_t^2 = \alpha_0 + \sum_i^q \alpha_i \epsilon_{t-i}^2 \tag{2}$$

Where $\alpha_0 > 0$, $\alpha_i \geq 0$; $i = 1, \ldots q$ the parameters of the model and q is the order of ARCH terms.

2.2. The GARCH (p, q) model

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-i}^2 + \cdots + \alpha_1 \epsilon_{t-q}^2 + \cdots + \beta_1 \sigma_{t-i}^2 + \cdots + \beta_p \sigma_{t-p}^2 \tag{3}$$

Alternatively, it can be stated as:

$$\sigma_t^2 = \alpha_0 + \sum_i^q \alpha_i \epsilon_{t-i}^2 + \sum_j^p \beta_j \sigma_{t-j}^2 \tag{4}$$

Where $\alpha_0 > 0$, $\alpha_i \geq 0$, $\beta_j \geq 0$ and $\alpha_i + \beta_j < 1$ for all i and j while q is the ARCH order terms, and p is the GARCH order terms.

2.3. EGARCH (p, q) model

The EGARCH (p, q) model was proposed by (Nelson, 1991)to formulate the volatility model as follows:

$$\log\left(\sigma_t^2\right) = \alpha_0 + \sum_{i=1}^{q} \alpha_i \left[\lambda\epsilon_{t-i} + \gamma\left\{|\epsilon_{t-i}| - \sqrt{\frac{2}{\pi}}\right\}\right] + \sum_{j=1}^{p} \beta_j \log\left(\sigma_{t-j}^2\right) \tag{5}$$

$\alpha_0 > 0$, $\alpha_i \geq 0$, $\gamma \geq 0$, $\beta_j \geq 0$ and $\alpha_i + \beta_j + \frac{\gamma}{2} < 1$ are the parameters of the model

2.4. GJR-GARCH (p, q) model

The GJR-GARCH model was proposed by (Glosten et al.,1993) to formulate the volatility model as follows:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \left(\alpha_i + \gamma_i M_{t-i}\right) \epsilon_{t-i}^2 + \sum_{j}^{p} \beta_j \sigma_{t-j}^2 \tag{6}$$

$\alpha_0 \geq 0$, $\alpha_1 \geq 0$, $\gamma \geq 0$, $\beta_j \geq 0$. Where, $M_{(t-i)}$ is an indicator for negative ϵ_{t-1} that is M_{t-i} is 1 if $\epsilon_{t-1} < 0$ and 0 otherwise.

3. Applications

3.1. Data Description

Dataset: The time-series data used for modelling volatility in this paper is the daily Nigeria stock Exchange (NSE) return of all index over the study period (January 2016 through April, 2022) obtained from the Nigeria Stock Exchange website. Eview-10 was used in analyzing the data collected for this research.

3.2. Empirical Analysis

Figure 1 below shows the trend of the series shows volatility clustering. Also we observed that during the COVID -19 periods high volatility follows high volatility while during the post COVID -19 period it shows that low volatility follow low volatility. An empirical analysis of the NSE index returns was carried out on return series. The

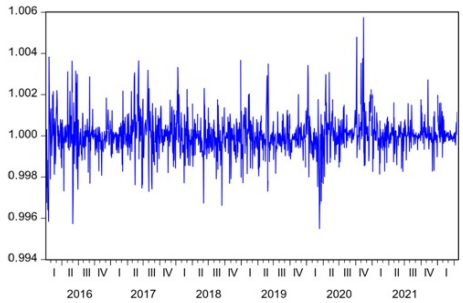

Figure 1. Volatility plot of NSE Return index

obtained results are shown in table 1 shows that the mean return series were positive, positive skewed and high kurtosis for the NSE index returns. The result of the Jarque Bera statistic indicated that the returns series NSE index return is not normally distributed. The series shows that the distribution is lepto-kurtic because it has a fat tail.

Table 1. Descriptive Statistics of the Nigeria Stock Exchange (NSE) Index Returns between January, 2016 – April, 2022.

Mean	1.000034
Standard Deviation	0.000932
Skewness	0.291674
Kurtosis	7.483139
Jarque Bera	1331.931
Probability	0.01
Observations	1564

3.3. Stationary Test

A test of stationarity was carried out using the augmented dickey-fuller test (ADF). The result obtained showed that the ADF test statistic were all less that their critical value at 1% as presented in table 1, therefore, there is no unit root. The returns series were all stationary, hence, there is no need for transformation.

Table 2. AUGUMENTED DICKEY- FULLER TEST

Stocks	ADF Test Statistics	Comment
NSE	-21.51284	Stationary at 1% level without transformation.

1% critical = -3.332218

3.4. ARCH Effect Test

The result of $f - statistic$ were significant at 1% for the NSE index returns which shows a different lag value that there is ARCH effect using Lagrange Multiplier test in table 3 below.

Table 3. Lagrange Multiplier Test of the presence of ARCH Effect

	ARCH EFFECT	F- STATISTIC	P- VALUE
NSE Return	At lag 1-2	688.55	0.001
	At lag 1-5	543.72	0.001
	At lag 1-10	260.92	0.001

3.5. Estimates of the parameters of GARCH Models and Selection Creterion on Nigeria Stock Exchange Index Returns

Table 3 presents the parameter estimates of volatility models estimated at 3 error distributions namely; Student t, Normal, and Generalized Error distribution using

returns from NSE. The result shows that the returns exhibit volatility clustering, because the GARCH term was significant in most of the models considered ($P < 0.05$) and ($P < 0.01$) which means that small changes in volatility returns tend to be followed by large changes in volatility and vice versa. In terms of leverage effect which measures whether there is a negative relationship between asset returns and volatility, it was discovered to be significant in GARCH, E- GARCH and GJR- GARCH models estimated at the three distributions of error innovation ($P < 0.05$). The performance of GARCH models and its extension estimated at three error innovation distributions namely: Student t, Normal, and Generalized Error distribution were compared in terms of selection criteria to validify the model. The table 4 below shows the result of the fitness and model selection based on the selection criteria of GARCH, E- GARCH and GJR- GARCH model. The normal error distribution performs better on GARCH (1,1) than EGARCH (1,1) and GJR-GARCH (1,1). The result of AIC outperformed SIC and Hanna-quinn as it has the least value of 2.841918.

Table 4. ESTIMATES OF THE PARAMETERS OF GARCH MODELS AND SELECTION CRETERION ON NIGERIA STOCK EXCHANGE INDEX RETURNS

Model	Error Distribution	g_0	g_1	h_1	γ	AIC	SIC	Hanna-quinn
GARCH (1,1)	Student t	0.761157	−0.0888895	0.4999595	-	2.941254	2.954957	2.946348
	Normal	0.491938	−0.008096	0.524059	-	2.841918	2.852195	2.845738
	Generalised	0.996561	0.146493	0.598777	-	3.240282	3.253984	3.245376
E-GARCH (1,1)	Student t	0.023910	0.033347	0.033345	0.033410	2.893943	2.911072	2.900311
	Normal	6.83×10^{-05}	0.010000	0.010000	0.010000	2.843262	2.856965	2.848357
	Generalised	6.83×10^{-05}	0.010000	0.010000	0.010000	2.844542	2.861670	2.850910
GJR-GARCH (1,1)	Student t	0.797194	-0.05280	0.050000	0.523447	3.030750	3.047879	3.037118
	Normal	0.491927	-0.008107	0.050000	0.524051	2.843196	2.856899	2.848290
	Generalised	0.996558	0.146490	0.050000	0.598776	3.241496	3.258624	3.247863

where g_0, g_1, h_1 and γ are the constant parameter, and the parameters of ARCH effect, GARCH effect and leverage effect respectively

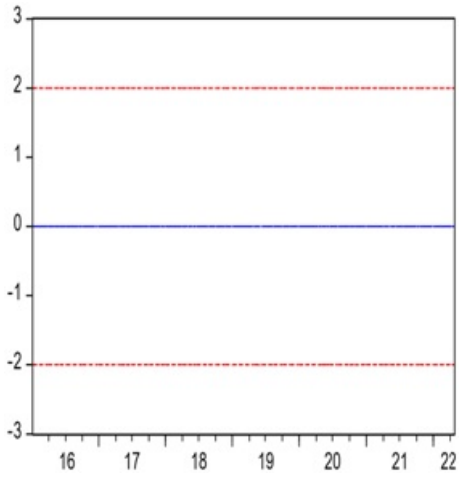

Figure 2. Forecast of Variance

```
Forecast: RETURNF
```

```
Actual: RETURN
Forecast sample: 1/06/2016 4/28/2022
Adjusted sample: 1/07/2016 4/28/2022
Included observations: 1564
Root Mean Squared Error  1.000034
Mean Absolute Error       1.000034
Mean Abs. Percent Error  100.0000
Theil Inequality Coefficient  1.000000
Bias Proportion          0.999999
Variance Proportion
Covariance Proportion   NA
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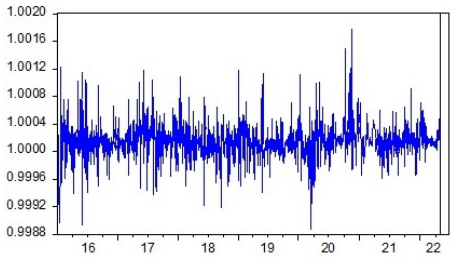

Figure 3. Volatility plot of NSE Return index

Figure 3 above explained that the return on NSE is stable but shows intense volatility. This also show that volatility may occur in the 1st, 2nd, 3rd and 4th month of the year 2022.

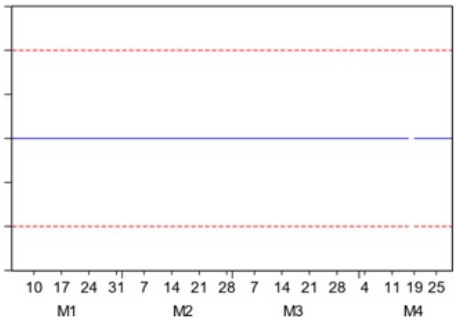

Figure 4. REDUCE SAMPLE FORECAST OF NSE RETURNS INDEX

```
Forecast: RETURNF
Actual: RETURN
Forecast sample: 1/04/2022 4/28/2022
1Included observations: 81
Root Mean Squared Error  1.000173
0Mean Absolute Error      1.000172
Mean Abs. Percent Error  100.0000
Theil Inequality Coefficient  1.000000
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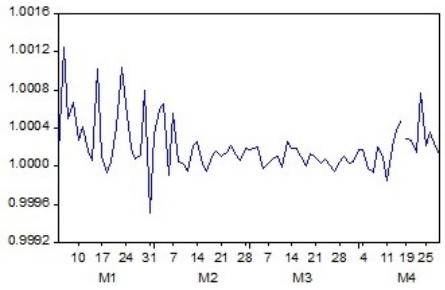

Figure 5. Forecast of Variance

Figure 5 above shows that the return on NSE is also stable and shows that volatility decelerates in April, 2022.

4. CONCLUSION

In this paper, we were able to investigate the impact of the post-COVID-19 pandemic on the performance of the Nigeria Stock Exchange (NSE) index return from January 2016 to April 2022. The empirical result shows a positive return in the mean, high kurtosis and positive Skewness. And the ADF test validates the result of the Jarque – Bera statistic that the return is stationary at level stated without transformation. The data also shows evidence of ARCH effects and the parameter also shows that most coefficient in the model were significant at 0.01. The results reveal that GARCH(1,1) with a normal error distributions outperforms other volatility models and error distributions, and has the lowest AIC. The normal error distribution outperforms the students t and generalized error distributions in term of best fit. Furthermore, the whole sample forecast reviews that the NSE return is stable but volatile. Volatility is likely to occur in the first four months of the year 2022, while the estimate on a smaller sample size is also stable with volatility slows toward April 2022.

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