THE VOLATILITY OF STOCK RETURNS AND THE COVID-19 PANDEMICS: EVIDENCE FROM SELECTED AFRICAN MARKETS

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ABSTRACT

The Covid-19 (coronavirus) phenomenon is considered as the largest health, social and economic crisis of the century. The contagious disease poses significant negative impacts including economic recession, retrenchment, and uncertainties in the financial markets. The paper aims to find whether the pandemic causes significant volatility of stock returns, thus identifying the countries whose stock prices are worst hit. Since volatility serves as a gauge of the extent of risk in the financial markets, the paper focuses is on the volatility of stock returns The paper uses the generalized autoregressive conditional heteroscedasticity (GARCH) model to examine the volatility dynamics of stock returns before and during the periods of the pandemics. According to the outcomes, stock market returns of four countries (Kenya, Morrocco, Tanzania, and Uganda) are significantly stable before the Covid-19 crisis and the volatility is not persistence but faded after temporarily perturbations. The evidence indicates the stock returns in Nigeria and South Africa (SA) are significantly unstable, nervous, and jumpy, as well as the volatility remains long and persistence in Nigeria and SA. However, the estimation identifies that the markets are jumpy during the pandemic period in all six countries examined. Specifically, the evidence identifies that SA, Nigeria and Tanzania are worse hit. The result has implication for regulations and policymaking as well as offering investors a guide to consider in making informed decisions, since volatility is essential to individual investors, fund managers as well as financial regulators to evaluate the level of uncertainty around their investments.

Keywords: Stock Returns, Volatility, GARCH model, Covid-19 Pandemics, African Markets.

1. INTRODUCTION

The immediate aim of this paper is to evaluate the impact of the Covid-19 pandemic on stock markets volatility in Africa. The Covid-19 (coronavirus) phenomenon is considered as the largest health, social and economic crisis of the century (The New Yorker, 2020). It remains a contagious which outbreak, was originated from China's Hubei city in December 2019, and quickly spread across China's 30 provinces. As the coronavirus continues to spread beyond China especially during the first half of 2020, the World Health Organization declared the disease as a global pandemic (Cucinotta & Vanelli, 2020). In past centuries, for instance, a similar pandemic shock, referred to as the "Black Swan Event" frighten investors and triggered rapid "panic-selling reactions (He, Liu et al., 2020). Likewise, the Covid-19 triggered different reactions leading to a recorded number of deaths.

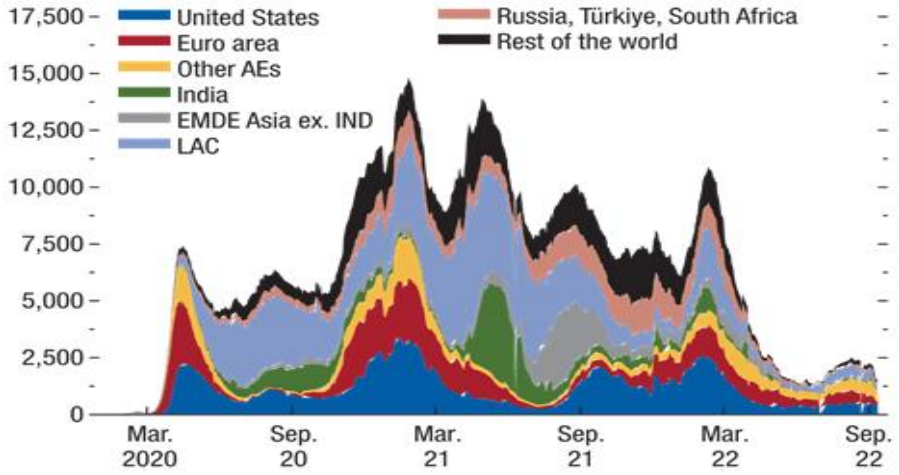
Alongside human losses, the contagious disease poses significant negative impacts including economic recession, retrenchment, and uncertainties in the financial markets. The stock markets exhibit historically high levels of intraday and daily volatilities leading to several operational disruptions during recent Covid-19. Many firms faced financial distress causing profound threats to markets indicators, especially the stock indexes (Barai & Dhar, 2021; Lassoued & Khanchel, 2021; Ruiz, Koutronas, & Lee, 2020). The reactions of stock markets were unprecedented, as major stock prices face different fluctuations (Baker et al., 2020) and the stock indexes in several markets cratered around mid-February 2020 (Barai & Dhar, 2021). Because China was the country where the virus started, the health shock incidence greatly affects the Chinese stock market. The Chinese equity index, the Shanghai Shenzhen CSI 300, recorded its ever-major daily drops of 7.88% on February 3, 2020, and experience a value plummeted by around 14.75% between January 23, 2020, and March 23, 2020.

Due to the extent and level of economic interdependence in the modern world, changes in the Chinese stock market have impact on other markets (Liu et al. 2021; Akhtaruzzaman et al. 2021). Notably, the value-weighted prices in advanced economies dropped by 40% from 17 February to 23 March, and the emerging market economies experienced a steeper drop. The virus shocks reported to influence volatilities in several African markets. The study of the effect of Covid-19 on Ghana, Nigeria, and other African economies show a decline in GDP, an increase in poverty, and a loss of valuations in different sectors. Andam et al. (2020) report that the lockdown imposed by the government cost the economy a total loss of 34.1% of GDP (i.e., $16 billion), with the services (agriculture) sector accounting for 65% (13.1%) of the output decline.

There is evidence that Covid-19 affects stock market in Africa. The stock performances in Africa were observed to significantly reduce between -2.7 % and -21 %, during and after the occurrence of the Covid-19, with some industries losing up to 60% of networth (Takyi & Bentum-Ennin, 2021). Researchers had tried to prove a connection between the Covid-19 outbreak and the financial market's turbulence (Vengesai, 2022; Periola-Fatunsin et al. 2021; Oliyide et al. 2021; Akhtaruzzaman et al. 2021; Harjoto et al., 2020; Fernandes, 2020). Clearly, the virus spread affect asset pricing making them more volatile, especially after the implementation of extensive controls, such as lockdown, sit at home and others to curtail the spread (Heyden & Heyden 2021; Padhan & Prabheesh 2021; Khan et al., 2020). Despite increasing studies on the response of stock market to the pandemic, care must be exercised in generalizing because specific analysis is required for different markets returns and countries (Liu et al. 2021; Ramelli & Wagner, 2020). Aside, important research questions remain, whether the pandemic causes more swing in the stock returns during relative to before the Covid-19, and whether the pandemic has a long-term effect on the stock volatility. Therefore, there is need for additional research to address these gaps, thus show a better understanding of the pandemic's long-term consequences on African stock markets.

The paper contributes, in different ways, to address this issue. Unlike precursory studies, the paper aims to find whether the pandemic cause significant volatility of stock returns, thus identifying the countries whose stock prices are worst hit. The focus is on the volatility of stock returns because volatility serves as a gauge of the extent of risk in the financial markets. Financial regulators, mutual fund managers, and individual investors all have interests in volatility since it is essential to evaluate the level of uncertainty around their investments. Hence, for the aim, we use the generalized autoregressive conditional heteroscedasticity (GARCH) model to examine the volatility dynamics of stock returns before and during the periods of the pandemics.

According to the outcomes, stock market returns of four countries (Kenya, Morrocco, Tanzania, and Uganda) are significantly stable before the Covid-19 crisis and the volatility is not persistence but faded after temporarily perturbations. The evidence indicates the stock returns in Nigeria and SA are significantly unstable, nervous, and jumpy, as well as the volatility remains long and persistence in Nigeria and SA. However, the estimation identifies that the markets are jumpy during the pandemic period in all six countries examined. Specifically, the evidence identifies that SA, Nigeria and Tanzania are worse hit. The result has implication for regulations and policymaking as well as offering investors a guide to consider in making informed decisions for portfolio and risk management. There is the need for structural reforms and diversifying the industrial base to make economies more resilient and reduce their reliance on primary commodities. The remainder of the paper is structured such that literature is reviewed in Section 2, the methodology is discussed in Section 3, the empirical results are presented in Section 4 and conclusion in Section 5.



Sources: Our World in Data; and IMF staff calculations.
Note: Data as of September 13, 2022. Economy group and regional classifications are those in the *World Economic Outlook*. "Other AEs" by International Organization for Standardization (ISO) country codes are AUS, CAN, CHE, CZE, DNK, GBR, HKG, ISL, ISR, JPN, KOR, MAC, NOR, NZL, SGP, SMR, SWE, and TWN. AEs = advanced economies; EMDE Asia ex. IND = emerging market and developing economies in Asia excluding India; LAC = Latin American and Caribbean economies.

FIGURE 1
NEW CONFIRMED COVID-19 DEATHS
(*PERSONS:SEVEN-DAY MOVING AVERAGE*)

2. LITERATURE REVIEW

Several studies have shown that the Covid-19 pandemic has impacts on the asset markets in many countries using different approaches. Some studies suggest that the measures taken to control the spread of the virus such as social exclusion, travel restrictions and lockdowns resulted in a significant socioeconomic cost for different countries (Bannigidadmath et al., 2021; Raifu et al., 2021; Alam et al., 2021; Kayanula & Tumwebaze, 2021). The outcomes of different studies differ with some result reporting that the pandemics impinges feverish stock reaction, and others reporting positive impacts, depending on the country and method applied for the investigations (Ramelli & Wagner; 2020; Paul & Isaac, 2020).

Owusu et al. (2024) shows existence of co-movements among stock markets in Africa, noting that in pendamics periods, portfolios diversification is not conducive in the African markets. Vengesai (2022) examines the equity markets during the pandemic in the South Africa (thereafter, SA) and finds significant, positive, high correlations between the Small Cap and the major indices, suggesting insignificant diversification during the pandemic. Takyi and Bentum-Ennin (2021) quantifies the short-run effects of the pandemic on stock markets performance in Africa and show that Covid-19 has restrictive effects on African's stock performances.

Raifu et al. (2021) reports that the effects of Covid-19 on stock returns swing between negative and positive before converging to equilibrium over the long term. The paper shows that lockdown policies and global Covid-19 cases and deaths negatively impacted Nigerian stock market returns more than local cases and deaths. Akhtaruzzaman et al. (2021) examined financial contagion between G7 countries and China during Covid-19. The paper shows that stock returns in China are negatively and significantly associated with the increase in total reported death due to Covid-19 and the growth rate in the total confirmed cases of Covid-19. Alam et al. (2021) use the event analysis of 55 companies listed on the Dhaka Stock Exchange (DSE) to show that the pandemic

had a significant negative impact on the stock market in Bangladesh. The study highlights the importance of policymakers implementing risk management strategies and providing liquidity support to companies to stabilize the stock market during crises.

Baker et al. (2020) determine how the pandemic will affect stock market volatility. They argue that the effect of Covid-19 disease on stock markets was strong such that no pervious pandemics, including the Black Swan Event and Spanish Flu outbreaks, have impacted the stocks like the Covid-19 did, especially when the infectious disease causes equity returns to significantly fluctuate (Periola-Fatunsin et al. 2021; Oliyide et al. 2021), rises stock markets contagion (Liu et al. 2021; Akhtaruzzaman et al. 2021) as well as has adverse impact on stock returns (Heyden & Heyden 2021; Padhan & Prabheesh 2021). Evidence from various academic works demonstrates that Covid-19's impact on the financial markets is severe compared to other crises that have occurred in the past (Umar et al., 2021; Baker et al., 2020; Zhang et al., 2020).

Kayanula and Tumwebaze (2021) examine the early evidence of the consequences of the pandemic on stock markets. Alongside pandemics, they investigate potential factors affecting the markets such as policy reactions, investor sentiment, and industry variances, and found that pandemics causes market instability and price decreases. Heyden and Heyden (2021) explore short term reactions of stocks during Covid-19 pandemic in the US and European and report that the markets are highly volatile with spiky fluctuations. The asymmetric connection which the market exhibits with related information on Covid-19 causes decline in return expectation across middle and upper quantiles. Zoungrana et al. (2021) reported that rather than confirmed cases, the weekly death cases were the primary informational factor that caused a market disturbance.

Di Chen et al. (2021) use a panel data analysis to investigate how the Covid-19 shocks impact the stocks of oil exploration and production sectors. The paper found that both the number of Covid-19 cases confirmed, and government reaction stringency index have adverse effect on stock prices. The authors show that the unfavourable response of the stock market to government response stringency measure is greater than that obtained from the confirmed cases. Song et al. (2021) note that the reaction of firms stock to pandemics may depends on several other factors. For instanced, firms with larger size, more leverage, cash flows, internationalization but with lesser returns on asset are more resilient to stock decrease during heat of Covid-19. David and Aharon (2021) note that during Covid-19, the market reactions to economic measures largely depends on the type and nature of the government intervention supports. Irrespective, the interventions measures are associated with adverse market reactions with the stay-at-home (lockdown) restrictions impinging the most negative influence on stock markets in emerging countries.

Ashraf (2020) notes that although the evidence is not sufficient to show that recorded Covid-19 fatalities have likely impact on global stocks, the number of recorded Covid-19 cases adversely affects market performances. Ramelli and Wagner (2020) examine markets reaction to the sudden emergence of neglected risks, especially how stock react to Covid-19 incidence. They note that since the outbreak, aggregate market has been underperforming, and they conclude that the health shocks has morphed into financial and economic meltdown. The paper further observed that financial channels amplify how Covid-19 impact the stock returns. Fernandes (2020) examines how Covid-19 crisis affect countries and specific industries and offers differ medium via which economic activities would be impacted by the pandemic. The global stock markets around the world were adversely affected in the SA, Brazil, and Colombia, among others. The oil, gas and coal sector led the negative returns in the stock market. Harjoto et al. (2020) show that, in emerging markets economies, stock market returns (volatility) react positively (negatively) to both number of confirmed and death cases during the pandemics, while in the developed markets economies, only confirmed cases negatively affect stock market return.

Paul and Isaac (2020) examine how Covid-19 impacts stock market performance in African and reveal that the pandemic possibly have a favorable impact on the performance of the markets examined. Specifically,

the paper uses the Bayesian structural approach and found that the pandemics leave a major negative impact on the stock markets of ten countries while having no significant or temporary negative impact on the remaining three countries. Cepoi (2020) verifies the response of stock market to coronavirus news in the Germany, France, Italy, Spain, US and UK at the early stage of the pandemic. He noted that due to diverse policies implemented, the stock markets are expected that to reflect some forms of reactions. Khan et al. (2020) examined the effect of Covid-19 on 16 countries. They observe that although during the early stages of the pandemic, investors did not react and stock were unaffected, but during the later stage of the Covid-19 outbreak stock market indices were negatively affected. Alber and Arafa (2020) reveal that fluctuation in stock return of exchanges in the Middle East and North Africa (MENA) region response negatively to by both cumulative and new reported death cases during Covid-19.

3. DATA AND METHOD

3.1 Data

This study uses daily data, covering 10/10/19 to 31/10/22, for six countries – Kenya, Morocco, Nigeria, Tanzania, SA, and Uganda. The daily data of Covid-19 (stock prices) for the considered African countries are sourced from the WHO (Investing.com) webpage. Figure 1 [Panel: A – E] depicts the daily stock returns for price index indicated. The series shows high fluctuations, which is an indication for clustered volatility of the returns. The plots show jumps and vertical striations during and after the Covid-19 incidence. The log returns show noticeable outliers with protrusion with relative mean reversion. Table 1 provides summary of the Covid-19 records, including the first-time report, total cases and total death recorded during the pandemic for six countries. The pre-Covid-19 case started on 1 October 2019 and went on up to 28 February 2020. The heated period begins after the first month of African countries' contact with the virus, which is typically March, and lasts until August 2020 after ease of the lockdown periods. The post period, which is the recovery period, starts from September 2020 up to the data span.

To describe the datasets of the stock price index and validate its deterministic properties, the paper first presents simple statistics and correlation matrix. Table 2 displays a summary of the Africa's country stocks before the Covid-19 pandemic. The average stock price index for Kenya, Morocco, Nigeria, Tanzania, SA, and Uganda, in the considered periods, are 1963.06, 11779.64, 1488.85, 1896.91, 58163.03, and 1416.27, respectively. The SA stock index has the highest spread (standard deviation) of 6656.33, followed by Morocco with a value of 1176.37, while Tanzania stock exhibit the lowest spread with a value of 90.18. The fact that the variations in the stock markets during the Covid-19 is greater in SA is due to the size of the country's stock market, which ranked the largest in the region, and the country is the worst hit by the endemic virus, in terms of the number of reported deaths. The average (mean) values of stock returns of Kenya, Morocco, Nigeria, SA, Tanzania and Uganda are 2589.12, 12004.04, 1166.30, 52180.25, 7015.58, 1755.704, respectively, whilst the average (mean) of the returns during the Covid-19 (heated) periods are 1940.75, 1031.39, 48863.24, 1825.42, 6525.74 and 1626.03. The statistics indicates that three of the countries (Kenya, Nigeria, and Tanzania) appear to have a lesser spread in their stock prices index compared to the Covid-19 (heated) periods, while the others (Morocco, SA and Uganda") seem to have a higher spread in their stock prices index compared to the Covid-19 (heated) periods.

Table 1. Covid-19 Cases

Country	First Case	Total Cases	Total Death
Kenya	13/03/2020	336,445	5,668
Morocco	02/03/2020	1,246,835	16,167
Nigeria	28/02/2020	258,934	3,144
Tanzania	16/03/2020	37,510	841

SA	05/03/2020	3,999,345	101,915
Uganda	21/03/2020	167,503	3,626

Note: The countries and their stock price index in parathesis "[]" are indicated. Kenya [NSE 20]; Morocco [Moroccan All Shares]; Nigeria [NSE All Share Index]; Tanzania [Tanzania All Share]; SA [South Africa Top40]; Uganda [Uganda All Share].

Source: Authors

Table 2. Sample Statistics

Country	$\boldsymbol{\mu}$	$\boldsymbol{med}$	$\boldsymbol{max}$	$\boldsymbol{min}$	$\boldsymbol{\sigma}$	$\tilde{\boldsymbol{\mu}}_{\boldsymbol{1}}$	$\tilde{\boldsymbol{\mu}}_{\boldsymbol{3}}$
Full Sample [10/10/19 − 31/10/22]							
Kenya	1963.07	1889.58	2766.77	1563.68	267.54	1.61	4.69
Morocco	11779.64	11955.63	13991.47	8987.89	1176.37	-0.41	2.41
Nigeria	1488.86	1594.00	2065.62	871.26	309.13	-0.36	1.75
SA	58163.05	60113.00	71034.00	36490.00	6656.33	-0.46	2.70
Tanzania	1896.92	1884.85	2136.52	1697.65	90.18	0.54	2.62
Uganda	1416.27	1370.70	1861.26	1130.12	164.96	1.12	3.54
Pre Covid-19 Sample [10/10/19 − 28/02/20]							
Kenya	2589.12	2609.00	2766.77	2337.03	94.27	-0.67	2.76
Morocco	12004.05	12057.70	12633.57	10806.41	374.04	-0.32	2.46
Nigeria	1166.30	1136.56	1320.02	1063.97	82.42	0.50	1.96
SA	52180.25	52757.00	54950.00	41631.00	2302.02	-2.52	10.76
Tanzania	2035.38	2052.64	2130.39	1763.57	74.23	-1.32	4.89
Uganda	1755.70	1775.97	1861.26	1531.06	86.94	-1.40	3.93
During Covid-19 Sample [01/03/20 − 31/08/2020]							
Kenya	1940.75	1954.93	2400.56	1723.96	121.71	0.76	5.50
Morocco	1031.39	1044.92	1158.82	871.26	64.28	-0.64	2.80
Nigeria	48863.24	49978.00	54341.00	36490.00	4281.01	-0.87	3.24
SA	1825.42	1805.22	2079.14	1739.63	84.46	1.76	5.09
Tanzania	6525.74	6574.87	6863.44	6116.16	183.70	-0.40	2.01
Uganda	1626.03	1611.91	1885.22	1455.21	71.00	0.91	4.33
Post-Covid-19 Sample [01/09/20 − 31/10/22]							
Kenya	1850.94	1866.27	2066.46	1563.68	101.66	-0.36	2.90
Morocco	12170.70	12176.11	13991.47	9952.63	952.68	-0.30	2.50
Nigeria	1654.14	1682.55	2065.62	1079.43	195.60	-1.02	4.42
SA	61411.85	61820.00	71034.00	48385.00	4531.87	-0.50	3.19
Tanzania	1887.53	1883.39	2136.52	1697.65	63.60	0.21	2.55
Uganda	1366.08	1358.47	1607.93	1130.12	99.24	0.23	2.34

Note: The Table shows the statistics $(\mu, med, max, min, \sigma, \tilde{q}_1, \tilde{q}_3)$ of the stock price index during $(10/10/19 \text{ to } 31/10/22)$. Where $\mu \equiv$ mean, $med \equiv$ median, $max \equiv maximum, min\ minimum$, $\sigma \equiv$Standard deviation, $\tilde{\mu}_1 \equiv$ skewness coefficient $\tilde{\mu}_3 \equiv$ $k$urtosis coefficient. The number of observations for the full, pre-, during- and post- Covid-19 samples are 765, 104, 123 and 538.

Source: Authors

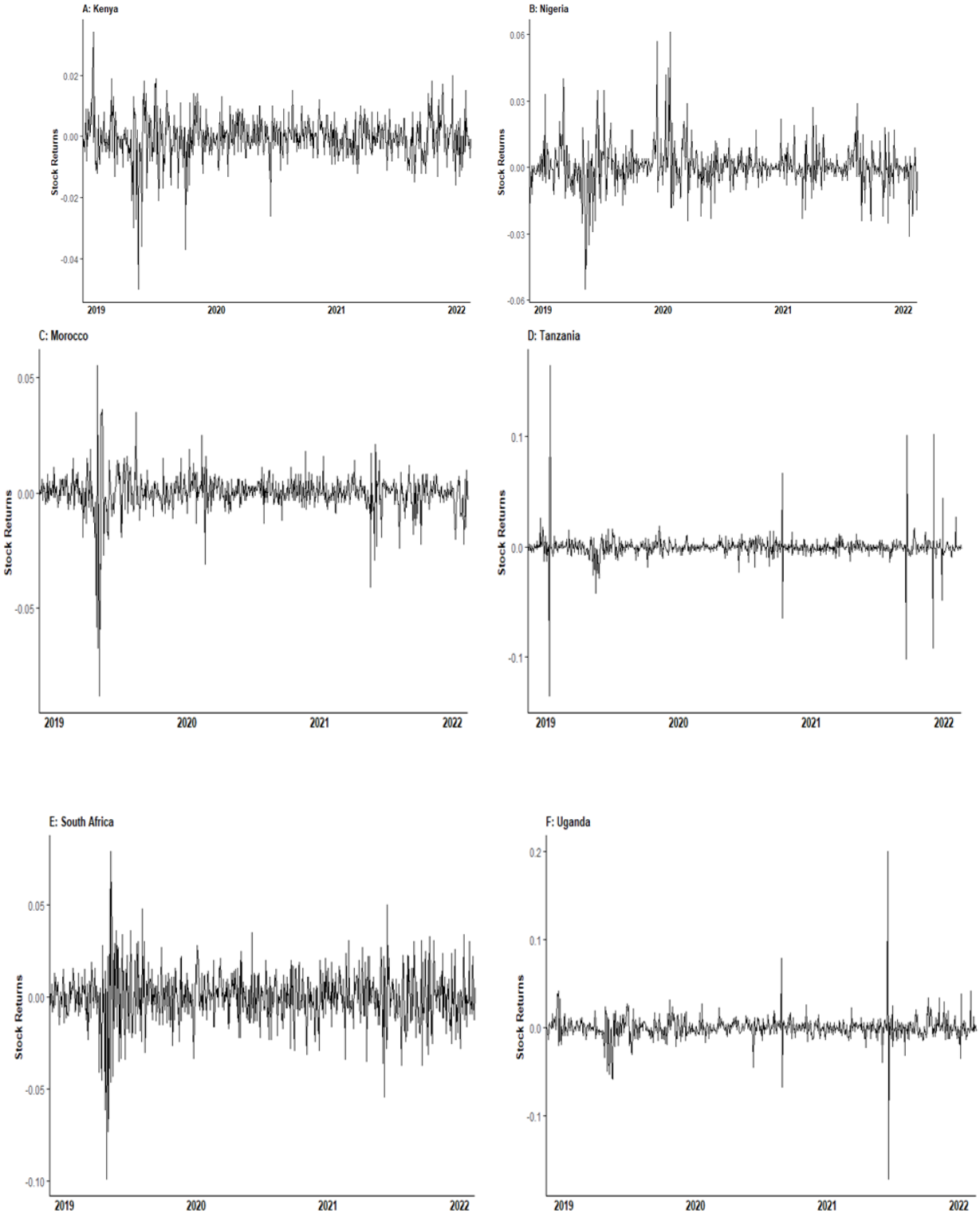
The results of the correlation matrix of the sample countries' stock marks are given in Table 3. The outcome identifies some degree of correlations amongst the African stock returns in the considered sample periods. Not surprisingly, the Kenya stock has its highest correlation of 0.650 with Tanzania, but surprisingly, with a negative correlation (of -0.495) with the Nigerian stock in the full sample periods. The SA stock has a strong positive and highest correlation (of 0.865) with Nigeria, followed by Morocco of 0.763. It has a negative correlation (of -0.408) with Kenya in the full sample but a strong and positive correlation (0.597) with Kenya in the pre-Covid-19 sample. The stock prices in Nigeria, Tanzania and Uganda appear to be significantly correlated with that of Kenya. The stock prices in Nigeria and SA are significantly correlated with that of Morrocco. Lastly, the stock of Nigeria, SA and Tanzania are significantly correlated with that of Uganda.

Table 3. Sample Correlations

Country	**Kenya [1]**	**Morocco [2]**	**Nigeria [3]**	**SA [4]**	**Tanzania [5]**	**Uganda [6]**
[1]	1.000					
[2]	0.061	1.000				
[3]	**-0.495**	0.750	1.000			
[4]	-0.408	**0.763**	**0.865**	1.000		
[5]	**0.650**	**0.478**	0.056	0.232	1.000	
[6]	**0.322**	0.201	**-0.362**	**-0.293**	**0.478**	1.000
Pre-Covid-19 [10/10/19-28/02/20]						
[1]	1.000					
[2]	0.366	1.000				
[3]	-0.117	0.763	1.000			
[4]	0.597	0.359	0.043	1.000		
[5]	0.080	0.593	0.650	-0.161	1.000	
[6]	0.613	0.741	0.648	0.201	0.689	1.000
During Covid-19 [01/03/20-31/08/2020]						
[1]	1.000					
[2]	-0.265	1.000				
[3]	0.026	0.680	1.000			
[4]	-0.787	0.513	0.260	1.000		
[5]	0.555	0.085	0.164	-0.674	1.000	
[6]	0.823	-0.082	0.268	0.758	0.775	1.000
Post-Covid-19 [01/09/20-31/10/22]						
[1]	1.000					
[2]	0.378	1.000				
[3]	0.212	0.687	1.000			
[4]	0.127	0.725	0.707	1.000		
[5]	0.497	0.578	0.292	0.417	1.000	
[6]	0.866	0.344	-0.239	0.079	0.636	1.000

Note: Table 4 shows the Pearson correlation coefficients, $r_{x_1x_2}$, defined for linear correlation of a pair, $x_i$and x_j, having n-set $[(x_{1,1}, x_{2,1}), (x_{1,2}, x_{2,2}), \ldots, (x_{1,n}, x_{2,n})]$ with $r_{x_1x_2} = \sum_i^n (x_{1,t} - \bar{x}_1)(x_{2,t} - \bar{x}_2) \left[\sqrt{(x_{1,t} - \bar{x}_1)^2}\sqrt{(x_{2,t} - \bar{x}_2)^2}\right]^{-1}$, and the value lies between –1 and +1. A value "0" means no correlation exists. **Bold** value is significant coefficient using probability, $p|t| = 0$.

Source: Authors



Note: Figure 1 [Panel: A - E] depicts the plots of daily stock returns based on price index indicated: Kenya [NSE 20]; Morocco [Moroccan All Shares]; Nigeria [NSE All Share Index]; Tanzania [Tanzania All Share]; SA [South Africa Top40]; Uganda [Uganda All Share].

3.2 Method

This study uses the generalized autoregressive conditional heteroscedasticity (simple GARCH) test to estimate the volatility model for the stock index. The GARCH model is a conditional heteroscedasticity extension of the simple ARCH (autoregressive conditional heteroscedasticity) models. The conditional variance process is given an autoregressive structure and the log returns are modelled as a white noise multiplied by the volatility:

$$z_t = e_t \sigma_t$$

$$\sigma_t^2 = \omega + \alpha_1 z_{t-1}^2 + \cdots + \alpha_\rho z_{t-\rho}^2 \quad (1)$$

Where e_t (the 'innovations') are nid with expectation 0 and variance 1 and are assumed independent from σk for all k ≤ t. The lag length p ≥ 0 is part of the model specification and may be determined using the Box-Pierce or similar tests for autocorrelation significance, where the case p = 0 corresponds to a white noise process. Tim Bollerslev (1986) extended the ARCH model to allow σ_t^2 to have an additional autoregressive structure within itself. The standard GARCH(1,1) (simpler generalized ARCH) model is given by

$$\varepsilon_t = \delta + \sigma_t z_t$$

$$\sigma_t^2 = \omega_0 + \omega_1 (\varepsilon_{t-1})^2 + \Omega \sigma_{t-1}^2 \quad (2)$$

Where $z_t \sim nid\ (0,1)$ and $\sigma_t^2 > 0$. The standard GARCH(1,1) and related GARCH(p,q) models are useful tools in econometrics. This model, in particular the simpler GARCH(1,1) model, has become widely used in financial time series modelling and is implemented in most statistics and econometric software packages. GARCH(1,1) models are favored over other stochastic volatility models by many economists due to their relatively simple implementation. ω_1 measures how volatility reacts to new information (i.e., catches the ARCH effect). Ω represents persistence of the volatility (i.e., catches the GARCH effect), and $\omega_1 + \Omega$ (close to 1) shows the overall measurement of persistence of volatility (ie., implies volatility remains long).

The procedure follows the general hypotheses of the standard rules that are based on the evaluation of the Kullback-Leibler measure, which uses the heteroscedastic information that more boundaries are evaluated for the AR-GARCH models than for AR models (Sin & White, 1996). We hypothesize and verify that the variance of error terms, ε_t, follows a GARCH (1,1). The *t*-test for the variance of the GARCH (1,1) components of ε_t for all the log-stock price index are significant (Gourieroux, 2012; Higgins & Bera, 1993). The GARCH model has been proved as a workhorse for volatility measures in financial applications.

4. RESULTS

We compare the outcome of the significance of the estimations for the stated stock markets price volatility models prior and after the advent of the Covid-19 for the considered countries. Applying ARCH family models has two approaches to test their underlying presumptions (Gourieroux, 2012; Higgins & Bera, 1993). We apply the GARCH effect test – with a null hypothesis of no GARCH effect. According to the procedure, the paper completes the estimation of the volatility models differently for the pre and post Covid-19 information, to confirm whether the pandemic causes more swing in the stock returns during the pandemic era relative to the period before the Covid-19. The GARCH model's estimation for the stock returns is completed separately for the different countries to realize the aim. We employ the model selection method to estimate the appropriate GARCH model. Table 4 (Table 5) presents the GARCH estimations for pre (post) Covid-19 variance equations

For the estimation prior to the Covid 19 pandemic, the outcome shows that the GARCH reaction parameter (ω_1) of stock returns four of the countries – Kenya (0.053), Morrocco (0.028), Tanzania (0.044) and Uganda (0.015) – all lies within the normal range of less than or approximately 0.05, suggesting the markets are relatively stable. However, for Nigeria and SA with reaction parameters 0.122 and 0.149, and significant

respectively, the outcome shows that the stock returns are significantly nervous and jumpy even before the pandemic. Furthermore, for both countries, the coefficient, Ω, which catches the GARCH effect are relatively higher and their sum ($\omega_1 + \Omega$) appear close to unity, indicating that the volatility remains long and persistence. The outcome of the estimation for the post Covid-19 shows GARCH effects for all six countries. The reaction parameter (ω_1) of stock returns for all the countries are clearly lies within the normal range 0.1 and significant suggesting that the markets are jumpy during the pandemic periods. With the overall persistency indicated, the evidence suggests a long memory for the volatility of returns in SA (0.916), Nigeria (806), and Tanzania (0.728) but a short memory for while Morocco (0.341), Uganda (0.36) and Kenya (0.434). This implies that SA, Nigeria and Tanzania are worse hit, while Morocco, Uganda and Kenya are least hit, accordingly.

The result is not surprising as the influence of Covid-19 has been widely suggested to affect the financial markets, especially stock returns. The financial markets respond to Covid-19 related information (Heyden & Heyden 2021) and the nature of changes in asset prices suggest that the effects of the pandemics may not be likely temporary (Pagano et al. 2020). Owusu et al. (2024) note that in pendamics periods, portfolios diversification is not conducive in the African markets. Vengesai (2022) finds significant, positive, high correlations between the small cap and the major indices during the pandemic.

Table 4. GARCH Estimations [Pre Covid-19's Variance Equations]

Parameters	**Estimates [α]**	σ_α	t_α	$p(t_\alpha)$
Kenya				
ω_0	0.001	0.000	8.146	(0.000)
ω_1	0.053	0.001	58.022	(0.000)
Ω	0.167	0.000	79.220	(0.000)
Morocco				
ω_0	0.000	0.000	13.369	(0.000)
ω_1	0.028	0.002	58.429	(0.000)
Ω	0.219	0.000	151.500	(0.000)
Nigeria				
ω_0	0.000	0.000	19.361	(0.000)
ω_1	0.139	0.000	87.983	(0.000)
Ω	0.520	0.000	204.030	(0.000)
SA				
ω_0	0.002	0.000	6.492	(0.000)
ω_1	0.152	0.000	39.000	(0.000)
Ω	0.613	0.000	201.000	(0.000)
Tanzania				

ω_0	0.000	0.000	18.181	(0.000)
ω_1	0.044	0.000	60.520	(0.000)
Ω	0.185	0.000	117.100	(0.000)
Uganda				
ω_0	0.000	0.000	16.950	(0.000)
ω_1	0.015	0.001	82.480	(0.000)
Ω	0.229	0.000	51.430	(0.000)

Note: The Table presents the GARCH estimations of the stock returns models for the pre-Covid 19 for Kenya, Morocco, Nigeria, SA, Tanzania, and Uganda. The statistics – σ_α, t_α, $and\ p(t_\alpha)$ – are the standard error, t - value and probability value of the estimate (α).

Figures in parathesis "()" are the probability values which suggest that the statistical significance using probability, $p|t| = 0$.

Table 5. GARCH Estimations [Post Covid-19 Variance Equations]

Parameters	**Estimates [α]**	σ_α	t_α	$p(t_\alpha)$
Kenya				
ω_0	0.000	0.000	4.427	(0.000)
ω_1	0.153	0.049	5.740	(0.000)
Ω	0.281	0.100	3.519	(0.000)
Morocco				
ω_0	0.000	0.000	4.108	(0.000)
ω_1	0.143	0.522	5.615	(0.000)
Ω	0.198	0.110	3.067	(0.002)
Nigeria				
ω_0	0.000	0.000	3.869	(0.000)
ω_1	0.148	0.048	5.647	(0.000)
Ω	0.668	0.097	4.407	(0.000)
SA				
ω_0	0.000	0.000	4.427	(0.000)
ω_1	0.161	0.049	5.740	(0.000)
Ω	0.755	0.100	3.519	(0.000)
Tanzania				
ω_0	0.000	0.000	4.169	(0.000)
ω_1	0.225	0.053	5.576	(0.000)
Ω	0.503	0.111	2.973	(0.003)

Uganda				
ω_0	0.000	0.000	5.249	(0.000)
ω_1	0.151	0.057	5.452	(0.000)
Ω	0.209	0.102	2.542	(0.011)

Note: The Table presents the GARCH estimations of the stock returns models for the post-Covid 19 for Kenya, Morocco, Nigeria, SA, Tanzania, and Uganda. The statistics – σ_α, t_α, $and\ p(t_\alpha)$ – are the standard error, t - value and probability value of the estimate (α).

Figures in parathesis "()" are the probability values which suggest that the statistical significance using probability, $p|t| = 0$.

5. CONCLUSIONS

Pandemics are sadly a part of human existence, and can manifest unanticipatedly (Donthu & Gustafsson, 2020). The Covid-19 inflicted wide ranging economic damages (Phan & Narayan, 2020) as well as unprecedented adverse influence on the stock markets and financial sectors (Goodell, 2020). The recent occurrence of the Covid-19 offers researchers a rare chance to assess the pandemics effects leading to general recession within the worldwide economies. The spread of the Covid-19 crisis specifically created uncertainties in the financial markets, thus, become a matter of concern for financial specialists, especially on the implication for excessive volatility of market returns. Clearly, the Covid-19 conveys shock that affects asset returns during the pandemic period. There were observed decline and excessive volatility of many stock prices, therefore, highlighting the need for research to be implemented to effectively examine the effects on stock volatility. Despite available evidence, care must be exercised in generalizing as specific analysis is required for each country's stock returns. Analyzing the individual stock market response to the Covid-19 crisis is crucial for gaining valued insights into the interconnectedness of stock markets and pandemics.

The paper examines the volatility behavior of the stock market returns in selected Africa before and after the Covid-19 crisis. The aim was intended to determine whether the returns are significantly more volatile during the periods of the pandemics than before it, hence, ascertain that the crisis likely cause increase volatility in the African stock markets. For the aim, we use the GARCH model to examine the volatility dynamics of stock returns before and during the pandemics periods. The model, through its ARCH effect and GARCH effect parameters respectively, is applied to measure and confirm the extent that the volatility of stock returns reacts to the new (Covid-19) information and the persistence of the volatility of the returns.

The procedure shows evidence that the stock market returns of four countries (Kenya, Morrocco, Tanzania, and Uganda) are significantly stable before the Covid-19 crisis and the volatility is not persistence but faded after temporarily perturbations. The evidence indicates the stock returns in Nigeria and SA are significantly unstable, nervous, and jumpy, as well as the volatility remains long and persistence in Nigeria and SA. However, the estimation identifies that the markets are jumpy during the pandemic period in all six countries examined. Specifically, the evidence identifies that SA, Nigeria and Tanzania are worse hit, while Morocco, Uganda and Kenya are least hit, accordingly. The result has implications for academics, policy making, regulations and stakeholders in the capital market, especially the foreign investors, in terms of portfolio diversification and risk management. It serves as a guide for investors to make informed decisions and reduce risks of impeding losses associated with pandemic.

Notably, recovery from instability associated with a global shock is usually slow recovery (UN Economic Commission for Africa, 2021), but it can be facilitated with the implementation of aiding policies. Therefore, we offer some recommendations to support the findings. There is the need for the implementation of more government intervention measures, such as government direct income aid as well as debt or contract relief, to sustain the recovering markets. Because in emerging economies, capital markets respond to government interventions depends on the type of the intervention (David & Aharon, 2021), caution must be exercise in

applying the appropriate intervention that would restrict market volatility. There should be structural reforms and diversification of the economy to the industrial base to make it more resilient. Furthermore, due to the strong link between market fluctuation and macroeconomic policy in an emerging stock market, the volatility of stock return can be controlled through implementations of the appropriate macroeconomic policies (Okonkwo, 2019). Policymakers should implement effective risk management strategies and provide liquidity support to stabilize the stock market during crises periods. There should be the establishment of an efficient regulatory framework in the stock exchange markets. Each country regulators should ensure expansion and more modernize stock markets, which should be integrated with those of other African nations to benefits from likely spillover effects.

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