THE COVID-19 AND EXCHANGE RATE VOLATILITY IN NIGERIA

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Abstract
With the current economic challenges facing the global economy consequent to the outbreak of the COVID-19 pandemic, economic variables of countries on the globe had been seriously affected. This paper seeks to didactically investigated effect of the COVID-19 pandemic on the volatility of exchange rate in Nigeria. We adopted the GARCH model, and created a dummy for the COVID-19 pandemic with a view to examining its effect on the volatility of Nigeria's exchange rate. The results revealed high persistence of volatility shocks in the exchange rate series of Nigeria and that the COVID-19 pandemic has had significant effect on volatility of the series. Based on the results, the paper recommended that a more optimal exchange rate policy in order to mitigate the effects and lessen the macroeconomic risks associated with high exchange rate volatility for effective exchange rate management in Nigeria.

KEYWORDS: COVID-19, Exchange Rate Volatility, Global Economy, GARCH.

1.0 Introduction

In the history of exchange rates, the 1970s had witnessed a dramatic adjustment in the international monetary system from a regime of pegged exchange rates which had prevailed for about a quarter of a century since the Bretton Woods conference, into a regime of flexible, though managed rates (Dornbusch,1980). Since that shift from a pegged exchange rate system to a flexible exchange rate system, exchange rates of various countries in the world have been fluctuating widely, and hence, the high volatility in exchange rates across countries which prevails until today. In most of the Sub-Saharan African countries, exchange rates have historically been highly volatile since the introduction of the economic liberalization reforms and structural adjustment programs in the 1980s and 1990s. The reforms had involved liberalizing their international trade and foreign exchange rate regimes, which occurred in the 1980s and 1990s (Maehle et al., 2013). Prior to the liberalization, the exchange rate regimes of many of them were hitherto characterized by stringent administrative control policies.

The world economy is currently hit by a huge preponderance of macroeconomic shocks and has found itself embroiled into an ominous economic recession due to the Corona virus pandemic, commonly known as the COVID-19. The first round of the infections associated with the pandemic were reported at the end of 2019 in China and have continued to spread globally, across all over the continents with at least 216 countries affected. The infections had spread at an exponential rate with over 307,537 deaths, 4,534,731 confirmed infections as at 17th May, 2020, around the globe (WHO Situational Report 17th May 2020). This global outbreak of the infection led WHO to declare it as a pandemic on 11th March, 2020. With the spread of the pandemic in the countries, many restrictions and measures have been taken to prevent the pandemic. All over the world, production has been disrupted and people have moved away from luxury consumption. Households have changed their behavior reduced their investments and started to stock them by increasing demand for low products. Especially as a result of the incoming bans, decreasing production and consumption, many businesses have closed down. However, with the increase in the level of government spending particularly through the relief materials the government was providing to assuage the effect of the pandemic on the welfare of the citizens, interest rate had risen which consequently led to the appreciation of exchange rate and hence and inducement of its volatility. Therefore, this paper seeks to investigate the effect of the COVID-19 on the volatility of Nigeria's exchange rate.

2.1 Literature review

The COVID- 19 pandemic came in to being two years ago, and, a plethora of academic research has been carried out on its effects on macroeconomic variables such as the exchange rate. For example, Thorbecke (2021) used stock returns to investigate the exposure of French and Korean firms to exchange rate appreciations and the pandemic The results indicate that Korean firms have also come through the pandemic better than French firms. The findings also indicate that the Korean economy is less exposed to appreciations than the French economy. The paper concludes with suggestions to increase firms' resilience to these twin shocks. While Mar'I and Tursoy (2021) analyzed the relationship between the increasing number of confirmed cases of Coronavirus and volatility in the emerging financial markets in the Middle East and the result found that the growth in the number of confirmed cases negatively affects stock market return and that the decrease in growth in confirmed cases leads to decrease volatility in the market. The result further indicated that market risk has increased due to the outbreak; individual responses in the market relate to the severity of the pandemic in each state.

In their paper, Loice and Kosei (2021) have investigated the effect of exchange rate fluctuations on the performance of the Nairobi securities exchange for the daily time series data for the period from January to May 2020.. The multiple regression model results pointed out that exchange rate fluctuation had a negative and statistically insignificant effect on the performance of Nairobi securities exchange in Kenya during the Pandemic. The results revealed that exchange rate fluctuations do not affect the performance of Nairobi securities exchange market in Kenya. The paper recommends that investors need to be conscious of the macroeconomic variables that influence the security prices particularly during pandemic. Syahri and Robiyanto(2020) analyzed the correlation of gold, exchange rate, and stock market on the COVID-19 pandemic period by using a GARCH method from January 2020 to June 2020. The result showed that changes of gold prices have significant effect of on stock price volatility, the presence of a positive dynamic correlation between Composite Stock Price Index (CSPI) and gold, and a negative dynamic correlation between CSPI and exchange rate. In the same vein, Judith and Chucks (2020) have assessed the impact of Covid-19 on capital flight in Nigeria by using Chow test. The result revealed that there is no significant impact on the capital flight by COVID-19 pandemic. Luckieta and Alamsyah (2020) have analyzed the influence of the Covid-19 Pandemic on the development of currency exchange rate in Indonesia. The study used data sources from the number of patients who were confirmed positive to COVID-19 with the middle rate of Bank Indonesia. The results of the study proved that positive patient data for COVID-19 had a positive influence on the development of the Bank Indonesia middle exchange rate against the US Dollar.

Adegbayibi,et al (2020) have explored the emergence of a novel virus disease called the COVID-19 that is ravaging and devastating both human health and global economy and permeate through Nigerian economy. The Ordinary Least Square (OLS) was used to analyze the Total Nigeria Confirmed Cases (TNCC), Total Africa Confirmed Cases (TACC) and Total Global Confirmed Cases (TGCC) as exogenous variables while the endogenous variables are market capitalization (mcapt), foreign exchange rate of US-Dollar to Naira (US $ & #) and crude oil price per day (copd) for period of 182days. The results revealed that the Covid-19 pandemic has had an adverse impact on market capitalization, exchange rate and crude oil price and Nigerian economy as a whole. The paper recommends that bailout funds should be made available to stakeholders in the capital market, funds in foreign exchange reserve accounts should be used to hedge foreign exchange fluctuations and funds in excess crude oil accounts should be used to cushion the effect of fall in crude oil price.

Barro, Weng, & José (2020) found that increased financial market volatility was influenced by high uncertainty and during the pandemic and that exchange rate dynamics had occurred similar to the economic dynamics of the global crisis of 2008 and the 2011and the Euro zone crisis (Liao & Zhang, 2020). Park, Rosenkranz, &Tayag (2020) have recorded a decrease in exchange rate among countries during the first three months of the pandemic; it decreased around 23.6% in Australia, 22.6% in Indonesia, and 11.0% in the Republic of Korea. On the other hand, Rogoff (2020) highlighted that a strengthening exchange rate in developed countries during the COVID-19 pandemic, among others: the euro, has so far appreciated 6% of the U.S. dollar, the yen-dollar exchange rate barely moved during the pandemic but varied between ¥ 90 and ¥ 123 against the dollar during the recession. The diversity of exchange rate responses between developing and developed countries explains global financial vulnerability. While currency weakening occurs in developing countries, there is a strengthening of the U.S. Dollar, increasing the cost of debt payments from developing countries.

It can be observed that from the literature so far reviewed, no study has sought to investigate the effect of the COVID-19 pandemic on the volatility of Nigeria's exchange rate. Therefore this paper tries to explore the effect of the pandemic on exchange rate volatility in Nigeria.

3.0 Methodology

3.1 Source of Data

The data for this research is mainly secondary data obtained from the Central Bank of Nigeria (CBN), Statistical database (2020) and the Nigeria Center for Disease Control (NCDC) various reports of daily basis. The period of the study covers from 2nd January, 2020 to 6th September, 2021.Conventionally, the statistical procedure for estimating volatility of a series is to first transform the series into returns which was accomplished in this paper by taking the logarithmic difference of the original exchange rate series and multiplying by 100. Therefore, it is noteworthy that the returns of the Nigeria's exchange rate series rather than the original series was used for the purpose of estimating the GARCH model in this paper. However, the dummy variable of the COVID–19 was formed by the coding 1 when the infections were high and zero otherwise over the sample period.

3.2 The Pre- estimation Tests

3.2.1 The Augmented Dickey-Fuller Tests

The Augmented Dickey-Fuller (ADF) unit root tests without breaks have been carried out. The tests are based on the equations below:

$$\Delta y_t = \mu + \delta t + \rho y_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta y_{t-i} + \varepsilon_t$$

(3.1)

$$\Delta y_t = \mu + \rho y_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta y_{t-i} + \varepsilon_t$$

(3.2)

$$\Delta y_t = \rho y_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta y_{t-i} + \varepsilon_t \quad (3.3)$$

The unit root presence is in each case tested based on the null hypothesis of a unit root, i.e. whether the parameter $\rho = 0$ or otherwise in the three equations above. If ρ equals zero, the series contains a unit root and if it is not, the series is referred to as stationary. In equation (3.1) the ADF-test with both a constant and time trend is specified. Equation (3.2) specifies the ADF-test with a constant only and no time trend, and equation (3.3) specifies the ADF-test with no constant and no time trend respectively. Hence, the set of hypotheses corresponding to equations (3.1) to (3.3) to be tested are:

$H_0 : \delta = \rho = 0$ (The series has a unit root with no time trend.)

$H_1 : \delta \neq 0 ;\ \rho < 0$ (The series is stationary with a deterministic trend.)

$H_0 : \mu = \rho = 0$ (The series has a unit root with no constant and no time trend.)

$H_1 : \mu \neq 0 ,\ \rho < 0$ (The series is stationary with a non-zero mean.)

$H_0 : \rho = 0$ (The series has a unit root.)

$H_1 : \rho < 0$ (The series is stationary with a zero mean and no time trend.)
We have tested for also tested for unit root in presence of breaks as mentioned earlier and the test is based on the following equation:

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1+i} + \mu D_t + \varepsilon_t \qquad (3.4)$$

The breaks are captured by the term D_t in the equation. It is noteworthy that interpretations remain the same for testing the unit root hypothesis in the two models (with break and without break).

3.2.2 Testing for GARCH Effects

The Autoregressive Conditional Heteroskedasticity Lagrange Multiplier (ARCH-LM) test is carried out to investigate whether or not there is presence of ARCH effects in the exchange rate series of Nigeria. The testing for GARCH effects is statistically instructive prior to estimating GARCH class of models, because ignoring ARCH effects results in loss of efficiency and mis-specification (Asteriou and Hall, 2011). The ARCH test is a Lagrange Multiplier test for autoregressive conditional Heteroskedasticity which tests whether or not there are ARCH effects up to lag order *q* in the residual series. The test was developed by Engle (1982), and is computed from an auxiliary regression given by the equation:

$$\varepsilon_t^2 = \beta_0 + \left(\sum_{s=1}^{q} \beta_s \varepsilon_{t-s}^2 \right) + v_t \qquad (3.5)$$

The above equation describes a regression of the squared residuals on a constant and lagged squared residuals up to lag order *q*.

3.3 The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model

Many economic and financial time series / variables exhibit periods of volatility. The GARCH models allow the conditional variance of a series to depend on the past realizations of the error process (Enders, 2010). The GARCH model was developed by Bollerslev (1986) and takes the following econometric specification:

$$Y_t = \alpha + \beta' X_t + u_t \qquad (3.6)$$

$$u_t \mid \Omega \sim iid\ N(0, \sigma_t^2)$$

$$\sigma_t^2 = \gamma_0 + \sum_{i=1}^{p} \delta_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \gamma_1 u_{t-j}^2 \qquad (3.7)$$

Conventionally, the econometric specification of the GARCH models has two mathematical equations, namely the conditional mean and conditional variance equations. The conditional mean equation is the predictability equation which provides information about the conditional mean of the series while the conditional variance equation provides information about the conditional volatility of the series and hence it is termed as the volatility equation i.e, the equation that provides information about volatility in the series. In this paper an attempt was made to investigate effect of the COVID-19 Pandemic on the volatility of the exchange rate series of Nigeria. For the purpose of this paper we have the following econometric specification of the model:

$$(\text{Re}\,turn\,Exr)_t = \alpha_0 + \alpha_1 (\text{Re}\,turn\,Exr)_{t-1} + u_t \quad (3.8)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 \sigma_{t-1}^2 + \gamma_2 u_{t-1}^2 + \gamma_3 DUM\_COVID_t \quad (3.9)$$

It is noteworthy that equation (3.8) is the specification used for the conditional mean, and, equation (3.9) is the conditional variance / volatility specification used in this paper. It is worth noting also that a dummy variable was created and included as part of the regressors in the conditional variance specification with a view to capturing the effect of the Pandemic on volatility of the series.

Justification for the use of the variables

With the advent of the COVID–19 in Nigeria in February, 2020, all the macroeconomic indicators were seriously affected in the country. One of these macroeconomic indicators affected by the pandemic is exchange rate which caused serious volatility of the exchange rate, notwithstanding the measures taken by the government during the Pandemic, ranging from restriction of movement to the lockdown of the entire country but yet the exchange rate during the period was unpredictably. Instead of exchange rate to remain fixed during the COVID–19 due to lockdown but it remain volatile. Therefore there is the need to look in to the effect of this pandemic on exchange rate volatility during the period.

4.0 Results and Discussion

4.1 Pre-estimation Tests

4.1.1 Unit Root Test

It is statistically instructive in time series data to investigate the stationary of a series so as not run into such statistical problems as mis-specification and hence spurious regression. Based on this, ADF unit root tests without break and with break are carried out to determine the order of integration of the series. Table 1 presents the result of ADF unit root test without break and we found that the exchange rate is not stationary at level but stationary at first difference. This indicates that the variable is integrated of order one that is I(1).

Table 1 ADF.Unit Root Test without Break

variable	ADF at Level		ADF at First Difference	
	t-Statistic	Prob.*	t-Statistic	Prob.*
Exr	-1.21209	0.6705	-22.66718	0.0000

The ADF test does not accommodate information about unknown structural break(s) dates inherent and this could weaken the statistical power of unit root tests. To overcome this shortcoming, ADF unit root test with break has been employed in this paper and the results are reported in table 2.

Table 2. Unit Root with Break

variable	ADF at Level		Break period	ADF at First Difference		Break period
	t-Statistic	Prob.*		t-Statistic	Prob.*	
Exr	-4.153703	0.1105	61	-30.21174	< 0.01	62

Table 2 above reports the result of ADF unit root with break(s) and it has been found that the Nigeria's exchange rate series is stationary at first difference with a break occurring at the date of 20/03/2020.

4.1.2 The Result of the GARCH Effect Test

The results of the GARCH effects test in table 3 indicate the rejection of null hypothesis of homoskedesticy in the series. This validates the use of GARCH model in paper because the result indicate that there are GARCH effects and hence evidence that the series might be volatile.

Table 3 Heteroskedasticity Test: ARCH

F-statistic	811.3998	Prob. F(8,408)	0.0000
Obs*R-squared	392.3397	Prob. Chi-Square(8)	0.0000

3.2 Estimates of the GARCH Model

Since we have known the order of integration of the series and accordingly tested for the GARCH effects we can forge ahead and estimate the GARCH model. It is noteworthy that the return of the series rather than the original series was used in estimating the model. Table 4 reports the results.

Table 4 GARCH Result

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.006449	0.009762	0.660579	0.5089
EXR_RETURN(-1)	-0.148699	0.034072	-4.36425	0.0000
	Variance Equation			
C	0.007733	0.003467	2.230595	0.0257
RESID(-1)^2	0.403161	0.059724	11.77345	0.0013
GARCH(-1)	0.298377	0.03136	15.8923	0.0026
DUM_COVID	0.05163	0.003639	2.447895	0.0142

R-squared	0.007715	Mean dependent var	0.034507
Adjusted R-squared	0.005352	S.D. dependent var	0.487969
S.E. of regression	0.486661	Akaike info criterion	0.427267
Sum squared resid	99.47233	Schwarz criterion	0.484779
Log likelihood	-84.15335	Hannan-Quinn criter.	0.449994
Durbin-Watson stat	1.920213		

The results from table 4 indicate high persistence of volatility shocks in the exchange rate series for Nigeria as the sum of the coefficients of the ARCH and GARCH term is close to unity that is (0.403161+ 0.298377=0.7), however the coefficient of the dummy for the COVID – 19 is 0.05 which is positive and statistically significant at 5% level. This suggests that the COVID -19 pandemic has had positive and significant effects on nigeria's exchange rate over the sample period. The log-likelihood statistic of the model is higher than the values obtained from other alternative specifications the Residual Sum of Squares statistic and the information criteria statistics, namely the AIC, SIC and HQ have been found to be much lower than the values obtained from alternative results. This has motivated the Authors to select this specification and to conveniently refer to the model as a good fit of the data these results commensurate with the findings of Luckieta and Alamsyah (2020) for Indonesia, Rosenkranz, &Tayag (2020) for Australia, Indonesia, and Republic of Korea. But contradict with findings of Mar'I and Tursoy (2021) for Middle East among others.

4.3 Diagnostic Tests

4.3.1 The ARCH-LM Test

The results in table 5 report the ARCH – LM test for remaining GARCH effects in the series which has once again been carried out on the residuals of the model and the results indicate absence of remaining GARCH effects in the series which implies that the model is statistically adequate (see Enders, 2010). Furthermore, tests for serial correlation were carried out on the residuals of the model at both the conditional mean and conditional variance levels to make sure that the model is correctly specified.

Table 5 ARCH-LM Diagnostic Test

Heteroskedasticity Test: ARCH

F-statistic	0.036329	Prob. F(1,419)	0.8489
Obs*R-squared	0.0365	Prob. Chi-Square(1)	0.8485

4.3.2 Serial Correlation Test

The two tests for serial correlation based on Q-statistics and Corrologram squared residuals were carried out to make sure that the conditional mean and conditional variance components of the model are correctly specified and that the residuals are white noise. It can be observed from tables 6 and 7 that the results indicate non rejection of the null hypothesis that the errors are not serially correlated. This implies that there is no serial correlation in residuals.

Table 6 Q-Statistics Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|. |	.|. |	1	0.007	0.007	0.0236	0.878
.|. |	.|. |	2	-0.022	-0.022	0.2381	0.888
.|. |	.|. |	3	0.020	0.021	0.4179	0.937
.|. |	.|. |	4	-0.016	-0.017	0.5250	0.971
*|. |	*|. |	5	-0.117	-0.116	6.4193	0.268
.|. |	.|. |	6	-0.008	-0.007	6.4445	0.375
*|. |	*|. |	7	-0.108	-0.114	11.537	0.117
.|. |	.|. |	8	-0.031	-0.027	11.961	0.153

Table 7 Corrologram Squared Residuals Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|. |	.|. |	1	-0.001	-0.001	0.0006	0.980
.|. |	.|. |	2	-0.020	-0.020	0.1668	0.920
.|. |	.|. |	3	-0.009	-0.009	0.1996	0.978
.|. |	.|. |	4	-0.009	-0.010	0.2373	0.993
.|. |	.|. |	5	0.003	0.003	0.2416	0.999
.|. |	.|. |	6	0.018	0.018	0.3867	0.999
.|. |	.|. |	7	-0.002	-0.002	0.3880	1.000
.|. |	.|. |	8	-0.022	-0.021	0.5962	1.000

The post-estimation diagnostic tests have revealed that the model is statistically adequate and hence, the results obtained can be referred to as robust.

5.0 Conclusions and Recommendations

The major finding of this paper is that the COVID–19 pandemic has had a positive and a significant effect on exchange rate volatility in Nigeria. This implies that any increase of the COVID–19 pandemic in Nigeria leads to high persistence of volatility shocks in the exchange rate series for country. Therefore, the paper concludes that, an increase in the number of confirmed cases of the COVID–19 pandemic induces a high persistence of volatility shocks in the exchange rate series for Nigeria. Based on the results, the paper recommended that, a more optimal exchange rate policy should be taken in order to mitigate the effects and lessen the macroeconomic risks associated with high exchange rate volatility for effective exchange rate management in Nigeria. More so serious measures should be taken by the government to curtail the spread of the pandemic as it has serious effect on the volatility of exchange rate.

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