Available online: https://journals.researchsynergypress.com/index.php/ijeass
International Journal of Entrepreneurship and Sustainability Studies (IJEASS)
ISSN 2807-1778(Online)| 2807-1921 (Print)
Volume 1 Number 2 (2021): 51-69

Impact of Covid-19 on Stock Market in Sub-Saharan Africa

Saifullahi Adam Bayero[1], Babangida Danladi Safiyanu[2], Zaitun Sanusi Bakabe[2]
[1]Federal University, Gashu'a, Nigeria
[2]Department of Economics and Developmental Studies, Federal University Gashu'a, Nigeria

Abstract

Coronavirus disease (COVID-19), which was declared by the World Health Organization as a global pandemic, caused serious economic problems in all the countries, including Sub- Saharan Africa. Given the negative impact of COVID19 on the world economy, this paper examined the impact of COVID19 related cases and death on stock exchange markets volatility in Sub-Saharan African countries. The study used the number of reported cases and death from four Sub-Saharan African countries viz Nigeria, South Africa, Kenya, and Botswana, reported cases and death from China and the U.S., and all share index as a proxy of stock markets in four countries from February28th, 2020 to December 21st, 2020. The study estimated GARCH 11, TGARCH 11, and EGARCH 11 since the variables are heteroskedastic in nature which makes the application of ARCH plausible; the selection criterion was based on Akaike, Schwarz, and Hannan info Criteria. The result showsthat COVID-19 confirmed cases and death do not affect the operation of the stock markets in Sub-Saharan African countries, but the volatility of the markets has increased within the period of analysis. Furthermore, Botswana and Kenya's stock markets were affected by external cases from China. We, therefore, recommended that stock markets stakeholders in Sub-Saharan Africa shouldbe more concerned about health safety measures and be ready for any future pandemic that might affect the markets.

Keywords: *Covid-19, Pandemic, Impact, Africa*

INTRODUCTION

Coronavirus 2019, otherwise called COVID-19, like other outbreaks, has brought Significant human suffering and economic disruption, which negatively affected global supply chains, travel, commodity, and financial markets (Barro, R. J., Ursúa, J., & Weng, J. 2020; Elsayed & Abdelrhim, 2020; Ezekiel et al., 2020; Hung, 2020; Majama et al., 2017; Lopatta, Alexander, Gastone & Tammen, 2020; Riaz et al., 2020). This has caused unprecedented changes in the world outlook, thereby painting the bleak picture that structures the future of the world (Ashraf, 2020). Covid-19 affected the world economy harder than any pandemic in history (Lee, 2020). The first case was identified on December 31st, 2019, in the city of Wuhan, China (Akanni and Gabriel, 2020; Jais, Lee & Chan, 2020; Liu, Manzoor, Wang, Manzoor, 2020; WHO, 2020). Its potential risk was underestimated, as it was considered a regional health challenge; for this reason, World Health Organization (WHO) declared that the health crisis in China had no potential global threat (Adesoji & Asongu, 2020). But later, it has spread to 210 countries and territories around the globe; it wasclear that as of April 23rd, 2020, there was a total of 2,638,909 cases, with 184,249 deaths (Khanthavit, 2020). On March 11th, 2020, WHO officially declared it a pandemic (Topcu & Gulal, 2020). Covid 19 inoculated unprecedented uncertainty in the financial markets around the world (Alam, Chavali & Alam, 2020; Chia, Liew & Rowland, 2020). While extensions in the lockdownsexacerbated the level of shocks, the Equity market plunged sharply and stashed away from public confidence over time, which led

Corresponding author
Saifullahi Adam Bayero, saifullahiadambayero@gmail.com
DOI: 10.31098/ ijeass.v1i2.774

to change in the volatility and returns of the equity market; as a matter of fact, Covid-19 became the worry for investors, policymakers and regulators (Dhiman & Kumar,2020).

Literature shows that there is a strong relationship between stock market returns and pandemic outbreaks (Alali, 2020; Quang, Nguyen, Tran, & Bakry, 2020). For this reason, risk aversion investors pulled their money out of the stock market a few days after the announcement of the Coronavirus as a pandemic, which caused 15% losses in market capitalization (Alali, 2020), causing investors to suffer substantial losses (Bahrini & Filfilan, 2020) that have not seen since 1987 (Bash, 2020). By inoculating fear, COVID-19 affected the stability of the financial market, which dampened the overall confidence of the financial system and caused volatility spills over, global economic and financial shockwaves that affected the financial markets negatively in both developed and undeveloped countries (Gunay, 2020; Harjoto, Rossi, & Paglia, 2020). It has alsocaused one of the greatest dramatic stock market crashes in history.

Covid 19 affected Sub-Saharan African countries as it affected other countries (KPMG, 2020). Even though the magnitude of the effect varies across the countries (Capelle-blancard and Desroziers, 2020). This has led to the enormous decline of the African economy in terms of loss of productivity within and among the countries. Specifically, it affected the key sectors of economies,and ultimately their overall income. However, different institutions analyzed the expected future loss of output as a result of the introduction of lockdown and movement restriction. For example,the International Air Transport Association (IATA) estimated revenue losses of up to US$113 billion, and the United Nations Economic Commission for Africa (UNECA) projected at least.

US$65 billion in revenue losses among Africa's top 10 fuel exporting economies. Moreover, the World Trade Organization (WTO) estimated a decline in world trade which is between 13 and 32percent in the year 2020, and an unprecedented global recession between 0.5 and 3.8 percent (Gondwe, 2020). In the same vein, Sub-Saharan African stock markets were affected by the global pandemic; the impact affected not only the banking sector but also the securities sector, where markets experienced high volatility. For example, in Nigeria, a 30 bond yield increases from its minimum value of 11.92 percent on February 25th, 2020, to 14.06 percent on March 16th, 2020. Also, South Africa has experienced the same volatility; a 30-year yield reached the highest value of 13.38 percent on March 23rd, 2020, from the lowest value of 10.07 percent on February 26th, 2020 (KPMG, 2020). This is applied to all other African countries. Many companies in the world, whether at home or abroad, have felt the impact of the COVID- 19 outbreak and is one of the causes of dwindling oil price and stock market performance in African countries.

There are growing studies that demonstrate how COVID-19 exerts enormous impacts on global financial markets in terms of volatility and stock price movements. Nevertheless, a survey of the literature confirmed that there are few or no such research in Africa, mostly in Sub-Saharan Africa (Quang, Nguyen, Tran, Al-Mohamad, & Bakry, 2020). Similarly, Salisu, Sikiru & Vo (2020) cried for a need for research to enhance the understanding of the virus and how they affect the stock market. In view of this, this paper is aimed at investigating the impact of COVID-19 related cases and deaths on stock market volatility in Sub-Saharan African countries and also to find out the impact of external cases and deaths, specifically China and the U.S., on Sub-Saharan Africa stock markets. In this paper, we critically look at the impact of COVID-19 on key stock markets in Sub-Saharan African countries, primarily Nigeria, South Africa, Kenya, and Botswana.

ISSN 2807-1778(Online)| 2807-1921 (Print)

LITERATURE REVIEW

Volatility estimates dispersion or variability about a central tendency (Rhiannon, 2020). It can be described as the extent of price movement of stock and other securities in the market. Volatility measures how the average return disperses around the mean and asset price range about its average level over a particular amount of time. Volatility is associated with asset variance. A stock is considered as volatile if the price varies over time. Moreover, if a price of stock deviates a little over time is regarded as a less volatile stock.

Standard deviation from the continuously compounded return is calculated as volatility over a given period of time. It is a measure of measuring risk; for instance, a security that is 50 percent volatiles considered as high risk because the value of its increase or decrease is up to its half value. There is little but ongoing literature on the impact of COVID-19 pandemics on stock markets. Elsayed and Abd Elrhim (2020) investigated the effect of COVID-19 spread on sectoral of the Egyptian Exchange, using a daily number of cases and deaths, found that the stock return sector is more sensitive to cumulative indicators of mortality than confirmed daily deaths from COVID-19. The coefficient of determination between independent variables and variables belonging to four sectors is 0.393. Using panel data technique, Salisu et al. (2020) examined the stock market performance and COVID-19 pandemic in 24 new emerging markets stock using the new data set on uncertainty due to pandemic as well as the global fear index for COVID-19 pandemic, concluded that emerging stock markets are more vulnerable to Uncertainty Pandemic and Epidemic UPE than developed nikkei stocks but developed stock markets provide a better hedge against UPE than emerging stock markets. Added that incorporating the UPE indicator in the valuation of stocks, particularly during a pandemic, is crucial for an investment decision.

Abdelrhim & Allam (2020) investigate the determinants of herding behavior in the time of COVID-19, the Case of Egyptian Stock Market Sectors. Found that during the period 1/3/2020 to 31/7/2020, the determinants identified are represented in the exchange rate stock trading volumes, stock returns, indicators of the spread of Corona Virus represented by the ratio of the total number of infections and deaths according to the population in Egypt. Osagie, Maijamaa, and Owoicholofu (2020) examined the effect of the COVID-19 outbreak on the Nigerian stock exchange performance using GARCH models; the results revealed a loss in stock return and high volatility in stock return under the COVID-19 period in Nigeria. Also, the application of Quadratic GARCH (QGARCH) and Exponential GARCH (EGARCH) models show that COVID-19 had a negative effect on the stock return in Nigeria.

To examine the COVID-19 outbreak and the affected country's stock market response, Liu, Manzoor, Wang, Zhang, and Manzoor (2020), using an event study method, found that the stock market in major affected countries fell quickly after the virus outbreak. They considered 21 leadingstock market indices in major affected countries, which include Japan, Korea, Singapore, the USA, Germany, Italy, and the U.K. Also, panel fixed effect regression supports the adverse effect of COVID-19 confirmed cases on stock indices' abnormal return through an effective channel by adding up investors' pessimistic sentiment on future returns and fears of uncertainties.

Rabhi (2020) examined stock market vulnerability to COVID-19 pandemic evidence from emerging Asian stock markets. Using ARDL found that both the reported daily growth of COVID-19 confirmed cases along with the fear event related to news about death affected the Asian stock market negatively; other variables like oil price, gold price, exchange rates, and the U.S. stock market were found to be determinants of Asian stock market during the period of analysis.

ISSN 2807-1778(Online)| 2807-1921 (Print)

Ezekielet al. (2020) investigated the COVID-19 pandemic and Nigerian stock market capitalization using a vector regression model; the result shows that confirmed cases of COVID-19 have a mixed association with Nigerian stock market equity capitalization, while the global announced confirmed cases show a negative relationship with the market capitalization, but the result is statistically insignificant.

However, from the reviewed literature, none is conducted in Sub-Saharan African countries together. This paper filled the existing gap by examining the impact of COVID-19 on the stock exchange market in Sub-Saharan Africa.

RESEARCH METHOD

Daily data on confirmed cases and deaths were collected from https://ourwoldindata.org for four Sub- Saharan African countries – Nigeria, Kenya, Botswana, and South Africa for the period of February 28th, 2020, to December 21st, 2020. At the same time, the All Share price index for the four countries was from https://www.investing.com. The study also uses confirmed cases and deaths from China and the United States of America in order to find out the impact of external cases and deaths on Sub-Saharan African countries; data were also obtained from the same sources and same period of time and estimated using EViews 10.

Garch Model

In 1986, Bollerslev developed a Generalized autoregressive conditional heteroscedasticity (GARCH) (p,q) model, which includes p lags of the conditional variance in the linear ARCH (q) conditional variance equation. The mean equation is the same for all GARCH families is presented as follows:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_t \quad \text{.......................................} \quad (i)$$

y_t is the daily ASI, β_0 is the intercept, y_{t-1} is one day lag of the ASI, X_{2t} stands for the cumulative confirmed cases and death for the Sub-Saharan countries at time t, while X_{3t} represents external confirmed cases and death (China and United States) at time t. βo is the intercept of the model, while β_1, β_2, and β_3 are slope coefficients, that is one day lag of ASI, confirmed cases and death for four Sub- Saharan African countries, China and U.S. confirmed cases and death, ε_t is the stochastic term which captured other variables affecting ASI that are not included in the model. The subscript 't' indicates time series data. The general GARCH (p,q) model has the following form:

$$\sigma^2_t = \gamma_o + \sum_{i=1}^{p} \gamma_i u^2_{t-i} + \sum_{j=1}^{q} \gamma j \theta u^2_{t-1} \text{ ....} (ii)$$

Where σ2t conditional variance at the time 't', γo is the intercept, γu2t-i is the ARCH term which captures the shocks from the previous period (day) measured as the lag of the squared residual, while θu2t-I is the GARCH term which measures the last periods' forecast variance as a function of the past residuals. It measures the time taken for the volatility to die out.

ISSN 2807-1778(Online)| 2807-1921 (Print)

The Threshold Garch (T-Garch) Model

A limitation of ARCH and GARCH specifications above is the fact that they are symmetric. By this, we mean that what matters is only the absolute value of the innovation and not its sign (because the residual term is squared). Therefore, in ARCH/GARCH models, a big positive shock will have exactly the same effect in the volatility of the series as a big negative shock of the same magnitude. The main target of this model is to capture asymmetries in terms of negative and positive shocks. However, COVID 19 confirmed cases and death news possibly have an impact on the volatility of all share price indexes in Sub-Saharan African countries. The variance of TGARCH is specified as follows.

$$\sigma^2_t = \gamma o + \gamma 1 u^2_{t-1} + \theta\, u^2_{t-1} d_{t-1} + ðht_{-1} \text{.................................(iii)}$$

Where it takes the value of 1 for $u_t < 0$, and 0 otherwise, so, 'good news' and 'bad news' have a different impact. Good news has an impact γ, while bad news has an impact of γ+ θ. If θ> 0, we conclude that there is asymmetry, while if θ= 0, the news impact is symmetric.

The Exponential Garch (E-Garch) Model

However, to overcome some of the weaknesses of the GARCH model, the exponential GARCH or EGARCH model was developed by Nelson (1991). The variance equation for this model is given by:

$$log(ht) = \gamma o + \sum_{j=1}^{q} \gamma 1 \left| \frac{Ut-j}{\sqrt{ht-j}} \right| + \sum_{j=1}^{q} €j \frac{Ut-j}{\sqrt{ht-j}} + \sum_{i=1}^{q} ðilog\,(ht-i) \text{..........(iv)}$$

Where γo, γ1, €, and ð are parameters to be estimated. Note that the left-hand side is the log of the variance series. This makes the leverage effect exponential instead of quadratic, and therefore the estimates of the conditional variance are guaranteed to be non-negative. The EGARCH model allows for the testing of asymmetries as well as the TARCH. To test for asymmetries, the parameters of importance are the €s. If €1 = €2 = ⋯ = 0, then the model is symmetric. When €i < 0, then positive shocks (good news) generate less volatility than negative shocks (bad news). However, equation (i), (ii), (iii), (iv and (iiv) are estimated using maximum likelihood function

$$L(\theta) = -\frac{1}{2}\sum(\text{In}2\pi + \text{In}\sigma 2t + \frac{u2}{\sigma 2t}) \text{ ....(v)}$$

where σ^2_t is specified in each of the GARCH models.

FINDINGS AND DISCUSSION

ASI Trend in Sub-Saharan Africa

Stock markets in Sub-Saharan African countries were affected by the COVID-19 global pandemic; visual inspection of figure 1 shows that the value of all share indexes for South Africa, Nigeria, Kenya, and Botswana have declined within the period of 6/04/2020-11/09/2020. As of February 28th, 2020, before movement restriction and lockdown of all business activities was announced, the values of all share indexes for South Africa, Nigeria, Kenya, and Botswana stood at 49874.51,

ISSN 2807-1778(Online)| 2807-1921 (Print)

37893.61, 133.66, and 12.3312, respectively. While towards the middle of the pandemic on April 14th, 2020, stock exchange markets in all the countries have responded negatively and fallen at a minimum value of 21879.95 for Nigeria, 12.0488 for Botswana, 133.59 for Kenya, and 48301.28 for South Africa.

Summary Statistics

Table 1 shows the summary statistics of all the variables in the study. Nigerian all-share index (Nig. ASI) has an average value of 29743.85; the minimum and maximum values of all share indexes were 24883.70 and 37902.87, respectively. The standard deviation (dispersion) has a value of 4207.000. The mean value of all share indexes in Kenya (KNY ASI) was 140.4086 during the period of analysis, while the minimum and maximum values were 129.2400 and 148.1200, respectively.

All share index in South Africa (SA ASI) has the highest dispersion compared to Nigeria, Kenya, and Botswana. The standard deviation stood at 5752.888, which shows that the stock market in South Africa has experienced high fluctuations as a result of the COVID-19 pandemic during the period of analysis.

The average total death in South Africa (T.D. S.A.) was 0.551789, high compared to Kenya, Botswana, and Nigeria. But Nigeria has the highest number of confirmed cases than South Africa, with a mean value of 2229.421. The skewness and Kurtosis of all the variables show that the variables are not symmetrical in shape, therefore, are not normally distributed.

Test of Stationarity

The descriptive statistics table above shows that the variables are not stationary; we subjected the variables to the unit root test since variables are time series in nature. This will enable us to avoid spurious results that are associated with the non-stationary time series model. From Table 2, all the variables are stationary at the first difference with the exception of Kenya share price index (ASI KNY), Botswana share price index (BWN ASI), China confirmed deaths (CHINA D), and U.S. confirmed deaths (US DEATH) that are stationary at level.

Heteroskedasticity Test: Arch

ARCH LM shows that there is an ARCH effect; this means that we cannot apply ordinary least squares to estimate the model. From Table 3, the hypothesis of no heteroscedasticity for all the variables are rejected for both countries. Hence it can be seen that the variables are heteroskedastic in their distribution which makes the application of an ARCH estimation technique plausible for all the countries.

COVID-19 and stock exchange markets in Nigeria, Kenya, Botswana, and South Africa

Table 4a shows the mean equation of all share index in Nigeria, lag of all share index follows a random walk but is negative and statistically significant, and this implies that within the period of analysis, as the number of COVID-19 cases increase, stock prices decrease continuously. Specifically, a one Naira increase in NIG ASI in the previous day decreases the price of the stock by 80% on average.

ISSN 2807-1778(Online)| 2807-1921 (Print)

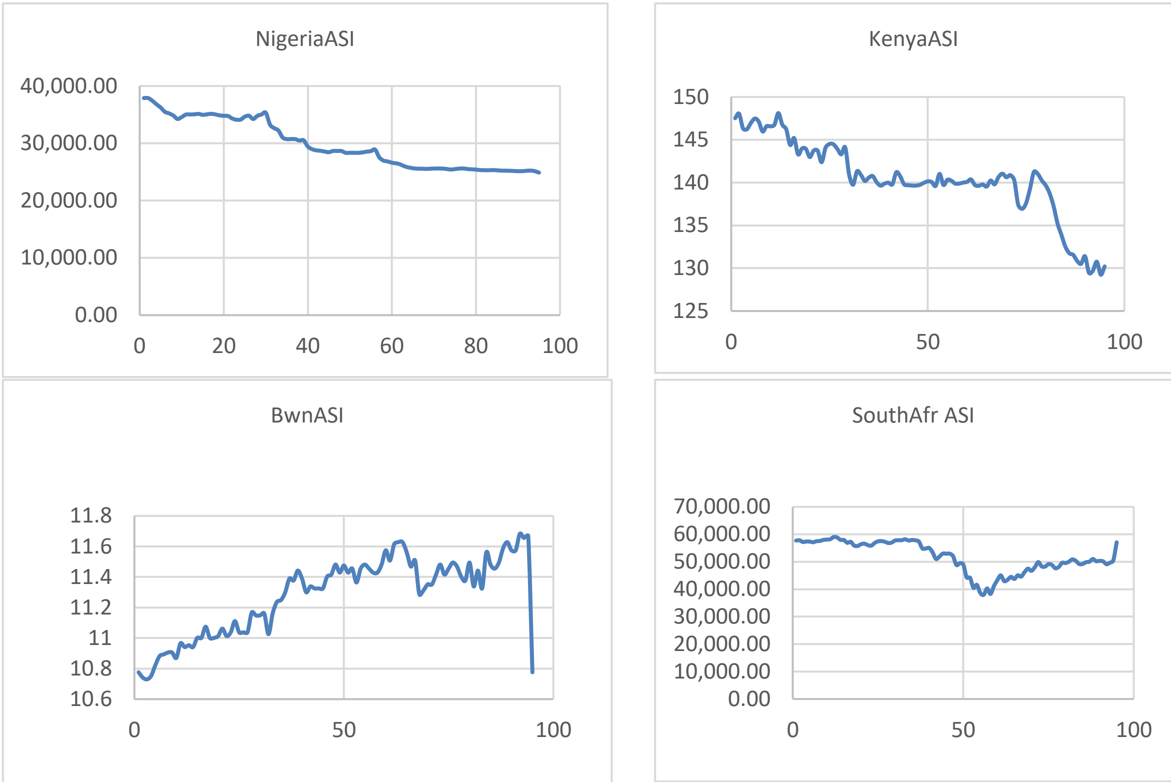

Figure 1. ASI Trend for South Africa, Nigeria, Kenya, and Botswana from 2/28/2020 to 12/12/2020

Table 1. Statistic Summary

	Nig ASI	CC Nig	TD Nig	KNY ASI	CC KNY	TD KNY	BWN ASI	CC BWN	TD BWN	SA ASI	CC SA	TD SA	CH CC	CH TD	US CC	US TD
Mean	29743.85	2229.421	0.434465	140.4086	597.7789	0.438505	11.27915	41.60000	0.420526	51657.06	1969.484	0.551789	65971.24	1.761821	165393.0	24.78647
Median	28634.35	407.0000	0.194000	140.2400	303.0000	0.260000	11.35130	24.00000	0.425000	51038.18	709.0000	0.000000	80860.00	2.170000	594.0000	0.066000
Maximum	37902.87	10578.00	1.450000	148.1200	2872.000	1.581000	11.68220	227.0000	0.425000	59001.87	10652.00	3.473000	83909.00	3.221000	944234.0	169.3520
Minimum	24883.70	1.000000	0.005000	129.2400	0.000000	0.000000	10.72960	3.000000	0.000000	37963.01	0.000000	0.000000	548.0000	0.012000	1.000000	0.000000
Std. Dev.	4207.000	3061.830	0.457740	4.556714	729.0862	0.471725	0.256423	44.07064	0.043604	5752.888	2707.471	0.907957	27478.29	0.933197	277092.2	46.54438
Skewness	0.389156	1.262336	0.723333	-0.701522	1.523323	0.907697	-0.512079	2.730525	-9.592218	-0.552150	1.511272	1.684111	-1.458352	-0.573243	1.514499	1.827724
Kurtosis	1.595622	3.262842	2.073084	3.359942	4.448139	2.580298	2.109003	11.26380	93.01064	2.294555	4.423695	4.762274	3.484208	2.337210	3.861646	5.005908
Jarque-Bera	10.20477	25.50376	8.733045	8.304952	45.04248	13.74257	7.294312	388.3657	33526.92	6.796969	44.18559	57.20000	34.60224	6.941806	39.25583	68.81946

ISSN 2807-1778(Online)| 2807-1921 (Print)

Probability	0.006082	0.000003	0.012695	0.015725	0.000000	0.001037	0.026065	0.000000	0.000000	0.033424	0.000000	0.000000	0.000000	0.031089	0.000000	0.000000
Sum	2825666.	211795.0	30.84700	13338.82	56789.00	41.65800	1071.519	3952.000	39.95000	4907421.	187101.0	52.42000	6267268.	167.3730	15712334	2354.715
Sum Sq. Dev.	1.66E+09	8.81E+08	14.66682	1951.783	49967264	20.91729	6.180777	182568.8	0.178724	3.11E+09	6.89E+08	77.49226	7.10E+10	81.86049	7.22E+12	203639.6
Observations	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277

Table 2. Unit Root Test

VARIABLE	LEVEL	FIRST DIFFERENCE	ORDEROF INTEGRATION
ASI NIG*	-1.012017 (0.7496)	-11.68060 (0.0000)	I(1)
NIG CC*	-0.160027 (0.9403)	-11.49022 (0.0000)	I(1)
NIG TD*	-1.026862 (0.7443)	-3.527876 (0.0079)	I(1)
SA ASI*	-1.659707 (0.4508)	-16.83726 (0.0000)	I(1)
SA CC*	0.012045 (0.9580)	-3.027056 (0.0336)	I(1)
TD SA*	-0.556607 (0.8764)	-6.552840 (0.0000)	I(1)
ASI KNY*	-5.417427 (0.0000)		I(0)
KENYA CC**	0.725170 (0.9925)	-2.769021 (0.0641)	I(1)
TD KENYA*	2.078223 (0.9999)	-12.64627 (0.0000)	I(1)
BWN ASI*	-3.825135 (0.0030)		I(0)
BWN CC**	4.366575 (1.0000)	-3.561010 (0.0071)	I(1)
TD BWN*	3.119603 (1.0000)	-18.23831 (0.0000)	I(1)
CHINA CC*	1.414775 (0.9991)	-5.768087 (0.0000)	I(1)
CHINA D*	-2.988817 (0.0372)		I(0)
US CC*	1.677050 (0.9996)	-3.024489 (0.0339)	I(1)
US DEATH*	-4.136764 (0.0092)		I(0)

Note: * and ** indicate 5% and 10% level of significant respectively

ISSN 2807-1778(Online)| 2807-1921 (Print)

Table 3. ARCH Test

	F-STATISTICS	P.Value
Nigeria	4.039785 Prob.F(1,273)	0.0454
Kenya	0.327176 Prof. F(1,293)	0.0078
Botswana	1.612703 Prob.F(1,293)	0.0051
South Africa	0.012476 Prob.F(1,293)	0.0111

Table 4a. COVID-19 and Nigerian stock exchange market

MEAN EQUATION				
Variables	**Coefficient**	**Std. Error**	**Z-Statistic**	**Probability**
NIG ASI(-1)	-0.830732	0.056244	-14.77020	0.0000
NIG CC**	9.625805	6.758137	1.424328	0.1544
NIG D	834.9794	280.9775	2.971695	0.0030
CHINA CC	-13.91425	12.56881	-1.107046	0.2683
CHINA D	4208.056	18876.17	0.222930	0.8236
US CC	0.471015	0.055318	8.514725	0.0000
US DEATH	622.9835	332.2961	1.874785	0.0608

The coefficient of Nigerian confirmed cases is positive and statistically insignificant with a p-value of 0.1544, while the reported death coefficient is positive and statistically significant with a p-value of 0.0030, total confirmed death is contrary to apriori expectation of negative sign. The reason for the insignificant sign of confirmed cases and a positive sign of confirmed death is that, during the time of lockdown and stay at home, directives from the government Nigerian stock market continued trading during normal hours and days through FIX Protocol and Virtual Private Network (VPN) platforms. As a result, the market has not been affected much by the global pandemic within the period of analysis. China and U.S. confirmed cases and death are all statistically insignificant, which means they have no influence on the Nigerian stock market.

This is in line with the finding of Onali (2020), which concluded that six other countries mostly affected by the pandemic, including U.S., do not have an impact on the U.S. market return, with the exception of the number of reported cases from China. Also, from Table 4b, ARCH and GARCH terms are statistically insignificant with a p-value of 0.3214 and 0.9411 respectively, this implies that internal shocks do not significantly contribute to changes in the volatility of NSE ASI. The asymmetric components of T-GARCH and E-GARCH show no presence of leverage effect, as T-GARCH is statistically insignificant and E-GARCH is positive. This shows that there is symmetric in terms of volatility and confirms the absence of leverage effect in the NSE ASI within the period of analysis. This result is similar to that obtained by Stephen et al. (2015), which shows the absence of leverage effect but contradicts the nature of financial time series that magnitude of bad and good news has a different effect on stock price volatility.

ISSN 2807-1778(Online)| 2807-1921 (Print)

Table 4b. Variance equation, GARCH (1,1) TGARCH (1,1), & EGARCH (1,1)

Model	Parameter	Estimate	P-value
	γ_0	1.11E+08	0.3184
GARCH 22	γ_1	0.082555	0.3214
	θ	0.074809	0.9411
	γ_0	17320191	0.7148
	γ_1	0.016907	0.7003
TGARCH	θ	0.066748	0.3169
	ð	0.868053	0.0341
	γ_0		
EGARCH	γ_1	33.47051	0.0000
	€	0.278205	0.0360
	Đ	0.822728	0.0000

From table 5a, all the variables are not significant in explaining the Johannesburg stock exchange in South Africa. Also, confirmed cases and death from China and U.S. do not significantly influence JSE ASI. This may be as a result, the stock market maintained the trading hours and strictly enforced some rules limiting uncovered short selling and lengthening the mandatory halts to trading circuit breakers (The Economic Times, March 2020). The ARCH component from table 5b is statistically insignificant, while the GARCH coefficient is significant with a p-value of 0.0010; this confirmed that previous volatility influences the current volatility of ASI in South Africa. The asymmetric components show the absence of leverage effect from both T-GARCH and E-GARCH.

Table 5a. COVID-19 and stock exchange market in South Africa

MEAN EQUATION				
Variables	**Coefficient**	**Std. Error**	**Z-Statistic**	**Probability**
SA ASI(-1)	-0.033920	0.056093	-0.604714	0.5454
CC_SA	-0.081753	0.719672	-0.113597	0.9096
DT SA	3.189216	2478.320	0.001287	0.9990
CHINA CC	-0.590611	17.42784	-0.033889	0.9730
CHINA D	-118.9861	9574.320	-0.012428	0.9901
US CC	-0.008900	0.079773	-0.111567	0.9112
US DEATH	308.3210	449.0109	0.686667	0.4923

From table 6a, the lag value of all share indexes is statistically significant; confirmed cases and death in Botswana are not statistically significant in explaining the changes in the stock market. The reason is that Mrs. Thapelo Moribame Botswana Stock Exchange Limited Head of Market Development said, over 60 percent of BSE staff worked from home to reduce the risk of infection, adding that important areas of the exchange such as trading, clearing, and settlement operated successfully without interruption (Botswana Daily News, March 2020).

Table 5b. Variance Equation

Model	Parameter	Estimate	P-value
	γ_0		
GARCH 11	γ_1	8148490	0.0135
	θ	0.006268	0.3938
		0.570919	0.0010

ISSN 2807-1778(Online)| 2807-1921 (Print)

TGARCH	γ_0	9962336.	0.1832
	γ_1	0.097806	0.5083
	θ	0.105780	0.4720
	ð	0.585502	0.0596
EGARCH	γ_0		
	γ_1	10.25197	0.0000
	€	4.452189	0.0000
	Đ	0.129200	0.0000

Table 6a. COVID 19 and stock market in Botswana

MEAN EQUATION				
Variables	**Coefficient**	**Std. Error**	**Z-Statistic**	**Probability**
BWNASI(-1)	0.811340	0.044790	18.11449	0.0000
CC BOTSW	7.20E-05	0.000987	0.073005	0.9418
TD BOTSW	-0.649053	0.574457	-1.129855	0.2585
CHINA CC	-0.005106	0.002115	-2.414550	0.0158
CHINA D	3.894316	1.441672	2.701249	0.0069
US CC	2.56E-05	1.06E-05	2.414390	0.0158
US DEATH	0.171573	0.049109	3.493701	0.0005

China's confirmed case is statistically significant; this implies that the stock exchange market in Botswana is affected by external cases from China within the period of analysis. Also, from Table 6b, the ARCH and GARCH components are statistically significant, which shows that previous shocks and volatility contributed to changes in ASI volatility in the stock market. The asymmetric component of E- GARCH is negative and statistically significant, which shows that negative news has more impact on the volatility of the stock exchange market in Botswana.

Table 6b. Variance Equation

Model	**Parameter**	**Estimate**	**P-value**
GARCH 11	γ_0	18.4782	0.0000
	γ_1	0.259222	0.0000
	θ	0.534860	0.0000
TGARCH	γ_0	9.773879	0.0000
	γ_1	0.311081	0.0000
	ð	0.245030	0.0000
	θ	0.674375	0.0000
EGARCH	γ_0	3.053002	0.0000
	γ_1	1.874397	0.0000
	€	-1.287786	0.0000
	Đ	0.184383	0.0000

The lag value of all share indexes from table 7a is statistically significant; confirmed cases and death in Kenya are statistically insignificant in explaining the changes in all share indexes in Nairobi. Confirmed cases from China inversely affected all share index in Nairobi and is statistically significant. The U.S. confirmed cases and death significantly affect all share indexes, but the coefficients show a positive sign.

ISSN 2807-1778(Online)| 2807-1921 (Print)

Table 7a. COVID 19 and stock market in Kenya

MEAN EQUATION				
Variables	**Coefficient**	**Std. Error**	**Z-Statistic**	**Probability**
ASPI KNY	0.707258	0.048535	14.57217	0.0000
CC_KENYA	0.011499	0.008706	1.320718	0.1866
TD_KENYA	3.909816	16.95083	0.230656	0.8176
CHINA CC	-0.00005	0.000138	-3.63	0.0000
CHINA D	-0.850564	0.6375594	-1.33	0.182
US CC	0.000294	9.08E-05	3.240642	0.0012
US DEATH	1.229503	0.599522	2.050807	0.0403

Table 7b shows that previous shocks contributed to changes in all share indexes as indicated by ARCH and GARCH components. E-GARCH is negative and statistically significant, which shows that negative news has an impact on the volatility of all share indexes in the Nairobi stock exchange market during the period of analysis.

Table 7b. Variance Equation

Model	Parameter	Estimate	P-value
GARCH 11	γ_0	2006.621	0.0000
	γ_1	0.265087	0.0000
	θ	0.690846	0.0000
TGARCH	γ_0	1658.917	0.0419
	γ_1	0.273755	0.0066
	ð	0.210716	0.0889
	θ	0.589692	0.0371
EGARCH	γ_0	4.265619	0.0000
	γ_1	1.854385	0.0000
	€	-1.599334	0.0000
	Đ	0.552113	0.0000

We used the estimated parameter from each model for computing volatility persistence. Table 8 shows that all the countries have displayed a varying degree of persistence in volatility; the estimated volatility persistence $\gamma 1+\theta$ is very high for Kenya and Botswana stock exchange markets. The volatility in the Nigerian stock market displayed relative tranquility during the period of analysis compared to South Africa that is more volatile than Nigeria. Thus, within the period of analysis, Kenya and Botswana Stock markets experienced high volatility.

From this finding, we can observe that the volatility of stock markets in these African countries was affected by COVID-19. Evidence shows that towards the end of February 2020, financial markets in Africa started experiencing a high level of volatility equivalent to the one observed over100 years ago. According to the report on the African financial market (PwC, 2020), when compared with other health crises such as the 2003 SARS epidemic and 2015 Ebola epidemic, these led to the short-lived spite in volatility, but COVID-19 results in a high level of volatility.

Table 8. Volatility Persistence

COUNTRIES	$\gamma 1+\theta$
Nigeria	0.157364

ISSN 2807-1778(Online)| 2807-1921 (Print)

South Africa	0.577187
Botswana	0.794082
Kenya	0.955928

Diagnostic Test

The diagnostic test presented in the Appendix shows that the three models (GARCH 11, TGARCH, and EGARCH) for all the countries passed all the three residual diagnostic tests, vis; serial correlation (correlogram of standard residuals), Normality test (Jarque-Bera), and heteroscedasticity test (ARCH). With regard to serial correlation, in the Appendix A, a correlogram of standard residuals was employed to see whether an error transfers from one day to another. We, therefore, fail to reject the null hypothesis and conclude that the residuals are independent for all the models.

Appendix B shows the normality test; Jarque-Bera was used to check whether the residuals are normally distributed. From the p-values of Jarque-Bera, we fail to reject the null hypothesis and conclude that the errors are normally distributed with 0 mean and constant variance for all the models. With respect to the heteroscedasticity test from Appendix C, we used the ARCH test and obtained p-values for the three models for the observed R-square for all the countries. Therefore, we fail to reject the null hypotheses of homoscedasticity and conclude that the variances of the residuals are homoscedastic (constant) for all the models.

CONCLUSION

This paper is a pioneer effort to investigate the impact of COVID-19 on the stock exchange markets in Sub- Saharan African countries focused on four countries-Nigeria, Kenya, South Africa, and Botswana. Based on the data employed, time frame, and statistical method used, this study submits that COVID-19 confirmed cases and deaths do not affect the operation of stock exchange markets in Sub-Saharan African countries but the fluctuation or volatility of all share indexes as a result of raises in confirmed cases within the period have increased, which affects the stability of the markets. Botswana and Kenya's stock markets were affected by external cases from China; the exponential increase in confirmed cases caused a negative shock to these markets.

We, therefore, recommended that stock market participants and regulators should be more concerned about health safety measures and be ready for any future epidemic or pandemic that might affect the market stability.

LIMITATION

One of the limitations of this study is that the use of the number of confirmed cases and deaths as the only repressors. Other variables such as exchange rate, interest rate, and inflation might explain the volatility in Sub-Saharan African stock markets within the period of analysis, but we couldn't use such variables due to the nature of their frequency compared with the COVID-19 period used. Secondly, GARCH models account for stochastic volatility of stock price or return, but the stock price or return series may have components that may not be explained by such models, such as trend or moving average. Thus, they may be unsuitable when an asymmetric effect is perceived as a different instability.

ISSN 2807-1778(Online)| 2807-1921 (Print)

REFERENCES

Adesoji, F., & Asongu, S. (2020). E uropean X tramile C entre of A frican S tudies. SSRN Electronic Journal, 1–24. https://doi.org/10.2139/ssrn.3637668

Alali, M. S. (2020). COVID-19 Infection and Mortality Rates Effect on Asian Stock Markets Returns. Sochi Journal of Economy, 14(2), 227–230.

Alali, M. S. (2020). Risk Velocity and Financial Markets Performance: Measuring the Early Effect of COVID-19 Pandemic on Major Stock Markets Performance. International Journal of Economics and Financial Research, 6(4), 76–81. https://doi.org/10.32861/ijefr.64.76.81

Alam, M. N., Chavali, K., & Alam, S. (2020). Stock Market Response during COVID-19 Lockdown Period in India: An Event Stock Market Response during COVID-19 Lockdown Period in India: An Event Study. Journal of Asian Finance, Economics and Business, 7(7), 131–137. https://doi.org/10.13106/jafeb.2020.vol7.no7.131

Ashraf, B. N. (2020). Stock Markets' Reaction to COVID-19 : Moderating Role of National Culture. SSRN Electronic Journal, January. https://doi.org/10.2139/ssrn.3608323

Bahrini, R., & Filfilan, A. (2020). Impact of the novel coronavirus on stock market returns: evidence from GCC countries. Quantitative Finance and Economics ·, 4(4), 640–652. https://doi.org/10.3934/QFE.2020029

Bash, A. (2020). International Evidence of COVID-19 and Stock Market Returns: An Event Study Analysis. International Journal of Economics and Financial Issues, 10(4), 34–38. https://doi.org/10.32479/ijefi.9941

Capelle-blancard, G., & Desroziers, A. (2020). The Stock Market Is not the Economy? Insights from the COVID-19 Crisis. SSRN Electronic Journal, January, 1–40. https://doi.org/10.2139/ssrn.3638208

Chia, R. C.-J., Liew, V. K., & Rowland, R. (2020). Daily New Covid-19 Cases, The Movement Control Order , And Malaysian Stock Market Returns. International Journal of Business and Society, 21(2), 553–568.

Dhiman, B., & Kumar, R. (2020). Impact Of Covid-19 And Its Containment Measures On Stock Market: Impact Of Covid-19 And Its Containment Measures On Stock Market : A Review At. Wesleyan Journal of Research, 22(13), 172–181.

Elsayed, A., & Abdelrhim, M. (2020). The Effect Of COVID-19 Spread On Egyptian Stock Market Sectors.

SSRN Electronic Journal, 1–16. https://ssrn.com/abstract=3608734

Ezekiel, A. M., Adeusi, S. A., & Oluwatoyin, F. (2020). COVID-19 PANDEMIC AND NIGERIAN STOCK

MARKET CAPITALISATION. Ilorin Journal of Economic Policy, 7(3), 12–23.

Gunay, S. (2020). A New Form Of Financial Contagion: Covid-19 And Stock Market Responses.

Harjoto, M. A., Rossi, F., & Paglia, J. (2020). COVID-19 : Stock Market Reactions to the Shock and the Stimulus COVID-19 : Stock Market Reactions to the Shock and the Stimulus. Applied Economics Letters, 1–14. https://doi.org/10.2139/ssrn.3622899

Hung, N. T. (2020). Dynamic spillover effects between oil prices and stock markets : New evidence from pre and during COVID-19 outbreak. AIMS Energy, 8(5), 819–834. https://doi.org/10.3934/energy.2020.5.819

ISSN 2807-1778(Online)| 2807-1921 (Print)

Jais, M., Lee, K. Y.-M., & Chan, C. (2020). Impact of covid-19 : Evidence from Malaysian stock market IMPACT OF COVID-19 : EVIDENCE FROM MALAYSIAN. International Journal of Business and Society, 21(2), 607–628.

Khanthavit, A. (2020). World and National Stock Market Reactions to COVID-19. ABAC Journal, 40(2), 1– 17. https://doi.org/10.13140/RG.2.2.22792.57606

Lee, H. S. (2020). Exploring the Initial Impact of COVID-19 Sentiment on US Stock Market Using Big Data. Sustainability, 12(6648), 1–19. https://doi.org/10.3390/su12166648

Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 Outbreak and A ff ected Countries Stock Markets Response. International Journal of Environmental Research and Public Health, 17(2800), 1–19. www.mdpi.com/journal/ijerph

Majama, N. S., Israel, T., & Magang, T. (2017). Strategic Planning in Small and Medium Enterprises (SMEs): A Case Study of Botswana SMEs. 8(1). https://doi.org/10.5430/jms.v8n1p74

Pwc, (2020). Financial market impacts of COVID-19© 2020 PwC Inc. [Registration number 1998/012055/21] (“PwC”)

Quang, T. T., Nguyen, D., Tran, Q., Al-Mohamad, S., & Bakry, W. (2020). COVID-19 in Vietnam : What Happened in the Stock Market ? SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3654017

Riaz, S., Ahmad, R., Parkash, R., & Ahmad, M. J. (2020). Determinants of Stock Market Investors â€TM Behavior in COVID-19 : A Study on the Determinants o f Stock Market Investors ’ Behavior in COVID- 19 : A Study on the Pakistan Stock Exchange. International Journal of Disaster Recovery and Business Continuity, 11(3), 977–990.

Salisu, A. A., Sikiru, A. A., & Vo, X. V. (2020). Pandemics and the emerging stock markets. Borsa Istanbul Review, 1–24. https://doi.org/10.1016/j.bir.2020.11.004

Topcu, M., & Gulal, S. O. (2020). The impact of COVID-19 on emerging stock markets. Finance Research Letters, August, 1–4. https://doi.org/10.1016/j.frl.2020.101691

ISSN 2807-1778(Online)| 2807-1921 (Print)

APPENDIX A.

GARCH11

Date: 01/01/01 Time: 00:18
Sample: 12/31/2019 5/18/2020
Included observations: 95

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob*</th></tr>
<tr><td>. |. |</td><td>. |. |</td><td>1</td><td>0.030</td><td>0.030</td><td>0.0858</td><td>0.770</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>2</td><td>0.140</td><td>0.139</td><td>2.0299</td><td>0.362</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>3</td><td>0.105</td><td>0.099</td><td>3.1251</td><td>0.373</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>4</td><td>-0.106</td><td>-0.133</td><td>4.2604</td><td>0.372</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>5</td><td>0.187</td><td>0.171</td><td>7.8459</td><td>0.165</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.005</td><td>0.018</td><td>7.8481</td><td>0.249</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>-0.018</td><td>-0.050</td><td>7.8812</td><td>0.343</td></tr>
<tr><td>. |** |</td><td>. |* |</td><td>8</td><td>0.223</td><td>0.192</td><td>13.153</td><td>0.107</td></tr>
</table>

TGARCH11

Date: 01/01/01 Time: 00:26
Sample: 12/31/2019 5/18/2020
Included observations: 95

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob*</th></tr>
<tr><td>. |. |</td><td>. |. |</td><td>1</td><td>0.020</td><td>0.020</td><td>0.0389</td><td>0.844</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>2</td><td>0.009</td><td>0.008</td><td>0.0467</td><td>0.977</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>3</td><td>0.008</td><td>0.008</td><td>0.0539</td><td>0.997</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>4</td><td>0.007</td><td>0.006</td><td>0.0583</td><td>1.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>5</td><td>0.000</td><td>0.000</td><td>0.0584</td><td>1.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>-0.003</td><td>-0.003</td><td>0.0593</td><td>1.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>-0.001</td><td>-0.001</td><td>0.0595</td><td>1.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>8</td><td>-0.002</td><td>-0.002</td><td>0.0599</td><td>1.000</td></tr>
</table>

Date: 01/01/01 Time: 00:18
Sample: 12/31/2019 5/18/2020
Included observations: 95

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob*</th></tr>
<tr><td>. |. |</td><td>. |. |</td><td>1</td><td>0.030</td><td>0.030</td><td>0.0858</td><td>0.770</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>2</td><td>0.140</td><td>0.139</td><td>2.0299</td><td>0.362</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>3</td><td>0.105</td><td>0.099</td><td>3.1251</td><td>0.373</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>4</td><td>-0.106</td><td>-0.133</td><td>4.2604</td><td>0.372</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>5</td><td>0.187</td><td>0.171</td><td>7.8459</td><td>0.165</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.005</td><td>0.018</td><td>7.8481</td><td>0.249</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>-0.018</td><td>-0.050</td><td>7.8812</td><td>0.343</td></tr>
<tr><td>. |** |</td><td>. |* |</td><td>8</td><td>0.223</td><td>0.192</td><td>13.153</td><td>0.107</td></tr>
</table>

ISSN 2807-1778(Online)| 2807-1921 (Print)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. |. |	. |. |	1	-0.004	-0.004	0.0020	0.965
. |. |	. |. |	2	-0.007	-0.007	0.0063	0.997
. |. |	. |. |	3	-0.008	-0.008	0.0125	1.000
. |. |	. |. |	4	-0.005	-0.005	0.0154	1.000
. |. |	. |. |	5	-0.002	-0.002	0.0158	1.000
. |. |	. |. |	6	0.000	0.000	0.0158	1.000
. |. |	. |. |	7	0.001	0.001	0.0160	1.000
. |. |	. |. |	8	0.005	0.004	0.0181	1.000

ISSN 2807-1778(Online)| 2807-1921 (Print)

APPENDIX B.

Please contact corresponding author

ISSN 2807-1778(Online)| 2807-1921 (Print)

APPENDIX C.

Heteroscedasticity Test: ARCH

Nigeria	GARCH11	Prob.F(1,293)	0.4455
	TGARCH	Prob.F(1,293)	0.5580
	EGARCH	Prob.F(1,273)	0.9961
KENYA	GARCH11	Prob.F(1,293)	0.564
	TGARCH	Prob.F(1,293)	0.5354
	EGARCH	Prob.F(1,293)	0.9463
SOUTH AFRICA	GARCH11	Prob.F(1,293)	0.1455
	TGARCH	Prob.F(1,293)	0.2581
	EGARCH	Prob.F(1,293)	0.2969
BOTSWANA	GARCH11	Prob.F(1,293)	0.1515
	TGARCH	Prob.F(1,273)	0.1580
	EGARCH	Prob.F(1,293)	0.9961

ISSN 2807-1778(Online)| 2807-1921 (Print)