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Stock markets response to contagious disease: Evidence on the impact of COVID-19 in the three worst hit African economies

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Abstract

This study analyses whether Coronavirus health shocks and government responses in terms of lockdown policy and stringency measures impact stock markets in Africa. We found that stock markets appeared to be more negatively responsive to growth in total number of COVID-19 reported cases than the growth in deaths in the case of Nigeria and South Africa. While for Egypt, the stock market reacted significantly negative to both COVID-19-related indicators. Our results further show that government stringency policy has significant negative effect on stock market returns in the case of Nigeria and South Africa, but positive in the case of Egypt.

KEYWORDS

Africa, CCR, COVID-19, covid-stringency index, DOLS, FMOLS, lockdown policy, stock market index

1 | INTRODUCTION

Our study is motivated by the following question: do financial markets in Africa respond to the ongoing COVID-19 health crisis, the lockdown and/or containment policy measures implemented by the various government authorities? Financial markets have a crucial part to play in the future of Africa. Financial markets on the continent remained resilient and innovative in the midst of declining global growth following the 2017 synchronized upturn. Compared to their counterparts in Latin America and Asia, they remain fragmented and shallow however. Moreover, more African economies have started developing strategies to encourage the growth and development of the stock market in the region. Nevertheless, there still exist major hurdles to the growth in capital market within the region because of illiquidity, low level of new listings and product monotony (Absa Africa Financial Markets Index, 2018, 2019). For example, market cap and the listed number of shares comprise a little proportion of the countries' economies (Bekaert et al., 2007; Boamah, 2016; Dirk et al., 2018; Ntim et al., 2011).

It is a worthy undertaking to investigate the effects of the current health crisis on African markets in this present stage owing to unending health and economic threats portrayed from the COVID-19 pandemic universally. This current health crisis displays similarities to those of previous viruses and epidemics, such as the H1N1 virus of 1918, the H2N2 virus of 1957 and 1958, H3N2 virus of 1968, the Swine flu of 2009–2010, Ebola virus of 2014–2016 and the MERS virus of 2012, which adversely affected economies worldwide (Salisu, Sikiru, & Vo, 2020).

Following the social and economic aftermaths of the COVID-19 health crisis, it has motivated the necessity to observe disease outbreaks better and to examine their influence on the overall economy, including the financial market. Theoretically, the foundation for investigating the relationship between contagious diseases and stock markets is centred on the hypothesis, which states that stock market performances and volatility are susceptible to events and macroeconomic circumstances that affect market financiers' judgements concerning the degree of risk and uncertainty in financial markets (see Narayan, 2020a, 2020b). In periods of widespread crises, such as financial crises, man-made and natural disasters, there is bound to be extremely high degree of risk and uncertainty in the markets, thereby making most market participants to be risk averse (see also, Eichenbaum et al., 2020; Haroon & Rizvi, 2020; Qadan, 2019).

As the health crisis continues to endure, several measures were recommended by the World Health Organization (WHO) for countries around the world to implement in order to contain the menace of the pandemic. Such measures introduced include partial to total lockdown, physical/social distancing, embargo on public gathering of any form, ban on local and international travels, maintaining of personal hygiene—using soap and water to wash hands, use of hand sanitizers where water is unavailable, and the use of nose masks in open places. These measures were accepted and implemented by both developed and developing economies.

These measures, particularly the total economic shutdown and physical/social distancing have had a tremendous adverse effect on all aspects of the economy, as well as the financial industry where the assets prices crashed unprecedentedly across the world. Specifically, in the period from January 2020 to March, 2020, the prices of key precious metals for example gold, palladium, copper, platinum, iron, aluminium, lead, nickel and silver dropped by 3.5%, 31.8%, 22.3% 41.1%. 5.5%, 12.8%, 14.3%, 17.9% and 28.9% respectively (Schmidhuber et al., 2020). Within the same period, the crude oil price, especially the WTI fells sporadically by 61.6%. The capital markets which provide platforms for the transactions of shares are not left out of the hook. The US Congressional Research Service report (2020) shows that around the same period, Dow Jones industrial index lost about one-third of its valued price which represent about 56.76% between 14 February and 23 March 2020. Similar trend was observed in the share price of S&P 500 as it fell by 33.81% within the same period. Since the COVID-19 pandemic is a global phenomenal, financial market in developing countries are also affected by some magnitudes. For example, between January and March 2020 also, the Egyptian stock index EGX30 dropped by 31.10%, NSE All share index in Nigeria declined by 26.15% while South Africa's Top 40 index dropped by 18.64% (Authors' calculation with underlying data from investing.com).

It is an established fact in the empirical literature that numerous events affect stock market (Al-Awadhi et al., 2020). For instance, studies such as Shanaev and Ghimire (2019), Bash and Alsaifi (2019) analysed the effect of political events on stock market, Salisu and Vo (2020) on health news and stock market and Li (2018) investigated news and stock market. Others include Guo et al. (2020) on environmental events and stock market, Buhagiar et al. (2018) on sports and stock markets and recently Kowalewski and Śpiewanowski (2020) examined disasters and stock markets. Furthermore, infections during pandemic are likely to affect stock markets as documented in Chen et al. (2009) and Chen et al. (2007) on the 2003 SARS outbreak, and in Ichev and Marinč (2018) on the Ebola outbreak in Central Africa.

Furthermore, following the common reaction of the stock markets during the ongoing global health pandemic, several studies have been carried out to determine whether COVID-19-related cases and deaths along with different government policy measures influence the financial markets performance (see, e.g. Ashraf, 2020a, 2020b; Al-Awadhi et al., 2020; Erdem, 2020; Gil-Alana & Claudio-Quiroga, 2020; Prabheesh, 2021; Sharma, 2021; Yan & Qian, 2021; Ambros et al., 2021; Cao et al., 2021; Størdal et al., 2021; Yang & Deng, 2021; among others). Generally, findings from these studies suggest that the COVID-19-related cases and deaths as well as the measures taking by government to minimize the widespread of the disease, specifically complete economic shutdown (stringency) adversely influence the performance stock markets. Nevertheless, some studies argued that the effects are not similar across different markets and economies (see Ambros et al., 2021; Gil-Alana & Claudio-Quiroga, 2020; Sharma, 2021; Størdal et al., 2021). Following the above argument, this study complements prior empirical studies on stock market returns and the global health shock. In specific terms, we investigate the effects of Coronavirus reported cases and deaths, and government stringency measures on the stock market returns in the top three worst hit economies in Africa—Egypt, Nigeria and South Africa.

The objectives of our study were implemented in the following manner. We computed the growth in the number of COVID-19 reported cases and deaths and evaluate their effects on the stock market returns of each of the three African markets. It is assumed that the impact of the confirmed cases might not be the same as the impact of deaths on stock market returns. We are also of the view that the effect of either infectious cases or deaths might vary from country to country. Therefore, it is important to examine these impacts to know the countries that are actually affected and the magnitude of the impact. Knowing this would provide country-specific strategies to policymakers in their efforts to bring economy back to life after the pandemic.

Next, across the world, several measures were taken to stem the tide of spreading of COVID-19 pandemic. The most important of these measures that brought the world economy to its knees are social distancing and total lockdown. Almost all the affected countries implemented these measures, although compliance varied across the countries. Hence, it is important to investigate how these measures affected financial sector, especially stock market returns in every country instead of lumping the countries together in panel form. Lumping countries together in panel estimation also suffers from the problem of generalization which can result in formulation and implementation of spurious policy. Hence, we examine the effects of social distancing and total lockdown on the stock market returns of each of the countries mentioned above. To capture the social distancing and total lockdown, we use the data on government intervention policy actions compiled by the Oxford University in conjunction with the Blavatnix School of Government. The data were collected for the series of measures taken by the governments across the world (Hale et al. 2020a, 2020b).[1] Hence, our current study investigates the interaction between the latest global COVID-19 pandemic and the stock market performance of African countries. Distinctively, we investigate the impact of the COVID-19 transmittable infectious illness on the capital markets of the three worst hit economies in Africa.[2] Following the introduction, the rest of the paper is structured as follows: the next section contains a review of literature; data, methodology and preliminary analysis are presented in Section 3, Section 4 contains the empirical results, while Section 5 presents the conclusion.

2 | LITERATURE REVIEW

It has been documented that several fundamental occasions affect stock markets (Al-Awadhi et al., 2020). For instance, some scholars have analysed numerous happenings that have effects on stock markets. Such studies include, for instance, Guo et al. (2020), in terms of environmental issues (Kowalewski & Śpiewanowski, 2020), in the advent of a disaster (Li, 2018), in terms of news (Buhagiar et al., 2018) and in terms of sports (Bash & Alsaifi, 2019; Shanaev & Ghimire, 2019) when there is political turmoil, among others. Further, as also documented in other studies such as Chen et al. (2007) and Chen et al. (2009), stock markets are susceptible to and react to shocks arising from infectious pandemics. For instance, the outbreak of SARS[3] in 2003, the outbreak of Ebola (Ichev & Marinč, 2018) and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Al-Awadhi et al., 2020; Ahmar and del Val 2020; Ashraf, 2020a).

Following the recent work of Narayan (2021), we structure the literature review section in terms of specific topics and themes thus:

2.1 | Stock markets and COVID-19

In a study on China, Al-Awadhi et al. (2020) examine the contagious nature of COVID-19 and the sectoral stock market outcomes. A panel data approach was adopted with companies' data ranging from 10 January to 16 March 2020 on stock market from Hang Seng Index and Shanghai Stock Exchange Composite Index. Data on coronavirus were obtained from Worldometer, which consisted of number of active daily reported infections and daily fatality cases. They found that the COVID-19 pandemic in terms daily reported cases and growth in daily death cases had a significant negative relationship with the returns on stock market in China. Similarly, Ashraf, 2020a investigated how COVID-19 affected stock markets in a panel of 64 countries from 22 January 2020 to 17 April 2020. Using daily changes in the main stock market index as the stock returns and daily growth in coronavirus reported cases and daily growth in the number of deaths, the study found that coronavirus reported cases had negative effect on stock markets. However, the negative response of stock market is more significant for the number of reported cases than for the growth in the number of fatalities. It was further argued that in the early period of the reported cases, the inverse market response was stronger than between 40 and 60 days after the initial reported cases. Generally, the study concluded that there is an instant response of the stock market to coronavirus disease; however, the reaction fluctuated over time conditional on the stage of the epidemic. Another panel study was conducted by He, Liu, et al. (2020) on Japan, Spain, China, Germany, Italy, France, South Korea, and the United States to empirically analyse the direct and spill-overs effects of COVID-19 on stock markets. By employing conventional t-tests and non-parametric Mann–Whitney tests, they found that there is short-run negative effect of COVID-19 on the concerned economies, and the effect of COVID-19 on stock markets has bi-directional spill-over effects between Asian economies and, European and American economies.

Using automated and human readings of newspaper articles to quantify the role of news about infectious disease outbreak, Baker et al. (2020) analysed the unprecedented response of the U.S. stock market to coronavirus from 2 January 1900 to 24 March 2020. They discovered that no prior outbreak of contagious virus, including the Spanish Flu has strongly affected the stock market as the current coronavirus pandemic. They therefore argued that the possible reason for the unmatched effect on stock market is as a result of the course of action taken by various authorities towards coronavirus pandemic. In another study in the US, Onali (2020) examined how coronavirus cases and fatalities affect the stock market—proxied by Standard & Poor's 500 and the Dow Jones indices, and their volatility. Using daily data for 1 year from 8 April 2019 to 9 April 2020, the study adopted three models—GARCH(1, 1), standard VAR and structural breaks Markov-switching models. From the GARCH model, they found that the US stock market returns was not impacted by movements in the number of cases and fatalities in the US and other nations (Spain, Italy, China, the United Kingdom, France and Iran) highly ravaged by coronavirus cases in the first 3 months of 2020, except for the log of number of documented cases in China. By extension, the VAR model showed that the number of confirmed cases in France and Italy has a positive effect on volatility index (VIX) and inverse effect on the Dow Jones returns. As a final point, the study concluded that the scale of the inverse effect of VIX on stock market returns tripled at the end of February 2020. Further, Ramelli and Wagner (2020) investigated feverish stock market responses to COVID-19 pandemic in the United States from 31 December 2018 to 3 April 2020. They opined that the coronavirus pandemic signifies an alarming and unparalleled challenge for both policy makers and financiers and as the virus spread, investors reacted by evaluating the economic costs. Generally, they found that from the viewpoint of actors in the stock market, the coronavirus health challenge transformed into a wider financial and economic challenge.

Similar to Baker et al. (2020), Ru et al. (2020) studied the reactions of the global stock markets to the SARS virus outbreak in 2003 and the current COVID-19 outbreak. They found that stock markets in economies that had experienced SARS disease (SARS-CoV-1) in 2003 responded more swiftly to the initial case of the novel coronavirus (COVID-19) pandemic in Wuhan China in late January 2020. Most countries that did not experience SARS in 2003 showed weaker responses to the outbreak of COVID-19 until the disease started spreading to other countries, such as Italy, South Korea in late February, and their stock markets started to topple. They therefore reported inappropriate response to the novel coronavirus in economies where similar crises had not been experienced. In a study by Alber (2020), the impact of COVID-19 spread on stock markets of the 6 worst hit economies was examined. These countries included China, Spain, Italy, France, Germany, and the United States, and the COVID-19 spread was determined by cumulative cases, new cases, cumulative deaths and new deaths for the period 1 March 2020 to 10 April 2020. Stock market returns were calculated by the change in stock market index while the COVID-19 spread was determined by number of infections per million population. Their results showed high sensitivity of stock market returns to COVID-19 cases than deaths and COVID-19 cumulative indicators more than new ones. They further document negative effect of COVID-19 spread on stock market returns for Spain, Germany, France, and China, while this effect could not be ascertained in the cases of the United States and Italy. Following the study of Alber (2020), Elsayed and Elrhim (2020) analysed the impact of coronavirus spread on the sectoral indices of the Egyptian Exchange from 1 March 2020 through 10 May 2020. After employing daily COVID-19 cases and deaths, and daily sectoral Egyptian stock market returns, they documented that the sectoral stock returns responded more to cumulative number of deaths than daily mortality from COVID-19, but they are more sensitive to new confirmed cases than to cumulative cases of the virus. Takyi and Bentum-Ennin (2021) reported that following the occurrence of COVID-19, stock markets performance in Africa dropped by around negative 2.7%–21%.

Gil-Alana and Claudio-Quiroga (2020) analysed the effect of COVID-19 pandemic on the stock markets of South Korea, Japan and China. With the aid of fractional integration methods, they reported that there is mean reversion and transient impact of fluctuations in the Japanese stock market, while the effect appears to be permanent in the cases of Korea and China. Yan and Qian (2021) examined the effect of COVID-19 on the stock market of the consumer sector in China using an event study approach. They found deteriorating and transitory effects on the stocks of consumer sector occasioned by ongoing COVID-19 crisis, which occurred around the first three trading days following an event. Yang and Deng (2021) investigated how various government policy measures taken during the COVID-19 period impacted stock market returns of 20 OECD economies. They found that the growth in number of confirmed COIVD-19 cases adversely impacted stock market returns of these economies, and the policy measures by the government to contain the virus—such as social distancing, contact tracing and testing amplify the adverse impact of the crisis on stock market returns.

Also, Ambros et al. (2021) examined how movements in COVID-19-related news affected stock markets of eight markets in the first 2 months of the health crisis. With the use of high-frequency data they find that stock market returns are insensitive to the fluctuations in the amount of COVID-19-related news, but stock markets in the European markets are positive and significantly related to COVID-19 news. Cao et al. (2021) examined the adverse effects of Covid-19 on stock market index. Using a panel regression approach for 14 stock market indices, they argued that local cumulative Covid-19 confirmed cases negatively and significantly impacted stock market indices. However, the movement of stock market index with domestic and global Covid-19 infections, coupled with global containment measures, the negative effect of the pandemic are expected to lessen. Harjoto et al. (2021) investigated the effect of COVID-19 crisis on stock markets using two events dates—the 11 March 2020 WHO declaration as the shock event and the 9 April 2020 Federal Reserve Bank response as the stimulus. They document negative relationship between COVID-19 shock and global stock markets, particularly for small firms and in emerging markets; also positive abnormal returns were found in the U.S. stock market following the Fed stimulus compared to other advanced economies and emerging markets. However, the positive abnormal returns after the stimulus were more beneficial to large firms than small firms in the United States.

Furthermore, Narayan et al. (2022) using a quantile regression framework investigated the impact of COVID-19 on the stock market returns in Australia. Their pattern of effect of COVID-19 revealed that the pandemic has heterogeneous impact on the different industries of the market—with some sectors losing while others such as consumer staples, health and information technology gaining. While, Størdal et al. (2021) investigated how various government policies to contain COVID-19 in Norway and Sweden, such as school closures and travel restrictions coupled with financial aid impacted equity markets during the initial period of the pandemic. They find little or no evidence of significant effects of non-pharmaceutical interventions on the stock market returns in Norway, whereas the Swedish stock market returns are positively affected, but the effects lessen as the number reported COVID-19 cases surges. In another study, Phan and Narayan (2020) provided preliminary explanation on how stock prices respond in real time to different phases of the COVID-19 advancement. They argued that with regard to any unanticipated events, stock markets react excessively to the pandemic, but corrected itself after more information became available and investors understand the consequences more generally. Further, He, Sun, et al. (2020) investigated the market performance and reaction movements of different sectors of China to the global COVID-19 health crisis. With the aid of an event study method, they documented that COVID-19 has negative effects on the stock prices of some industries such as electricity and heating, environment, mining and transportation, while other sectors such as education, health-care, information technology and manufacturing were resilient to the pandemic. In another study for China, Xiong et al. (2020) examined the responses of stock market to the COVID-19 pandemic. By using listed companies in China, they documented that market react negatively to the COVID-19 outbreak and the reaction is more pronounced in companies that are vulnerable to the pandemic within the sectors and those with large number of institutional investors.[4]

2.2 | Exchange rate markets

Narayan et al. (2020) analysed the resilience of the Yen–US dollar exchange rate to COVID-19 health shocks during the pre-COVID-19 and COVID-19 periods. They argued that the Yen was non-stationary in the pre-COVID-19 period, whereas during the crisis period, it became generally stationary, which indicate that shocks to the Yen have a transient impact. Rai and Garg (2022) analysed the dynamic relationships and the instability spillovers between stock markets and exchange rates in BRIICS countries during the global COVID-19 health and economic crisis. By volatility modelling they revealed that there are significant negative dynamic correlations and volatility spillovers between stock and exchange rates returns in majority of these economies, and the link is more prominent in the earlier periods of lockdowns. Further, substantial risk transfers intensified between stock market and exchange rates market during the pandemic, causing deterioration in domestic stock market returns and consequent outward capital flight thus causing exchange rates depreciation. Narayan et al. (2021) investigated the link between the exchange rate (Japanese Yen to US dollar) and the stock market returns in Japan for the pre- and during the COVID-19 health crisis periods. With the use of different econometric models, they argued that the stock returns in Japan improve as the Yen depreciated against the Dollar. Also, the relationship appeared to be more pronounced during the COVID-19 period than the period before the disease outbreak. Fang and Zhang (2021) also examined the dynamic asymmetric impact of the coronavirus crisis on the RMB exchange rate.

2.3 | Uncertainty pandemic and epidemic

This includes all studies conducted on uncertainty caused by pandemics and epidemics (UPE). Salisu and Sikiru (2020) examined whether the Asia-Pacific Islamic stock market can be used as an appropriate hedge against uncertainty caused by pandemics and epidemics (UPE), and reported that the Asian-Pacific Islamic stocks has the prospect of being a good hedge against UPE, but the efficacy is weakened during the Coronavirus crisis. In another study, Salisu, Sikiru, and Vo (2020) investigated the reaction of stock markets in emerging economies following the uncertainty of pandemics and epidemics

(UPE), including the recent Coronavirus infectious disease. Using stock markets returns from 24 emerging market stocks in comparison with developed market stocks, they find that developed market stocks are more resilient to UPE than emerging stock markets. Also, by including the UPE variable in the stock's valuation, during the health crisis is fundamental to the choices of investment. Salisu and Akanni (2020) constructed a global fear index (GFI) for the Coronavirus disease to support financial, economic and policy analyses; and demonstrated how the GFI is applicable to the predictableness of stock returns in the context of OECD. They argued that the GFI appeared to be the right predictor of stock returns in the period of the COVID-19. Other studies on UPE include Salisu, Raheem, and Eigbiremolen (2020), Salisu, Lasisi, and Olaniran (2021), Salisu, Oloko, and Adediran (2021), Salisu and Sikiru (2021) and Padhan and Prabheesh (2021).

2.4 | Energy sector

Wang and Su (2021) examined the asymmetric relationship between COVID-19 and stock prices of the fossil energy industry, using a bootstrap Fourier Granger Causality test in quantiles. They find significant impact of COVID-19 on the stock prices of the oil and natural gas firms when the market is bullish, but no evidence of significant causality association was found in the coal market. Following the advent of COVID-19 pandemic, Salisu and Adediran (2020) analysed how uncertainty occasioned by contagious diseases can predict volatility in energy market, with the use of Equity Market Volatility-Infectious Diseases (EMV-ID). Similar to the results documented in Salisu and Akanni (2020), they found that the new measure of market uncertainty appear to be the appropriate predictor of energy market volatility in both in-sample and out-of-sample tests. Also, Polemis and Soursou (2020) analysed the influence of the recent global health crisis on the stock market returns of quoted energy firms on the Greek stock exchange. By using the event study method during the general lockdown caused by COVID-19, they argued that the health crisis affected the returns of most of the quoted energy firms; but the adverse effects of the pandemic diminishes as one move away from the event day. Gurrib et al. (2021) analysed the impact of the embargo placed on short-selling enacted by the National Commission for Companies and the Italian Stock Exchange (CONSOB) market, and argued that the ban was effective but was transitory. Sharif et al. (2020) examined the linkage between the ongoing global COVID-19 infectious disease, shock of oil price volatility, the stock market, geopolitical and EPU in the United States within a time-frequency context. Using the coherence wavelet method and the wavelet-based Granger causality tests, they find that COVID-19 has unprecedented negative influence on stock market volatility over the low incidence bands. Other studies which investigated the energy sector during the coronavirus include Gil-Alana and Monge (2020), Kartal (2020), Prabheesh et al. (2020), Devpura (2020) and Zhang and Hamori (2021).

2.5 | Others

Here we reviewed other studies on COVID-29 related news, international investors influence, herding behaviour of the stock market, various government policies, foreign portfolio investment (FPI), commonality in volatility and international investor attention. In a study on Asian market, Prabheesh (2021) investigated the causal relationship between the Indian stock market returns and foreign portfolio investment (FPI) in period of the Coronavirus crisis. By employing Toda-Yamamoto Granger causality test and daily data, they found unidirectional causality coming from FPI flows to stock market returns in the period of the pandemic. Also, Sharma (2021) in a group of markets analysed the whether the commonality in volatility in five Asian countries—Hong Kong, Japan, Russia, Singapore and South Korea have changed during the COVID-19 pandemic. It was documented that Commonality in volatility was more pronounced in the case of Singapore than the other sampled countries during the period of COVID-19. Ben Amar et al. (2021) investigated the connectedness among regional financial markets during the COVID-19 pandemic period. From a spillover index measure, they find that financial markets responded generally in similar manner to the economic uncertainty occasioned by the Coronavirus. They also argued that there is a substantial evidence of disconnection between the markets in America, emerging economies and the global financial markets.

Further, Cao, Woo, Li and Liu et al. (2022) examined the impact of Covid-19 on the alpha and beta of a U.S. stock exchange traded fund (ETF). By employing efficient market hypothesis (EMH) and the *J*-test of non-nested hypothesis, and a panel GMM approach, they find that unexpected persistence substantially decreases the alphas and betas of small-cap and mid-cap ETFs, but does not affect large-cap and sector and speciality ETFs. In another study, Espinosa-Méndez and Arias (2021) examined the effect of COVID-19 on the herding behaviour of the stock market in Australia, and argued that the global COVID-19 economic crisis enhances herding behaviour and it became more prominent during the health crisis and extreme periods. Nguyen et al. (2021) examined the contagion effects of international equity markets, the persistence of their volatilities and the volatility spillover from two large stock markets—United States and China to other markets in the periods before and during COVID-19 crisis. They document substantial contagion impact running from the United States and Chinese stock markets in the period of the pandemic. Huang et al. (2020) analysed whether international investors influence the crash risk of stock prices. Using the stock market in China, they find that international investors substantially stimulate crash risk of stock prices and the positive relationship is strengthened in companies with high information asymmetry levels or efficient internal control.

Following the recent structural adjustments in the Indian economy in terms of demonetization and enactment of the Goods and Services Tax (GST), Mishra et al. (2020) examined the effect of Coronavirus on the Indian financial market. Unlike in the period of the structural adjustments, they find inverse relationship between COVID-19 and stock market returns for all indices in the GST period, and the severity of the effect is stronger during the pandemic period than in that of the GST and demonetization. Salisu and Vo (2020) analysed the predictability of stock returns during the ongoing worldwide COVID-19 pandemic, with the consequence of health-news trends for top-20 economies ravaged by the health crisis. They concluded that health news search is an imperative appropriate predictor of stock returns following the advent of the COVID-19 crisis. Also, Iyke and Ho (2021) investigated the financial consequences of escalating international investor attention related to the Coronavirus outbreak for 14 stock markets in Africa. By employing daily investor attention indices based on global COVID-19-related Google search queries; they found that a rise in investor attention constantly causes reduction in stock returns in Botswana, Nigeria and Zambia, while it enhanced stock returns in Ghana and Tanzania. Implying that in times of uncertainty such as the ongoing COVID-19 outbreak, stock markets such as those of Ghana and Tanzania provide prospective benefits for investors to diversify. Other studies in diverse areas also include Sha and Sharma (2020), Liu et al. (2020), Bauer and Weber (2021), Haldar and Sethi (2021), Wei and Han (2021) and Dey et al. (2022).

The interaction between stock market performance and the recent COVID-19 health crisis has been broadly considered (e.g. Alber, 2020; Ambros et al., 2021; Cao et al., 2022; Cao et al., 2021; Mishra et al., 2020; Narayan et al., 2022; Nguyen et al., 2021; Ru et al., 2020; Salisu & Vo, 2020; Sharif et al., 2020; Størdal et al., 2021; Wang & Su, 2021; Yang & Deng, 2021). As shown in the review and Table 1, most of these studies were centred on the response of stock markets to the COVID-19 pandemic with the view from regional or global viewpoint and grouping both emerging and developed markets together (e.g. Ambros et al., 2021; Ben Amar et al., 2021; Cao et al., 2021; Harjoto et al., 2021; Phan & Narayan, 2020; Rai & Garg, 2022; Sharma, 2021; Yang & Deng, 2021; among others); others concentrate on developed stock markets (e.g. Cao et al., 2022; Gurrib et al. (2021); Narayan et al., 2021; Sharif et al., 2020). Further, other studies focused on emerging markets in Asia, these include Narayan et al. (2020) for Japan; Prabheesh (2021) for India; Yan and Qian (2021) for China; Wang and Su (2021) for China; He, Sun, et al. (2020) for China, among others, thereby neglecting the effect of the global pandemic on the stock market activities in other developing markets such as Africa. However, few empirical works have been conducted for the link between COVID-19 and stock markets in Africa (see Abu et al., 2021; Babarinde, 2020; Elsayed & Elrhim, 2020; Iyke & Ho, 2021; Takyi & Bentum-Ennin, 2021).

However, deviating from these prior studies which only motivated on how COVID-19 cases and deaths affect stock markets performance without taking into consideration the policy measures taking by government to contain the spread of the virus, the measures, especially the lockdown that have crippled the economic activities; our study investigates the comparative effects of COVID-19 confirmed cases and deaths as well as lockdown policy on stock market returns in the three African countries most hit by the COVID-19 pandemic. Moreover, our attention is centred on an area that appears to have been under-investigated—stock markets in Africa during the global health crisis relative to advanced and other emerging markets. However, our study is similar to the empirical studies carried out by Yang and Deng (2021) and Størdal et al. (2021), yet it differs in terms of period and scope of the pandemic, approach to government policy measure, method and investigation.

Moreover, our paper adds to the existing literature in the following relevant aspects: first, we add to previous studies that have analysed how diverse catastrophes and disasters affect the stock market. Few examples include Kowalewski and Śpiewanowski (2020), who analysed how mine disasters affect stock market. Becchetti and Ciciretti (2011) investigated the effects of the Global Financial Crisis in 2007–2009 on stock market. Gangopadhyay et al. (2010) investigated stock market response and share price behaviour about the 2005 hurricane Katrina. We add to these and other similar researches by investigating the effects of the current global coronavirus pandemic on stock markets.

TABLE 1 Summary of selected studies

S/N	Author(s)	Country/region	Dependent variable	Independent variables	Methods	Key findings
1	Narayan et al. (2020)	Japan/Asia	Yen-US dollar exchange rate	COVID-19	Narayan and Popp unit root model	COVID-19 has influenced the Yen-US dollar exchange rate's resistance to shocks
2	Salisu and Sikiru (2020)	Asia	Stock market index	UPE	Westerlund and Narayan, (2012, 2015) predictive model	Hedging potential of the Asia-Pacific Islamic stocks against UPE albeit with lower hedging effectiveness during the COVID-19 pandemic
3	Gil-Alana and Claudio-Quiroga (2020)	South Korea, japan and China	Stock market indices	–	fractional integration methods	The effects can be transitory or permanent
4	Prabheesh (2021)	India	Stock returns, FPI	Stock returns, FPI	Toda-Yamamoto Granger causality	Unidirectional causality runs from FPI flows to stock returns
5	Sharma (2021)	Hong Kong, Japan, Russia, Singapore, and South Korea	Stock market indices	–	GARCH	Commonality increased during COVID-19 period in Singapore than the other countries
6	Yan and Qian (2021)	China	Stock market index	–	Event study approach—AR; CAR	Negative impact of COVID-19 on stock returns
7	Yang and Deng (2021)	20 OECD countries	Stock indices	COVID-19 confirmed cases	Panel regression analysis	Negative effect of COVID-19 on stock returns
8	Wang and Su (2021)	China/Asia	Prices of fossil energy	COVID-19 cases	Bootstrap Fourier Granger Causality test in Quantiles (BFGC-Q)	COVID-19 has significant influence on oil and natural gas prices, not significant for the coal market
9	Ben Amar et al. (2021)	Europe, North America, Pacific, Asia, Latin America, and GCC	Stock market indices	–	Diebold and Yilmaz (2012) spillover index approach	Financial markets reacted generally in similar way to economic uncertainty during COVID-19 period
10	Ambros et al. (2021)	Eight markets	Stock market indices	COVID-19-related news	OLS	No effects, positive only in European markets
11	Cao et al. (2021)	14 countries	Stock market index	COVID-19 cases, deaths and recoveries	Panel fixed-effects model	Negative relationship
12	Cao et al. (2022)	United States	Stocks ETFs	Covid-19 confirmed cases, deaths and recoveries	GMM	Negative relationship

TABLE 1 (Continued)

S/N	Author(s)	Country/region	Dependent variable	Independent variables	Methods	Key findings
13	Harjoto et al. (2021)	United States and other developed and emerging	Stock indices	–	Event study approach—CAR, AR	Negative relationship
14	Espinosa-Méndez and Arias (2021)	Australia	Stock prices	–	Chang, Cheng, and Khorana (2000) cross-sectional absolute deviation (CSAD)	COVID-19 increases herding behaviour
14	Narayan et al. (2020)	Australia	Stock prices	Cumulative number of COVID-19 cases	Quantile regression	Heterogeneous effect
15	Rai and Garg (2022)	BRIICS	Stock indices, exchange rates	Stock indices, exchange rates	DCC—GARCH; BEKK—GARCH	Negative relationship
16	Nguyen et al. (2021)	Global	Stock indices	–	VAR Granger causality; GARCH	Negative contagion effects
17	Størdal et al. (2021)	Norway and Sweden	Stock indices	OxCGRT; Confirmed COVID-19 cases	Pooled OLS	No effect in Norway and positive effect in Sweden
18	Huang et al. (2020)	China	Stock price crash risk	Foreign ownership	Panel fixed effects	Positive relationship
19	Narayan et al. (2021)	Japan	Stock price index	Exchange rate	GARCH models	Exchange rate depreciation leads to improvement in stock returns
20	Salisu and Akanni (2020)	OECD	Stock prices	GFI—COVID-19 cases and deaths	Forecast predictability evaluation	Negative
21	Phan and Narayan et al. (2020)	Panel—24 countries	Stock indices	Country responses	Descriptive	Negative
22	He, Sun, Zhang and Li (2020)	China	Stock indices	–	Event study approach—CAR	Mixed—negative and no effect
23	Mishra et al. (2020)	India	Stock index	COVID-19 cases	MS-VAR	Negative
24	Zhang et al. (2020)	China	Stock index	–	Event study approach	Mixed—negative and positive
25	Salisu and Adediran (2020)	Panel	Energy market volatility	UPE	Bivariate predictive model	Negative

(Continues)

TABLE 1 (Continued)

S/N	Author(s)	Country/region	Dependent variable	Independent variables	Methods	Key findings
26	Polemis and Soursou (2020)	Greece	Stock prices	–	Event study approach—AR and CAR	Negative
27	Gurrib et al. (2021)	Italy	Stock market index	–	Descriptive	Negative
28	Sharif et al. (2020)	United States	Stock price index	COVID-19 cases	Wavelet	Negative
29	Salisu and Vo (2020)	20 countries	Stock prices	COVID-19 cases and deaths-related news searches	Predictive model	Negative

Source: Compiled by the authors.

Second, we complement the ongoing literature that investigates the reaction of stock markets to COVID-19 pandemic. Studies in this area include, Al-Awadhi et al. (2020) used data from China at the firm level and analysed the beginning effect of coronavirus outbreak on share prices in China. Alfaro et al. (2020) employing data from the United States of America argues that pandemics such as SARS and COVID-19 cause equity market to decline. Baker et al. (2020) employed textual analysis of news reports and concluded that coronavirus has led to unprecedented stock market volatility more than any previous endemic illness including the 1918 Spanish flu. Similarly, Zhang et al. (2020) argued that coronavirus has led to heightened risk in the global financial market. By extension to the burning issue, we investigated the reaction of stock markets to coronavirus pandemic with data from the three major stock markets in Africa.

3 | MODEL, METHODOLOGY, DATA AND PRELIMINARY ANALYSIS

3.1 | Data

The datasets used in this study consist of stock market indexes of the three worst hit economies by the COVID-19 infections which incidentally match the three biggest stock exchanges in Africa. Data on the number of Covid-19 reported cases and deaths at the daily level is collected from the website https://ourworldindata.org/. The ranking of each country is listed in line with the total number of cases, deaths, daily confirmed cases and deaths. The datasets cover a period from 2 January 2020 to 30 June 2021. Then, daily stock market indexes data were downloaded from the www.investing.com historical data archive over a similar period. These countries are Nigeria, South Africa and Egypt. To get a consistent sample across countries, we used the data of only one major stock market index from each country. To capture the overall effects of COVID-19 on stock markets, we introduced a dummy variable, which takes value 0 from 2 January 2020 to 14 February 2020 for Egypt, 28 February 2020 for Nigeria and 5 March 2020 for South Africa. We also include covid-stringency index, which was sourced from the Oxford COVID-19 Government Response Tracker (OxCGRT) project (https://ourworldindata.org/covid-stringency-index). The project computes an Index for Stringency, which is a composite measure of nine of the response metrics, sourced from Our World in Data. The nine metrics used to compute the Stringency Index include closures of school and workplace; embargo on public events; restrictions on

TABLE 2 Countries details

Country	Stock index	The date the index COVID-19 case was confirmed	Observations
Nigeria	ASI	28 February 2020	381
South Africa	TOP 40	05 March 2020	382
Egypt	EGX 70 EWI	14 February 2020	378

Source: Authors' compilation.
Note: This table contains the sample countries, the stock market index employed for a country, the date for index COVID-19 case was confirmed in a country and the number of data observations from each country.

public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls.

The index on any given day is computed as the average score of the nine metrics, each taking a value between 0 and 100. A higher score indicates a stricter response (i.e. 100 = strictest response). If policies vary at the subnational level, then the index is shown as the response level of the strictest sub-region.[5] It has been submitted that the stringency index has a negative effect on stock market returns (Ashraf, 2020b). We examine the veracity of this claim by investigating the impact on the stock market returns of Egypt, Nigeria and South Africa. We applied certain filters to refine the data. We dropped observations with missing values because although COVID-19 data is available for each day since a country observed its first confirmed case, the stock markets data is not available for weekends or national gazetted holidays. In the case of Egypt, the stock exchange is opened from Sunday to Thursday, while in Nigeria and South Africa, the stock markets are opened from Monday to Friday. After applying the filters, our final dataset has 381, 382 and 378 observations for Nigeria, South Africa and Egypt respectively over the period from 2 January 2020 to 30 June 2021. Table 2 lists the countries, the stock market index chosen (the data of which was used for a country) and the number of daily data observations from each country. Besides, it also mentions the date when the first COVID-19 case was confirmed in a country. The data for any specific country in the sample starts from 2 January 2020.

3.2 | Model and methodology

The study adopts the same approach as those used by Narayan and Narayan (2005), Lee and Wang (2018) and Saboori et al. (2014). To enable us analyse the relationship between stock market index, growth in total COVID-19 cases, COVID-19-related deaths and covid-stringency index, the model below is proposed:

$$SM_t = \sigma_0 + \sigma_1 CoV_t + D_t + \mu_t \quad (1)$$

Where μ_t is the idiosyncratic error term, SMt is the dependent variable (here it is the stock market index for Nigeria, South Africa or Egypt), σ_0 is the constant, σ_1 is the slope coefficient of the model and CoV_t is a vector of independent variables (i.e. growth in total COVID-19 cases, deaths and covid-stringency index of daily cases) and D_t is a time dummy, which captures the structural effect of COVID-19 on the stock market. The dummy takes the value 0 for the period 2 January 2020 to the date before COVID-19 was first confirmed in a particular country and 1 otherwise.

We employed three cointegrating regression models for analyses—fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS) and canonical cointegrating regression (CCR). For lack of space, we provide explanations for the FMOLS method only (see Park, 1992; Saikkonen, 1992; Stock & Watson, 1993 for more details on CCR and DOLS methods, respectively). The FMOLS regression method was first employed in a study by Phillips and Hansen (1990) to present best estimation of cointegrating regressions. The method transforms OLS in order to eliminate the endogeneity challenges in the regressors, which result from the existence of cointegration relationship.

Likewise the FMOLS method reduces the challenges that emanate from the long-run correlation between the cointegrating equation and adjustments in the random regressor. The FMOLS estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference (Hansen, 2002). Let us look at the linear regression model below:

$$SM_t = \sigma_0 + \sigma_1 CoV_t + D_t + \mu_t \qquad t = 1, 2, ..., n, \quad (2)$$

where the K x 1 vector of I(1) regressors are not cointegrated themselves. Thus, CoV_t is process with stationarity at the first-differences which is stated as follows:

$$\Delta CoV_t = \eta + \upsilon_t, \qquad t = 2, 3, ..., n \quad (3)$$

TABLE 3 Summary statistics for Nigeria, South Africa and Egypt

	SMI	TC-19	DH-19	STRINDEX	DUMMY
Nigeria					
Mean	0.089853	3.157040	2.010157	0.561475	0.892388
Maximum	6.047828	132.1756	91.62907	82.92630	1.000000
Minimum	−5.032939	0.000000	0.000000	−25.12654	0.000000
Std. dev.	1.048626	10.63014	7.867766	6.759666	0.310297
Skewness	0.677768	7.839358	7.694780	8.737906	−2.532444
Kurtosis	10.27042	79.81883	71.12355	95.14685	7.413271
Jarque–Bera	868.3070	97582.90	77432.79	139643.6	716.4395
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	381	381	381	381	381
South Africa					
Mean	0.041969	3.784086	2.697020	0.800912	0.879581
Maximum	7.907103	109.8612	78.84574	160.8718	1.000000
Minimum	−10.45042	0.000000	0.000000	−46.52423	0.000000
Std. Dev.	1.665296	11.29862	6.838304	11.57304	0.325878
Skewness	−0.999080	6.386274	6.268576	9.274230	−2.332649
Kurtosis	11.38102	52.22360	55.02654	116.7441	6.441253
Jarque–Bera	1181.561	41162.11	45584.40	211401.5	534.9151
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	382	382	382	382	382
Egypt					
Mean	−0.092007	3.318506	2.562454	0.290638	0.920635
Maximum	5.752515	299.5732	69.31472	51.10056	1.000000
Minimum	−9.807850	0.000000	0.000000	−67.92497	0.000000
Std. dev.	1.485967	16.72152	7.492474	6.512462	0.270666
Skewness	−1.384120	15.11148	5.646588	0.633641	−3.112267
Kurtosis	12.21056	263.0763	41.32616	60.54366	10.68621
Jarque–Bera	1456.837	1,079,711.	25143.78	52177.85	1540.706
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	378	378	378	378	378

Note: SMI represents stock market index for each country, TC-19, DH-19 and STRINDEX stand for growth total confirmed COVID-19 cases, growth total COVID-19-related deaths and government stringency index.

in which η is a K x 1 vector of drift parameters and υ_t is a K × 1 vector of I(0), or stationary variables. It is assumed that $\zeta_t = (\mu_t, \upsilon_t')'$ is strictly stationary with zero mean and a finite positive-definite covariance matrix, Σ.

Two stages are involved in carrying out the calculation of FMOLS evaluation of σ. Stage one, *SMt* long-run interdependence of μ_t and υ_t is corrected. As a result $\widehat{\mu}_t$ is the OLS residual vector in Equation (1) and:

$$\zeta_t = \begin{pmatrix} \widehat{\mu}_t \\ \widehat{\upsilon}_t \end{pmatrix}, \qquad t = 2, 3, \dots, n, \qquad (4)$$

where $\widehat{\upsilon}_t = \Delta CoV_t - \widehat{\eta}$ for $t = 2, 3, \dots, n$ and $\widehat{\eta} = (n-1)^{-1} \sum_{t=2}^{n} \Delta CoV_t$.

A consistent estimator of the long-run variance of ζ_t is given by

$$\widehat{\varpi} = \widehat{\sum} + \widehat{\lambda} + \widehat{\lambda}' = \begin{bmatrix} \overset{\widehat{\varpi 11}}{1} \times 1^{\widehat{\varpi}_{11}} & \overset{\widehat{\varpi 21}}{1} \times k^{\widehat{\varpi}_{21}} \\ \overset{\widehat{\varpi 21}}{k} \times 1^{\widehat{\varpi}_{21}} & \overset{\widehat{\varpi 22}}{k} \times k^{\widehat{\varpi}_{22}} \end{bmatrix},$$

TABLE 4 Pearson correlation

	SMI	TC-19	DH-19	STRINDEX	DUMMY
Nigeria					
SMI	1.000000	−0.223331	−0.004892	−0.058900	0.027665
TC-19		1.000000	0.350563	0.346935	0.103268
DH-19			1.000000	−0.018625	0.088839
STRINDEX				1.000000	−0.057969
DUMMY					1.000000
South Africa					
SMI	1.000000	−0.262399	0.152876	−0.127870	0.044706
TC-19		1.000000	0.134132	0.250162	0.124083
DH-19			1.000000	−0.028687	0.146122
STRINDEX				1.000000	−0.086318
DUMMY					1.000000
Egypt					
SMI	1.000000	−0.174912	−0.146929	0.105726	0.015728
TC-19		1.000000	0.266875	0.080680	0.058346
DH-19			1.000000	0.156898	0.100549
STRINDEX				1.000000	0.013121
DUMMY					1.000000

Note: SMI represents stock market index for each country, TC-19, DH-19 and STRINDEX stand for growth total confirmed COVID-19 cases, growth total COVID-19-related deaths and government stringency index.

where $\widehat{\sum}=\frac{1}{n-1}\sum_{t=2}^{n}\widehat{\zeta}_t\widehat{\zeta}_t, \widehat{\lambda}= \sum_{s=1}^{m}w(s,m)\widehat{\Upsilon}_s, \widehat{\Upsilon}_s=n^{-1}\sum_{t=1}^{n-s}\widehat{\zeta}_t \widehat{\zeta}'_{t+s}$ and $w\ (s,m)$ is the lag of window with horizon m. Now let

$$\widehat{\delta}=\widehat{\sum}=+\widehat{\lambda}=\begin{bmatrix}\widehat{\delta}_{11} & \widehat{\delta}_{12}\\ \widehat{\delta}_{21} & \widehat{\delta}_{22}\end{bmatrix},$$

$$\widehat{Z}=\widehat{\delta}_{21}-\widehat{\delta}_{22}\widehat{\varpi}_{22}^{-1}\widehat{\varpi}_{21},$$

$$\widehat{SM}_t^{*}=SM_t-\widehat{\varpi}_{12}\widehat{\varpi}_t^{-1}\widehat{\upsilon}_t,$$

$$^{D}(k+1)\times k=\begin{bmatrix}\overset{0}{1}\times k^{0}\\ \overset{Ik}{k}\times k^{I_k}\end{bmatrix}.$$

In stage two, the FMOLS estimator of σ is given by

$$\widehat{\sigma}_{*}=(W'W)^{-1}\left(W'\widehat{SM}^{*}-nD\widehat{Z}\right),$$

where $\widehat{SM}^{*}=\left(\widehat{SM}^{*},\widehat{SM}^{*},...,\widehat{SM}_n^{*}\right)', W=(\tau_n, CoV)$, and $\tau_n=(1,1,...,1)'$. Therefore, the FMOLS estimator utilizes preliminary evaluations of the equality and the residuals of the one sided long-run covariance matrices.

3.3 | Preliminary analyses

3.3.1 | Descriptive statistics

Summary statistics such as average, maximum, minimum, standard deviation, skewness, kurtosis and Jarque–Berra are displayed in Table 3—panel A for Nigeria, panel B for South Africa and panel C for Egypt. We observed from Table 3 that, on the average, South Africa has the highest growth in the number of COVID-19 cases with 3.78, followed by Egypt with 3.32, while Nigeria has least average cases with 3.16 for the period 2 January 2020 to 30 June 2021. Similarly, in terms of fatalities, South Africa continues with the highest growth in the number of deaths reported on average with 2.70 deaths, followed by Egypt with 2.56 deaths and Nigeria with least at 2.01 deaths reported. On the other hand, Egypt recorded the largest amount of growth in the number of confirmed cases, followed by Nigeria and then South Africa at the maximum amount of 299.57, 132.18 and 109.86, respectively. The variation in the number of COVID-19 cases could be as result of how many tests are being carried out. In the case of covid-stringency index, it is observed that among the three countries, South Africa appear to be more restricted, followed by Nigeria and then Egypt. Furthermore, in terms of stock market returns, Table 3 shows that both South Africa and

Nigeria recorded positive average returns, while the Egyptian stock market recorded a negative stock returns on average within the period of investigation.

Further, Table 4 contains Pearson correlation coefficients between the series and is reported in panels A, B and C for Nigeria, South Africa and Egypt respectively. As expected, there is negative correlation between the stock market returns and the growth in total COVID-19 cases, deaths, covid-stringency, while the dummy variable shows a positive correlation for Nigeria. In the case of Egypt, Table 4 shows negative correlation between stock returns and the growth in COVID-19 cases and the covid-stringency index, whereas it is positive with growth in number of COVID-19 deaths and the dummy variable. In addition, stock market returns in South Africa is negatively correlated with the growth in number of COVID-19 cases and deaths, but positively correlated with the covid-stringency and the dummy variable. The negative relationships observed in Table 4 are further confirmed in Figures 1 and 2 for Nigeria, South Africa and Egypt, respectively. Looking at Figures 1 and 2, we observed that the stock markets in these economies started responding negatively ever before the COVID-19 outbreak was declared a global pandemic by the World Health Orgainsation (WHO) on 11 March 2020.[6] However, most stock markets around the world crashed following the announcement from the WHO. The vertical lines in the figures indicate the negative response of stock market to COVID-19 when these economies started recording cases and when it was declared a global pandemic in March 2020 by WHO.

3.3.2 | Unit root tests

First and foremost, it is conventional and also required to ascertain the order of integration for each series as the FMOLS approach is only applicable for series that are I(0) or I(1) or fractionally integrated. However, there is common knowledge in the literature that the processes of

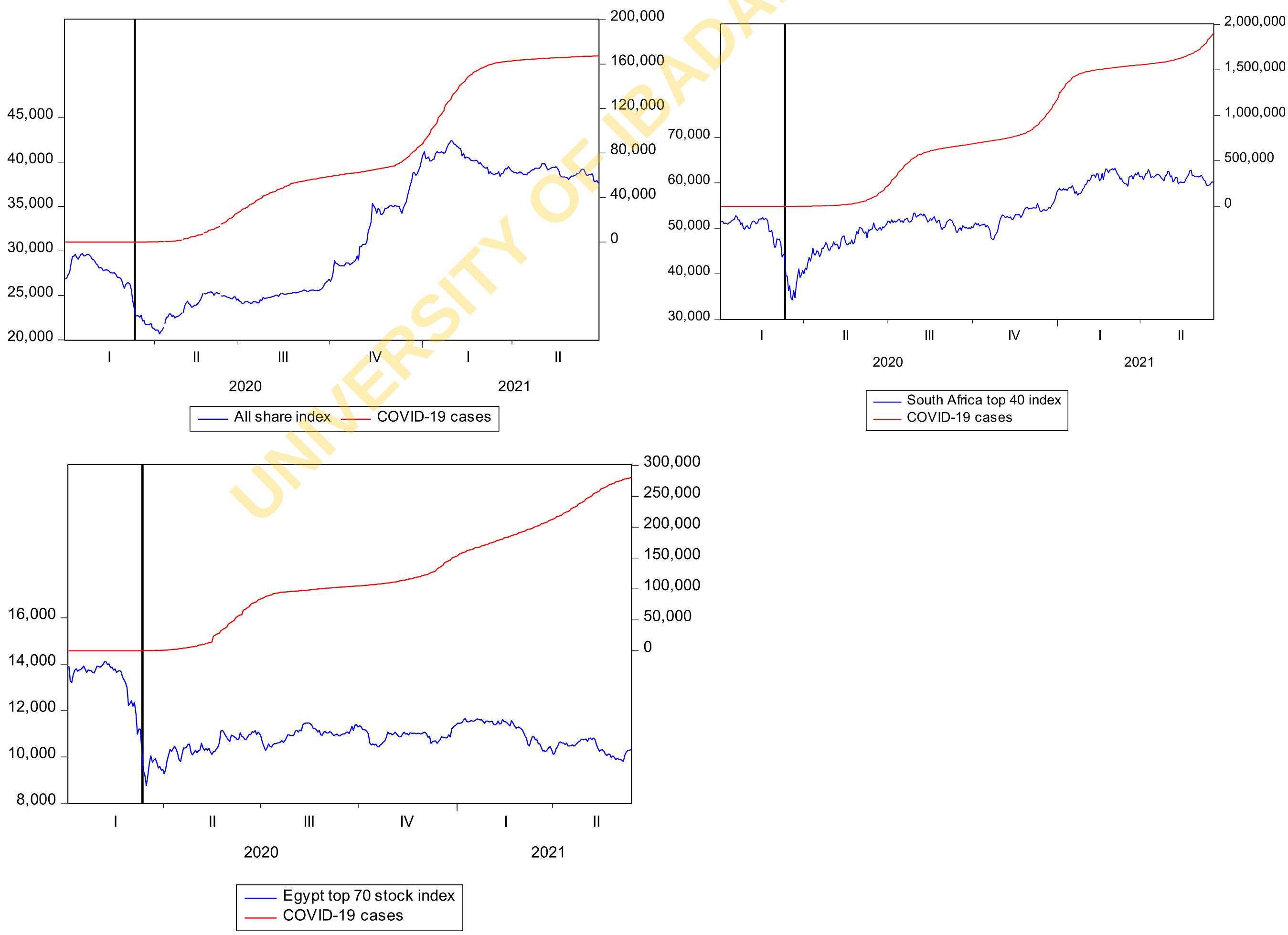

FIGURE 1 COVID-19 total cases, and stock market indices for Nigeria, South Africa and Egypt [Colour figure can be viewed at wileyonlinelibrary.com]

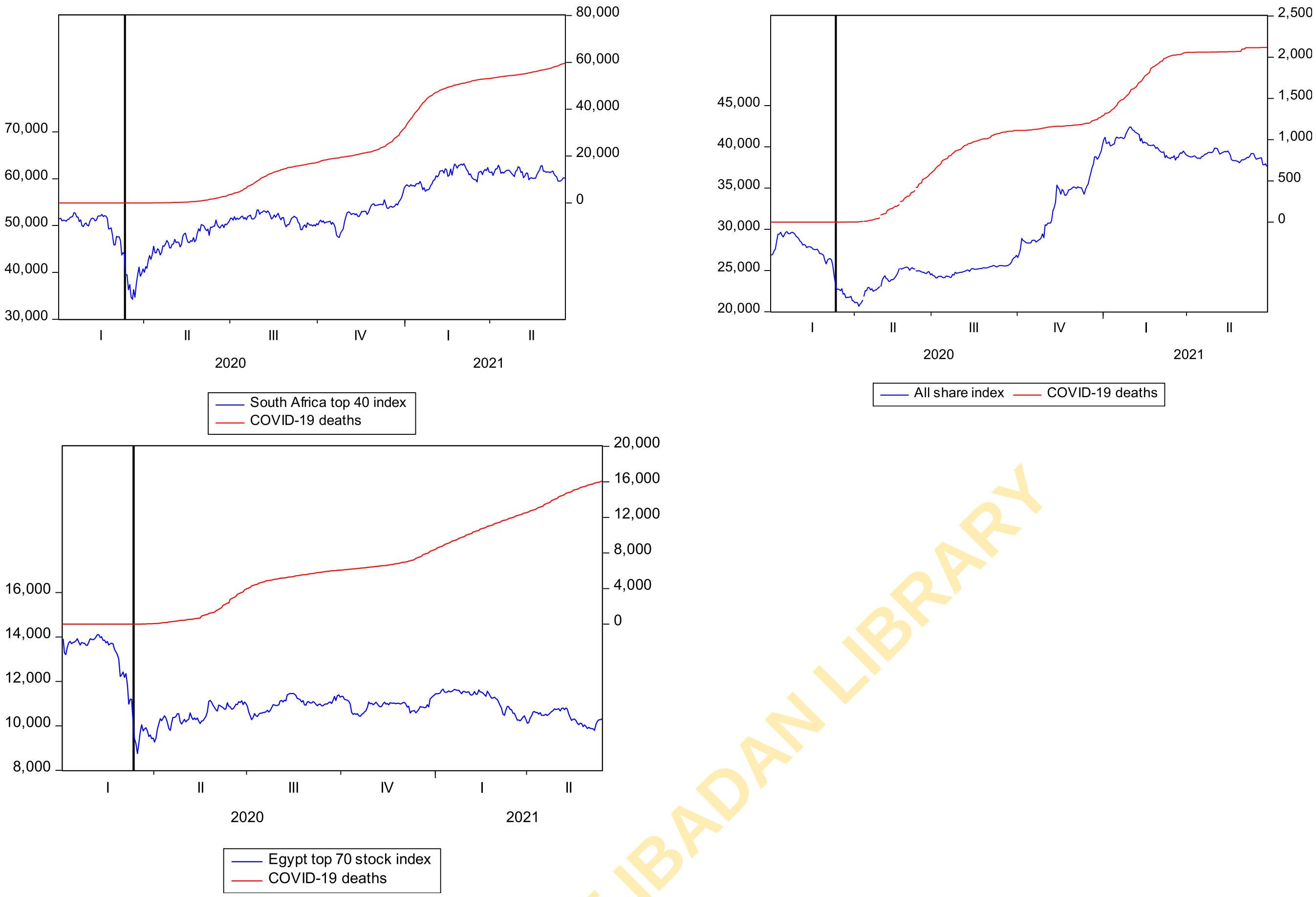

FIGURE 2 COVID-19 total deaths, and stock market indices for Nigeria, South Africa and Egypt [Colour figure can be viewed at wileyonlinelibrary.com]

data generation for various economic series are described by random movements leading to incorrect conclusion if the features of the data are not examined with great caution. A variable is adjudged stationary over time if its autocovariances and the mean are time independent, and the reverse is true for a non-stationary series, which means it has a unit root. In the literature, there are conventional techniques to test the stationarity of a series—the unit root test and the common tests available for individual time series are the Augmented Dickey–Fully (ADF) unit root test (Dickey and Fully, 1979; 1981), Phillips–Perron (PP) unit root test (Phillips & Perron, 1988), and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root test (Kwiatkowski et al., 1992). Also, to verify that the unit root detected for a particular series is not due to structural breaks, we adopted Perron (2006) test to account for structural breaks while testing for unit root.

Table 5 contains the results of ADF, PP, KPSS and Perron tests for unit root on the natural logarithms of the levels and first differences of the series for the three countries. The outcomes indicate that some of the variables are stationary at the level I(0), while others are at the first difference, which signifies I(1) order of integration. For the KPSS, it tests the null hypothesis that the series has no unit root—indicating stationarity of the series, whereas the alternative hypothesis, states that the variable non-stationary (has a unit root).[7] Therefore, from the unit root results, there is no evidence of I(2) for all the series, thus confirming the suitability of FMOLS, DOLS and CCR approaches for the long run association between stock market and COVID-19. The results for the three methods—FMOLS, DOLS and CCR for Nigeria, South Africa and Egypt are reported in Table 7.

Further, the break analysis for the three countries shows that Nigeria had a break point on 23 March 2020, South Africa had its break point on 12 March 2020 and Egypt had a break point on 23 February 2020.

4 | RESULTS

4.1 | Cointegration test

The non-stationarity of two or more variables may be made stationary in a linear combination (Engle &

TABLE 5 Unit root test results—conventional and break point unit root tests

Tests	ADF(l)	ADF(D)	PP(l)	Pp(D)	KPSS(l)	KPSS (D)	Unit root with break test	Break date
Nigeria								
SMI	−9.5744***	–	−15.4932***	–	0.2388	0.5000**	3037.118**	3/23/2020
TC-19	−3.3901**	−7.5310***	−18.5871***	–	0.6777**	0.2545		
DH-19	−2.8023*	−21.6455***	−22.6864***	–	0.5119**	0.4803**		
STRINDEX	−8.3122***	–	−19.4180***		0.4786**	0.1863		
DUMMY			−2.9034**	−19.4679***	0.8774***	-		
South Africa								
SMI	−20.3841***	–	−20.4193***	–	0.0831	0.0029	−21.8638***	3/12/2020
TC-19	−3.6358***	−10.9577***	−14.7917***	–	0.6416**	0.0315		
DH-19	−3.1045**	−25.4773***	−17.0280***	–	0.6216**	0.0760		
STRINDEX	−5.2869***	–	−19.4779***	–	0.4571*	0.0826		
DUMMY	−2.7213*	–	−2.7212*	–	0.9551***	–		
Egypt								
SMI	−14.9228***	–	−14.7095***	–	0.2620	0.1958	794.5877***	2/23/2020
TC-19	−6.0534***	–	−19.3636***	–	0.6951**	0.0639		
DH-19	−2.4228	−9.3926***	−16.7246***	−54.3400***	0.6088**	0.0290		
STRINDEX	−5.8792***	–	−17.7080***	–	0.3138	0.0769		
DUMMY	−3.4499***	–	−3.4497***	–	0.7003**	0.2626		

Notes: 1. SMI represents stock market index for each country, TC-19, DH-19 and STRINDEX stand for growth total confirmed COVID-19 cases, growth total COVID-19-related deaths and government stringency policy index. 2. (*l*) and (*D*) represent unit root tests at level and the first difference.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

Granger, 1987). The existence of stationary linear combination is an indication that there is cointegration among the non-stationary time series, resulting in long-run equilibrium among the series. In this study, we employ the Johansen conintegration test (Johansen, 1988). The rationale for our choice is that the Johansen approach is more efficient than other cointegration test, e.g. Engle-Granger single equation test method since the maximum likelihood procedure has useful large and finite sample features (Cheung & Lai, 1993). Also, it uses two ratio tests, a trace test and a maximum eigenvalue test, to test the number of cointegrated relationships. However, in the event of disparity in results between the trace statistics and maximum eigenvalue statistics, preference is accorded to the result of the maximum eigenvalue test because of the advantage of performing separate tests on each eigenvalue.

Johansen cointegration test results are documented in Table 6, panel A is for Nigeria, panel B for South Africa and panel C for Egypt. It is seen from Table 6 that both the trace test and maximum Eigen statistic test shows there exist at least two cointegrating equations at the 5% level and the maximum eigenvalue test also further signifies the existence of at least two cointegrating equation for all three economies. Hence, we conclude that the null hypothesis of no cointegration among the series is rejected at the 5% level. Therefore, based on the Johansen cointegration test results in Table 6, we inferred the existence of a long-run equilibrium association between stock market returns and COVID-19 (proxied by the growth in total number of confirmed cases and number of deaths) and covid-stringency index in Nigeria, South Africa and Egypt.

4.2 | Empirical results

The results for the three methods (FMOLS, DOLS and CCR) and for the three countries are reported in Table 7. Two models are estimated for each of the methods; the first model captures the growth in COVID-19 cases, while the second model captures the growth in COVID-19 deaths. The results for Nigeria as shown in panel A of Table 7 indicate that the growth in total reported cases of

TABLE 6 Johansen's cointegration test

Number of CE(s)	Trace statistic	Maximum-Eigen statistic
Nigeria		
$r = 0$*	212.2516***	96.96589***
$r \leq 1$*	115.2857***	65.18434***
$r \leq 2$*	50.10138***	31.85890***
$r \leq 3$	18.24248**	9.747075
$r \leq 4$	8.495408***	8.495408***
South Africa		
r = 0*	397.0631***	167.9522***
r ≤ 1*	229.1109***	112.7695***
r ≤ 2*	116.3414***	93.72500***
r ≤ 3	22.61638***	14.58643**
r ≤ 4	8.029946***	8.029946***
Egypt		
$r = 0$*	304.3768***	139.9246***
$r \leq 1$*	164.4523***	90.19990***
$r \leq 2$*	74.25235***	49.58170***
$r \leq 3$	24.67065***	13.71899*
$r \leq 4$	10.95166***	10.95166***

Note: Trace and Maximum-eigenvalue tests indicate 4 cointegrating equation(s) at the 5% level.
*Significance at less than 10% level of the cointegrating equation.
**Significance at less than 5% level of the cointegrating equation.
***Significance at less than 1% level of the cointegrating equation.

COVID-19 has negative and statistical significant impact on stock market returns for all the three methods. An increase in the cumulative cases of coronavirus led to decrease in the Nigerian stock market returns when considering the FMOLS and DOLS models. Similar to the FMOLS model, the CCR model showed that as the total coronavirus cases in Nigeria increase, the NSE stock returns will decrease. In terms of level of significance, the results showed that all the coefficients on the growth in total COVID-19 cases are statistically significant at the one and five percentage levels. On the contrary, growth in the cases of fatalities (deaths from COVID-19) has positive impact on the stock market returns in the case of DOLS, but show negative relationship when we consider the FMOLS and CCR models. However, the results are not statistically significant in all the models. Next, the results for the covid-stringency index reveals a negative association with stock market returns in the each of the second equations (i.e. equations with COVID-19 deaths) for all models. This shows that the growth in number COVID-19 cases and government restraining polices have adverse impact on the financial market in this country. As COVID-19 cases surges, the stock market returns deteriorates. These results are consistent with the findings in prior studies such as Ashraf (2020b), Størdal et al. (2021), and Yang and Deng (2021). Further, as stated in the methodology section, we introduced dummy variable in our model to account for structural change caused by COVID-19. The dummy variable is a binary variable, 0 for the period before a COVID-19 case was first confirmed in the reported country and 1 for the period from the date a case was first reported. The results from the dummy variable indicate that there is positive and statistically significant effect of COVID-19 on stock market returns. This implies that the outbreak of coronavirus has caused a structural shift in the Nigerian stock market.

Further, panel B Table 7 contains the results for the South African stock market. Consistent with a priori expectations and extant studies, the results for South Africa show a negative relationship between the stock market returns and the growth total COVID-19 confirmed cases for all models in all three methods (FMOLS, DOLS and CCR). A rise in the growth in total number of COVID-19 cases deteriorates the South African stock market returns in all three models. Statistically, the coefficients on the FMOLS and CCR are significant at 1% conventional level, while it is significant at the 5% significance level for the DOLS model. Further, when we consider the growth in the number fatalities, the results show that as the number of deaths increases, the stock market returns in South Africa improves. For the FMOLS model, COVID-19-related death cases cause the stock market returns to appreciate from a rise in the number of deaths, and this is statistically significant at the 1% level. For the DOLS model, rise in coronavirus related death will give rise to a rise in the stock market, but it is statistically insignificant. In the CCR model, an increase in the COVID-19 death related cases causes the stock market in South Africa to increase at the 1% level of significance. Moreover, similar to COVID-19 cases, the covid-stringency index has negative and high significant relationship with the stock market returns in all three models with COVID-19-related deaths. The results indicate that as the government becomes more restrictive in order to curtail the spread of the virus, stock market returns deteriorates. Again, the results for South Africa showed evidence of positive structural change as a result of the advent of coronavirus. This is validated by the outcomes from the dummy variable. The results from the dummy variable on the three models show that the South Africa stock market has recovered from the negative impact by the outbreak of coronavirus pandemic. Again our results are in line with the findings in prior studies such as Ashraf (2020b), Størdal et al. (2021), and Yang and Deng (2021).

TABLE 7 Results of cointegrating regression analysis

Estimation methods	FMOLS (1)	FMOLS (2)	DOLS (1)	DOLS (2)	CCR (1)	CCR (2)
Nigeria						
TC-19	−0.0317***		−0.0269**		−0.0324***	
	(0.0070)		(0.0125)		(0.0112)	
DH-19		−0.0101		0.0162		−0.0189
		(0.0090)		(0.0155)		(0.0127)
STRINDEX	−0.0059	−0.0246**	−0.0021	−0.0582***	−0.0162	−0.0392***
	(0.0103)	(0.0101)	(0.0194)	(0.0188)	(0.0174)	(0.0141)
DUMMY	0.5316**	0.2504	0.4062	0.4207**	0.5426**	0.3196
	(0.2627)	(0.2667)	(0.3130)	(0.1777)	(0.2758)	(0.2709)
Cointegrating equation	0.0831	0.1131	0.0198	−0.1109	0.1048	0.1466
Deterministics	(0.2016)	(0.2089)	(0.2258)	(0.1168)	(0.1994)	(0.2065)
R^2	0.045		0.076	0.289	0.029	
Adj-R^2	0.035		0.059	0.217	0.019	
Cointegration	26.7744***	8.8215	7.9821*	17.7704***	21.2615***	11.6437**
Coefficient Diagnostic[a]	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4
Cointegration Test[b]	75.8796***	579.9367***	0.0087	0.0135	1.5454***	2.7623***
Normality	756.5438***	864.0729***	850.4656***	1860.525***	730.1034***	823.4328
South Africa						
TC-19	−0.0548***		−0.0342**		−0.0578***	
	(0.0051)		(0.0146)		(0.0063)	
DH-19		0.0524***		0.0346		0.0579***
		(0.0079)		(0.0211)		(0.0100)
STRINDEX	−0.0063	−0.0171***	−0.0246	−0.0474***	−0.0054	−0.0173**
	(0.0044)	(0.0042)	(0.0212)	(0.0178)	(0.0080)	(0.0073)
DUMMY	0.8360***	−0.0248	0.8331**	0.1479	0.8799***	−0.0773
	(0.1997)	(0.1936)	(0.3712)	(0.3650)	(0.2049)	(0.2002)
Cointegrating equation	−0.0353	−0.1647	−0.1244	−0.2126	−0.0321	−0.1651
Deterministics	(0.1442)	(0.1417)	(0.2500)	(0.2404)	(0.1426)	(0.1397)
R^2	0.092	0.039	0.255	0.122	0.090	0.037
Adj-R^2	0.082	0.029	0.228	0.091	0.081	0.027
Cointegration	136.8334***	71.3119***	13.3831***	13.3606***	103.4659***	48.9836***
Coefficient diagnostic[a]	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4
Cointegration test[b]	1360.722***	160.5318***	0.0134	0.0239	6.9143***	2.5087***
Normality	608.6728***	922.4290***	180.9223***	973.9660***	623.2225***	900.9862***
Egypt						
TC-19	−0.0203***		−0.0661***		−0.0270***	
	(0.0053)		(0.0105)		(0.0059)	
DH-19		−0.0338***		0.0596**		−0.0504***
		(0.0103)		(0.0253)		(0.0134)
STRINDEX	0.0242*	0.0305***	0.0583*	−0.0647*	−0.0071	0.0280*
	(0.0133)	(0.0110)	(0.0337)	(0.0363)	(0.0140)	(0.0156)
DUMMY	−0.0944	−0.0360	0.3825	−0.6248	0.1420	0.1754
	(0.3682)	(0.3100)	(0.2713)	(0.4059)	(0.2938)	(0.3179)

TABLE 7 (Continued)

Estimation methods	FMOLS (1)	FMOLS (2)	DOLS (1)	DOLS (2)	CCR (1)	CCR (2)
Cointegrating equation	−0.0018	0.0298	0.0364	−0.0207	−0.0208	−0.0037
Deterministics	(0.3088)	(0.2541)	(0.1451)	(0.3214)	(0.2416)	(0.2544)
R^2	0.045	0.041	0.271	0.157		0.033
Adj-R^2	0.035	0.030	0.218	0.096		0.022
Cointegration	19.4385***	18.6810***	40.2759***	7.4734	23.3132***	15.8595***
Coefficient diagnostic[a]	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4	DF = 4
Cointegration test[b]	65.9113***	586.0938***	0.0135	0.0231	1.6842***	1.5326***
Normality	1089.797***	936.4304***	275.7674***	428.0716***	1069.313***	925.2267***

Notes: TC-19, DH-19 and STRINDEX stand for growth total confirmed COVID-19 cases, growth total COVID-19-related deaths and government stringency policy index.

Abbreviation: DF, degree of freedom; FMOLS, fully modified OLS; DOLS, dynamic OLS; CCR, canonical cointegrating regression.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

[a]Cointegration coefficient diagnostic test has been conducted by Wald test.

[b]Cointegration test has been conducted by Hansen parameter instability test for the null hypothesis (null hypothesis: series are cointegrated). Standard errors of the coefficients are reported in brackets.

Finally, we present the results for the Egyptian market in panel C of Table 7. Consistent with the findings for Nigeria, panel C Table 7 indicates that for all the three methods—FMOLS, DOLS and CCR, there is a negative and very high significant relationship between the growth in total number of COVID-19 reported cases and stock market returns in Egypt. An increase in the growth in the total number of COVID-19 cases will cause the stock market in Egypt to fall when the FMOLS, DOLS and CCR models are considered. These results are statistically significant at 1% for the three methods, respectively. Further, as found for Nigeria, the results for Egypt indicate that there are negative relationships between the stock market returns and the growth in the number of reported COVID-19-related deaths for the FMOLS and CCR models, but the relationship is positive when we consider the DOLS model. In terms of fatalities, a rise in COVID-19 deaths-related cases causes the stock market in Egypt to drop for the FMOLS and CCR models, respectively, but improves in the case of DOLS models and are all statistically significant at the 5% conventional level. On the other hand, and contrary to the results for Nigeria and South Africa, we find that there is a positive relationship between the covid-stringency and the stock market returns in Egypt. This means that the growth of government control measures to contain the virus will results to rise in the stock market in Egypt. Further, based on the results from the dummy variable, we do not find evidence of a structural change emanating from the outbreak of COVID-19.

On the whole, our results are consistent with other scholars' findings in the literature. For example, Alber (2020) found the similar outcomes in a study for worst six countries hit by the COVID-19 pandemic. He reported that stock market returns appears to more responsive to COVID-19 cases than deaths and COVID-19 cumulative cases than new ones. Al-Awadhi et al. (2020) investigated the impact of Coronavirus infected cases and fatalities on stock market returns in two stock exchanges in China (Hang Seng Index and Shanghai Stock Exchange Composite Index), they documented that daily growth in total reported cases and total death as a result of Coronavirus significantly have an inverse effect on stock returns of all companies.[8] Also, Elsayed and Abd Elrhim (2020) found that at the sectoral level, sectors' stock market returns are more sensitive to cumulative deaths than daily reported deaths from COVID-19 and the responsiveness is more to new COVID-19 cases than the cumulative cases. Further, Ru et al. (2020) who studied the different responses of stock markets to the 2003 SARS and Coronavirus reported that countries that did not experience the 2003 SARS do not have timely and strong reactions to the current pandemic (COVID-19).

5 | CONCLUDING REMARKS

This study examined the impact of COVID-19, government stringency and lockdown policy on the stock markets of the three worst hit economies in Africa. These are Nigeria, South Africa and Egypt. For the purposes of robustness, we employed three cointegrating regression models, that is, FMOLS, DOLS and CCR. Our study is novel in the literature as it investigated the impact of the growth in COVID-19-related cases and deaths, covid-stringency and lockdown policy on the stock markets of the most affected economies in Africa. The empirical analyses show that in the case of Nigeria, we found that the stock market was more responsive to the growth in total number of reported cases of COVID-19 and covid-stringency policy than the growth in the COVID-19 death. Further, we also confirmed evidence of positive structural shift as a result of the outbreak of the novel coronavirus. From our findings, we can conclude that the stock market in Nigeria has recovered from the negative response when the coronavirus was declared a global pandemic in March 2020.

Moreover, in the case of South Africa, similar to Nigeria, the stock market also responded negatively to the growth in confirmed COVID-19 cases and covid-stringency index, but positively to the growth in fatalities cases of coronavirus. Also, there was strong evidence for positive structural change on the South African stock market occasioned by the spread of COVID-19. Also, following our findings, we can conclude that the stock market in South Africa has rebounded from the crash it experienced during the period of March 2020. Last for Egypt, our results indicate that the stock market is responding significantly negative to the two COVID-19 indicators—growth in total confirmed cases and mortality cases. Nonetheless, we do not find evidence of structural change in the Egyptian stock market.

CONFLICT OF INTEREST

We affirm that there is no existing conflict of financial interests or individual associations likely to affect this paper.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article

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ENDNOTES

[1] See the section on data and methodology for details on the covid-stringency index.

[2] Zach (2003) argued that major events may significantly affect stock market.

[3] Severe Acute Respiratory Syndrome of 2003.

[4] Others include Topcu and Gulal (2020), Ali et al. (2020), Diaz et al. (2022) and Drake (2022).

[5] It is important to note that this index simply records the strictness of government policies. It does not measure or imply the appropriateness or effectiveness of a country's response. A higher score does not necessarily mean that a country's response is 'better' than others lower on the index.

[6] A plausible reason could be investors' speculation and withdrawal of foreign investors from these emerging markets.

[7] In KPSS test, probability values for rejection of the null hypothesis are based on Kwiatkowski et al. (1992) LM statistic p-values.

[8] Similar studies include Størdal et al. (2021); Yang and Deng (2021), Ashraf (2020a, 2020b), Baker et al. (2020), Okorie and Lin (2021), Onali (2020), Ramelli and Wagner (2020), among others.

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