# Stock markets' reaction to COVID-19: Analyses of countries with high incidence of cases/deaths in Africa ☆

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## ARTICLE INFO

## ABSTRACT

Exploring daily panel dataset spanning January 5, 2015 to January 28, 2021, we examine the reaction prowess of African stock markets to the different phases of the COVID-19 outbreak namely, pre–COVID period; epidemic period; and pandemic period. We show that irrespective of the different phases of the COVID-19 outbreak, South Africa ranked first as the country with the highest incidence of COVID-19 in Africa both in terms of number of confirmed cases and deaths. However, while Morocco and Tunisia ranked second and third in terms of the number of COVID-19 cases, it was Egypt that ranked second in terms of the number COVID-19 deaths. Employing a PMG –based panel–ARDL model, we offer evidence –based insights on the dynamic of stock markets during COVID-19. We show that number of confirmed cases rather than number deaths tend to be responsible for the declining stock returns in Africa during the pandemic phase of the COVID-19 outbreak. Whereas, the evidence of declining stock returns during the epidemic phase of the COVID-19 appears to be mainly attributable to changes in the international oil prices and exchange rates, respectively. That said the effectiveness or otherwise of efforts at minimizing negative reaction of stock returns to COVID-19 cannot be in isolation of whether the emphasis is on the number of confirmed cases and/or the number of confirmed deaths.

## Introduction

There is no gainsaying that investors throughout history have had to contend with the prospect of financial market crisis, which is usually attributed to pro-cyclical changes in the supply of credit [41]. Classical examples include the 1997 Asian Financial Crisis, 2008 Global Financial Crisis, and 2016 European debt crisis. However, despite the fact the recent COVID-19 pandemic did not start off as a financial crisis, its effect on financial market and economy has been predicted as likely to have as far reaching effects as those attributed to conventional financial crises (see [39,25]). For instance, as the WHO and other public health officials communicate the number of confirmed cases as well as the risk of the COVID-19 outbreak to

the general public, investors are likely to shape their sentiments towards the disease, which in turn is capable of influencing the stock markets [42]. Supporting this position is the view that the frequency of stock market jumps during the different stages of COVID-19 is attributable to the increasingly rapid diffusion of news of the pandemic (see [25,46,11,12,9]).

Despite the COVID-19 outbreak only here for two years, there has been proliferation of empirical literature on the potential effects of the pandemic on financial markets, which may not be unconnected to the continual high market risk and the heightened uncertainty engendered by the pandemic. Essentially, there has been growing hypothesis linking the recent widespread declining trends in the stock markets to the COVID-19 outbreak ([39,14,47,43,35,2]; Baig et al. 2020; ). However, the bulk of these extant studies predominantly focused on the case of developed and some emerging economies, where the severity and degree of the spread of the virus seems relatively more pronounced. On the contrary, there has been dearth of empirical literature particularly in the context of developing African countries partially due to the relatively low number of COVID-19 cases in the continent. When COVID-19 struck in China and rapidly spread to the other parts of the world, it was widely hypothesized that the spread of the pandemic would be devastated in Africa. But, as at January 20, 2021, countries in Africa are only responsible for 3.45 per cent of the infections around the world. Consequently, the extant literature in the context of African economies has been at best ad-hoc in nature with emphasis on whether the relative low cases of COVID-19 in Africa are a myth or reality.

That is, while acknowledging the vastness of empirical literature on the economic implications of COVID-19 particularly from financial markets channel (see [41,13,45,5,6,24,36,20,36,30,19]), only few of the extant studies considered the case of stock markets in Africa (see for example, [28,23,42,31]). Motivated by the dearth of empirical literature from the viewpoint developing African countries; coupled with the fact that the choice of policy –mix and strategies seeking to mitigate the potential adverse effects of the pandemic on financial markets is likely to varies for different economies and regions, this study contribute to the literature in twofold.

First, none of the few existing literature on the case of African economies considered the likelihood of the stock markets responding differently to increasing incidence of confirmed cases of COVID-19 compared to confirmed number of death. Taken cognisant of the limited resources available to African countries to cope with the potential devastating impacts of the pandemic on her financial markets, it does become imperative to understanding which dimension of the pandemic is capable causing such devastating effects on the continents' stock markets. Secondly, we partition the sample coverage into different sub-samples, and the essence is to offer evidence –based insights on which phases of the COVID-19 outbreak is capable of intensifying the wide spread hypothesis of declining response of stock markets to COVID-19. More importantly, we explore the PMG –based PARDL to innovatively capture both the short and long run dynamics of the reaction of stock markets to COVID-19 outbreak.

The outline of the remaining sections is as follows: Section 2 briefly reviews findings from the previous studies. Section 3 explains the data and offers some preliminary analyses. Section 4 explains the econometric framework. Section 5 presents the empirical finding of the study, while Section 6 concludes the paper.

## Brief literature review

Even before the recent outbreak of COVID-19 disease, the nexus between stock markets and pandemic diseases for instance Severe Acute Respiratory Syndrome (SARS) as well as Ebola Virus Disease (EVD) have long been investigated in the literature (see [17,16,8,44,7,22,18,27]). Partially due to the severity of the economic implications of the COVID-19 compared to the previous variant of pandemic diseases, there has been improving efforts in the literature to understand the economic consequences of the recent outbreak of COVID-19, particularly from the viewpoint of financial markets. Quite a number of the empirical literature examines the effects of COVID-19 on financial markets from the perspective of connectedness or interdependence feature of the financial markets. Bouri et al. [11]a for example, explore the TVP-VAR connectedness approach to reveal disturbing effects of COVID-19 outbreak on the structure and time-varying patterns of return connectedness across different asset classes. In the case of Bouri et al. [12]b, they explore a predictive approach to show that incorporating EMVID into a forecasting setting significantly enhances the forecast accuracy of oil realize volatility during the unprecedented episode of uncertainty resulting from the COVID-19 outbreak.

In another development, Youssef et al. [46] investigates the case eight countries where COVID-19 was most widespread.[1] Using a nonlinear framework, the study shows that the dynamic of connectedness amongst stock markets in the investigated economies were more pronounced for negative than positive returns. This submission also finds support in Guo et al. [25] conclusion from their analyses of the global stock markets in connection with COVID-19, where it was reported that the degree of correlation among the global stock markets is higher with the spread of COVID-19. Alqaralleh and Alessandra [4], Camillo and Gradojevic [15], Abuzayed et al. [1], and Shahzad et al. [40], are some of the studies whose findings further confirms the COVID-19 outbreak alter the dynamics of connectedness between/amongst financial markets. In sum, Seven and Yılmaz [39] while considering the subject matter from the global point of view concludes, that the severity of the COVID-19 outbreak has further worsened the poor recovery processing of world equity markets.

Indeed, the financial market remains the barometer to measuring the stability or otherwise of an economic. Thus, beyond the question of whether the COVID-19 outbreak has led to the altering of the dynamic of connectedness among the various

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[1] China, Italy, France, Germany, Spain, Russia, the US, and the UK

**Table 1**

List of countries with high incidence of COVID-19 Cases and Deaths as of 20th January 2021.

| Countries with high incidence of COVID-19 Cases | | | | Countries with high incidence of COVID-19 Deaths | | | |
|---|---|---|---|---|---|---|---|
| Rank | Countries | No. of Cases | % of Total | Rank | Countries | No. of Deaths | % of Total |
| 1 | South Africa | 1369,426 | 40.77 | 1 | South Africa | 38,854 | 47.46 |
| 2 | Morocco | 462,542 | 13.77 | 2 | Egypt | 8747 | 10.68 |
| 3 | Tunisia | 188,373 | 5.61 | 3 | Morocco | 8043 | 9.82 |
| 4 | Egypt | 158,963 | 4.73 | 4 | Tunisia | 5921 | 7.23 |
| 5 | Ethiopia | 132,034 | 3.93 | 5 | Algeria | 2849 | 3.48 |
| 6 | Nigeria | 114,691 | 3.41 | 6 | Ethiopia | 2044 | 2.50 |
| 7 | Libya | 111,124 | 3.31 | 7 | Kenya | 1736 | 2.12 |
| 8 | Algeria | 102,606 | 3.05 | 8 | Libya | 1715 | 2.09 |
| 9 | Kenya | 99,444 | 2.96 | 9 | Sudan | 1603 | 1.96 |
| 10 | Ghana | 58,431 | 1.74 | 10 | Nigeria | 1478 | 1.81 |
| 11 | Zambia | 40,949 | 1.22 | 11 | Zimbabwe | 879 | 1.07 |
| 12 | Uganda | 38,628 | 1.15 | 12 | DR Congo | 642 | 0.78 |
| 13 | Namibia | 31,253 | 0.93 | 13 | Zambia | 585 | 0.71 |
| 14 | Zimbabwe | 29,408 | 0.88 | 14 | Senegal | 546 | 0.67 |
| 15 | Mozambique | 29,396 | 0.88 | 15 | Cameroon | 455 | 0.56 |
| 16 | Cameroon | 28,010 | 0.83 | 16 | Angola | 444 | 0.54 |
| 17 | Sudan | 26,279 | 0.78 | 17 | Eswatini | 407 | 0.50 |
| 18 | Ivory Coast | 25,597 | 0.76 | 18 | Mauritania | 407 | 0.50 |
| 19 | Senegal | 23,642 | 0.70 | 19 | Ghana | 358 | 0.44 |
| 20 | DR Congo | 21,308 | 0.63 | 20 | Malawi | 353 | 0.43 |

Source:https://www.statista.com/statistics/1170463/coronavirus-cases-in-africa/.

Note: The number of total confirmed cases of COVID-19 in Africa was 3358,823 as 20th of January 2020, while the number of COVID-19 deaths in Africa was 81,863 as at 20th of January 2020.

classes of assets; efforts has also been committed to validate the hypothesis of declining equity (stock) returns during crisis and turbulent periods in the context of COVID-19 outbreak (see [41,32,29,26,5]). Using the case of European stock markets, Aslam et al. [6] attribute the recent declining in the intraday efficiency of European stock markets to the growing cases of COVID-19. On the other hand, however, Garcin is of the view that the COVID-19 pandemic has had more effect on the US stock market than on Asian and Australian stock markets. Deciphered from these varying conclusions is that the reaction of stock markets to COVID-19 is not uniform across regions and countries (see [45,9,35,24,36,47,20,36,30,19,2,21]).

However, and partially due to relatively low number of cases of COVID-19 in developing African countries, the vast of the literature on the subject matter predominantly focus on the case of developed and some emerging economies. Although, Iyke and Ho [28]; Erdem [23]; Takyi and Bentum-Ennin [42]; and Omane-Adjepong and Alagidede [31] are some of the notable exceptions, but none of these studies to the best of our knowledge consider the potential of stock returns reacting differently to number of COVID-19 confirmed cases compared to number of COVID-19 confirmed deaths. Thus, in addition to considering the sample of African countries with sizable number of incidence of COVID-19, this study innovatively capture the short and long run dynamics of the reaction of stock markets to COVID-19 differently for number of confirmed cases compared to number of deaths and across different phases of the COVID-19 outbreaks.

## Data and preliminary analysis

### Data description and source

As of 20th January 2021, the total confirmed COVID-19 cases and deaths in Africa is **3**358,823 and 81,863, respectively. Table 1 presents the list of twenty (20) African countries with high incidence of COVID-19 cases and deaths as obtained from the website (www.cdc.gov) of the Centre for Disease Control and Prevention (CDC). The list also ranked countries according to the number of cases and deaths reported respectively. Morocco is the country where the African first case of COVID-19 was confirmed, precisely on the 2nd of February 2020; however, South Africa with no reported case of COVID-19 until 5th of March 2020 and has consistently ranked as the country with the most reported COVID-19 cases and COVID-19 deaths, respectively.

In addition, an interesting observation of the table is the fact some countries not listed amongst the countries with high incidence of COVID-19 cases, yet emerged as among the 20 countries with high incidence of COVID-19 deaths. Hence, our motivation to test the potential of stock markets reacting differently to number of COVID-19 confirmed cases compared to number of COVID-19 deaths. Due to data limitations, our empirical strategy is only able to cover 12 countries, namely Cote d'Ivoire, Egypt, Ghana, Kenya, Morocco, Namibia, Nigeria, Senegal, South Africa, Tunisia, Uganda, and Zambia. Table 2 show the various stock market indices explore as a proxy for stock market performance in each of these countries.

The BRVM Composite Index (BRVMCI) is used in the case of Cote d'Ivoire, the Egyptian Exchange EGX 30 Price Index (EGX30) in the case of Egypt, and the GSE Composite Index (GSE-CI) for Ghana. Others are Kenya NSE 20 Index (NSE20), Moroccan All-Share Index (MASI) for Morocco, FTSE NSX Overall (FTN098) for Namibia, the NSE All-Share Index (NSEINDEX)

**Table 2**
Sample information.

| Country | Stock index | COVID-19 Indicator | |
| --- | --- | --- | --- |
| | | First confirmed case | First confirmed death |
| Cote d'Ivoire | BRVMCI | 11–03–2020 | 29–03–2020 |
| Egypt | EGX30 | 14–02–2020 | 08–03–2020 |
| Ghana | GSE-CI | 14–03–2020 | 21–03–2020 |
| Kenya | NSE20 | 13–03–2020 | 26–03–2020 |
| Morocco | MASI | 02–02–2020 | 10–03–2020 |
| Namibia | FTN098 | 14–03–2020 | 10–07–2020 |
| Nigeria | NGSEINDEX | 28–02–2020 | 23–03–2020 |
| Senegal | TTLS | 03–02–2020 | 01–04–2020 |
| South Africa | JTOPI | 05–03–2020 | 27–03–2020 |
| Tunisia | UNINDEX | 04–03–2020 | 19–03–2020 |
| Uganda | ALSIUG | 21–03–2020 | 24–03–2020 |
| Zambia | LASILZ | 14–03–2020 | 02–04–2020 |

Source: Authors' construction using information from www.investing.com.

for Nigeria, Total Senegal S.A. (TTLS) for Senegal, the FTSE/JSE Top 40 Index (JTOPI) for South Africa, the Tunis Stock Exchange Index (TUNINDEX) for Tunisia, Uganda All-Share (ALSIUG) for Uganda, and LSE All-Share (LASILZ) for Zambia.

In addition to the COVID-19 data, we also take cognisant of some of the conventional determinants of stock markets that have been prominently established in the literature as significant for explaining stock markets, namely; exchange rate and oil prices (see [37,38]). Hence, the exchange rate (*ER*) in this study is measured as log of the national currency of the selected African countries relative to US dollar, while the oil price (*OP*) is measured as log of the Brent international crude prices. Same as the stock price index, the exchange rate and oil price series are collected from the web portal (www.investing.com).

As regards data measurements, investors are usually more concerned about trends in returns rather than prices when making investment decision. Thus, the stock returns series utilize in this study is computed as the first difference of the natural logarithm of Stock Price Index (SPI) as below.

$$spr_t = 100 * [\Delta \log(SPI_t)]$$

More importantly, the COVID-19 indicator(s) is measured as daily growth in total conformed cases (*TCC*) and daily growth in total cases of death (*TCD*). Our COVID-19 sample covers the period between 11 and 03–2020 to 28–01–2021 and named '**Pandemic Period**'. However, the pre–COVID-19 sample can be divided into two sub-sample periods. The first covering the period between 05 and 01–2015 and 07–12–2019 which is the period before the epidemic phases of the COVID-19 outbreak can be tagged '**Pre-Epidemic Period**', while the second sub-sample period covering between 08 and 12–2019 to 10–03–2020 is '**Epidemic Period**'. Finally, since stock markets in the investigated economies is traded five times in a week (Monday – Friday), we therefore; filters other series under consideration across these number of days in a week.

Fig. 1 below shows the historical dynamics of stock indices in the investigated economies. The individual charts in the figure were portioned into three quadrants indicating the three subsamples considered in the study, namely; pre-covid-19 sample, epidemic sample and pandemic sample. Quite visible in the charts, however, is the fact that the largest decrease in the indices' value fort the majority of the countries were recorded during the epidemic and pandemic periods.

*Preliminary results*

Table 3 contains the individual and group summary statistic distribution of stock returns in the selected African economies. It is evident from the table that most of the African countries experienced a decline in their stock returns. However, the prevalence of the negative mean value appears to be relatively more pronounced in the epidemic and pandemic phases of COVID-19 when compared to pre –crises period. For instance, eight (8) out of the twelve (12) countries considered recorded negative stock returns during the epidemic and pandemic phases of COVID-19, whereas negative returns were only evident in six countries prior to epidemic and/or pandemic period.

Essentially, Kenya, Nigeria, South Africa, and Tunisia are among the top ten (10) COVID-19 worst hit African countries both in terms of reported cases and deaths. Hence, it is no surprising that these countries are also the ones to have consistently experienced negative stock returns during the epidemic and pandemic phases of COVID-19. Even the positive returns seen in Nigeria during the pandemic phase of COVID-19 may not be unconnected to the fact that the country had suffered economic crises before the announcement of COVID-19 with the incidences of declining oil prices at the international markets for crude oil. Thus, the pandemic period in that instance might have coincided with the period when the economy has just begun to recover from the oil crises.

Also, the magnitude of the standard deviation statistic appears to be relative higher during the epidemic and pandemic period when compared to the pre –crisis period. This implies that the degree of disparity between the maximum and minimum values is generally higher in the crisis period compared to the calm period. Beyond the descriptive statistics of the series, we further subjected each of the variables to unit root testing. Although, a look at Table 4 shows that the order
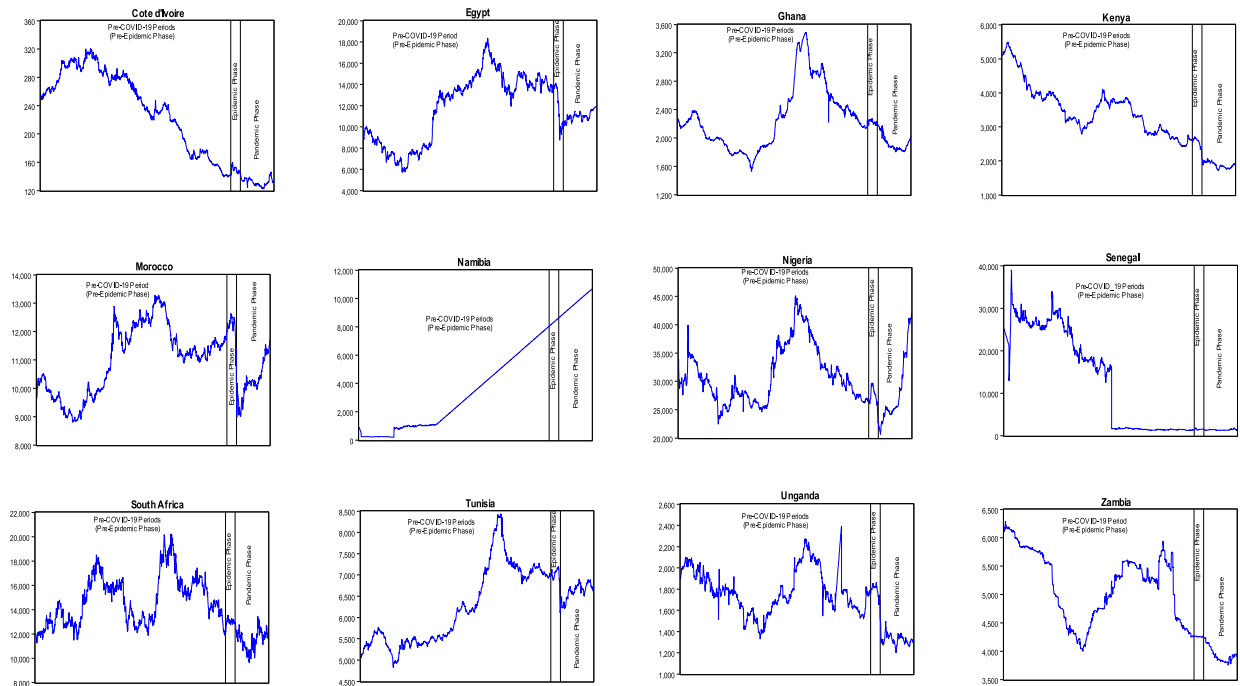
**Fig. 1.** . Historical dynamics of stock indices in the investigated countries before and during the pandemic.

**Table 3**

Descriptive statistic on stock return data distribution.

| Statistics | Period I: Pre-Epidemic sample | | | | Period II: Epidemic sample | | | | Period III: Pandemic sample | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | StDev | Min. | Max | Mean | StDev | Min. | Max | Mean | StDev | Min. | Max |
| **Cote d'Ivoire** | −0.0005 | 0.0076 | −0.0484 | 0.0343 | 0.0004 | 0.0109 | −0.0237 | 0.0348 | −0.0004 | 0.0095 | −0.0440 | 0.0629 |
| **Egypt** | 0.0003 | 0.0479 | −1.1651 | 1.1639 | −0.0041 | 0.0260 | −0.0981 | 0.0575 | 0.0006 | 0.0101 | −0.0356 | 0.0449 |
| **Ghana** | −0.0001 | 0.0088 | −0.1611 | 0.1626 | 0.0003 | 0.0092 | −0.0268 | 0.0330 | −0.0003 | 0.0101 | −0.0398 | 0.0859 |
| **Kenya** | −0.0005 | 0.0066 | −0.0452 | 0.0336 | −0.0017 | 0.0077 | −0.0306 | 0.0132 | −0.0009 | 0.0092 | −0.0514 | 0.0212 |
| **Morocco** | 0.0002 | 0.0058 | −0.0220 | 0.0330 | −0.0013 | 0.0107 | −0.0599 | 0.0184 | 0.0001 | 0.0119 | −0.0923 | 0.0352 |
| **Namibia** | 0.0016 | 0.0498 | −0.7833 | 1.5558 | 0.0011 | 0.0001 | 0.0011 | 0.0011 | 0.0009 | 0.0001 | 0.0000 | 0.0011 |
| **Nigeria** | −0.0002 | 0.1303 | −3.2822 | 3.2845 | −0.0014 | 0.0119 | −0.0503 | 0.0348 | 0.0025 | 0.0107 | −0.0379 | 0.0605 |
| **Senegal** | 0.0013 | 0.1339 | −2.3026 | 4.1046 | 0.0018 | 0.0352 | −0.0749 | 0.0896 | −0.0002 | 0.0253 | −0.0779 | 0.0723 |
| **South Africa** | 0.0001 | 0.0173 | −0.1006 | 0.0848 | 0.0009 | 0.0116 | −0.0249 | 0.0294 | −0.0004 | 0.0254 | −0.0923 | 0.0753 |
| **Tunisia** | 0.0002 | 0.0046 | −0.0448 | 0.0268 | −0.0002 | 0.0044 | −0.0148 | 0.0111 | −0.0001 | 0.0067 | −0.0418 | 0.0189 |
| **Uganda** | −0.0001 | 0.0181 | −0.3027 | 0.1685 | −0.0009 | 0.0104 | −0.0501 | 0.0232 | −0.0011 | 0.0120 | −0.0572 | 0.0301 |
| **Zambia** | −0.0003 | 0.2707 | −4.8432 | 4.8432 | −0.0001 | 0.0009 | −0.0033 | 0.0033 | −0.0004 | 0.0040 | −0.0178 | 0.0184 |
| **Africa** | 0.0002 | 0.0974 | −4.8432 | 4.8432 | −0.0004 | 0.0150 | −0.0981 | 0.0896 | 0.0000 | 0.0133 | −0.0923 | 0.0858 |

Note: The return series is measures as: $spr_t = \log(spi_t/spi_t(-1))$ where $spi$ denote stock price index. In addition Min & Max implies minimum and maximum statistics while StdDev represent standard deviation.

**Table 4**

Unit root test results.

| Test Method | Pre-Epidemic -sample | | | Epidemic -sample | | | Pandemic -sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPR | EXR | OP | SPR | EXR | OP | SPR | EXR | OP | TCC | TCD |
| *Levin-Lin-Chu (LLC) test* | <0.01* | <0.01* | <0.01** | <0.10* | <0.01** | <0.05** | <0.01* | <0.01** | <0.01* | <0.01** | <0.01** |
| *Breitung t-stat* | <0.01* | <0.01** | <0.01* | <0.01* | <0.01** | <0.05** | <0.01* | <0.01** | <0.01* | <0.01** | <0.01** |
| *Harris-Tzavalis: HT rho* | <0.01* | <0.01** | <0.01** | <0.01** | <0.01** | <0.01** | <0.01* | <0.01** | <0.01* | <0.01** | <0.01** |
| *Im-Pesaran-Shin (IPS) test* | <0.01* | <0.01* | <0.01* | <0.01* | <0.01** | <0.01* | <0.01* | <0.01** | <0.01* | <0.01** | <0.01** |
| *ADF Fisher Chi-square* | <0.01* | <0.01* | <0.01* | <0.01* | <0.01** | <0.01** | <0.01* | <0.01** | <0.01** | <0.05** | >0.01* |
| *Hadri Z-stat.* | >0.10* | >0.05** | >0.10** | >0.10** | >0.10** | >0.10** | >0.10** | >0.05** | >0.10** | >0.05** | >0.10* |

Note: The null hypothesis for the first three methods is unit root with common process while the null for the fourth and fifth tests is unit root with individual unit root process. However, the null hypothesis for the (Hadri) test is no unit root with common unit root process. Thus, the asterisk * & ** on the reported probability values implies rejection of the null at level and at first difference for LLC, Breitung, HT IPS & ADF Fisher. Whereas, the asterisk * & ** in the case of Hadri implies non-rejection of the null of no unit root at level and at first difference.

of integration for the variables hovered around I(0) and I(1). The mixed order of integration should not be a source of worry as the methodology allows for the combination of both *I*(0) and *I*(1).

## Methodology

To capture both short run and long run dynamics of stock markets' reaction to COVID-19, we give preference to the Panel variant of the ARDL model (PARDL) .[2] The biasness for the PARDL model as the most appropriate in the context of this study, hinge on its suitability to accommodate the non-stationary dynamic of the panel sample under consideration, particularly when explore via the pooled mean group (PMG) estimator. The panel dataset use in this study are characterise with both large time series (T) and large cross-sectional (N) dimensions, respectively. According to Blackburne and Frank [10], the asymptotics of panel data with large *T* and large *N* are different from those associated with small *T* irrespective of whether the *N* is large or small. Estimators for panel data with small *T* dimension, namely; Fixed Effect, Random Effect, and GMM estimator are usually considered as sufficient when pooling individual groups and allowing only the intercepts to differ across the groups with the slope coefficients assumed to be homogenous.

Motivated by the inappropriateness of the assumption of homogeneity of slope parameters when dealing with large *N* and large *T* (see [34,33]), this paper favour the PMG estimators for the non-stationary dynamic of the panel sample under consideration in which the parameters will be assumed heterogeneous across groups to estimate the effects of COVID-19 on stock returns. Primarily, we specify the following as our baseline model.

$$\Delta spr_{it} = \beta_{0i} + \beta_{1i} spr_{i,t-1} + \beta_{2i} exr_{t-1} + \beta_{3i} op_{t-1} + \sum_{j=1}^{p} \lambda_{ij} \Delta spr_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij} \Delta exr_{t-j} + \sum_{j=0}^{q} \delta_{ij} \Delta op_{t-j} + \mu_i + \varepsilon_{it}$$

$$i = 1, 2, N; \quad t = 1, 2, ..., T.$$

(1)

We refers to Eq. (1) as our baseline model because it only express stock returns as a function of its conventional determinants namely, exchange rate and oil price. $spr_{it}$ is the log of stock price index for each unit *i* over a period of time *t*; $ext_t$ is log of exchange rate; $op_t$ denotes log of oil price and $\mu_i$ is the group-specific effect.

For each cross-section, the long run slope (elasticity) coefficient is computed as $-\frac{\beta_{2i}}{\beta_{1i}}$ and $-\frac{\beta_{3i}}{\beta_{1i}}$ since in the long run, it is assumed that $\Delta sr_{i,t-j} = 0$, $\Delta exr_{t-j} = 0$ and $\Delta op_{t-j} = 0$. In view of this, the short run estimate for exchange rate and oil price are obtained as $\gamma_{ij}$ and $\delta_{ij}$. The PARDL model in Eq. (1) can be re-represented in an error correction form as below.

$$\Delta spr_{it} = \psi_i \xi_{i,t-1} + \sum_{j=1}^{p} \lambda_{ij} \Delta spr_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij} \Delta exr_{t-j} + \sum_{j=0}^{q} \delta_{ij} \Delta op_{t-j} + \mu_i + \varepsilon_{it}$$

(2)

where $\xi_{i,t-1}$ is error from the correction term for each unit while the term $\psi_i$ is the estimated parameter associated with the error-correcting speed of adjustment term for each unit.

$$\Delta spr_{it} = \beta_{0i} + \beta_{1i} spr_{i,t-1} + \beta_{2i} exr_{t-1} + \beta_{3i} op_{t-1} + \beta_{4i} covid_{t-1} + \sum_{j=1}^{p} \lambda_{ij} \Delta spr_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij} \Delta exr_{t-j} +$$

$$\sum_{j=0}^{q} \delta_{ij} \Delta op_{t-j} + \sum_{j=0}^{q} \eta_{ij} \Delta covid_{t-j} + \mu_i + \varepsilon_{it}$$

(3)

Eq. (3) is our extended PARDL model which now includes the indicators for COVID-19 which will be captured singly as number of confirmed cases and number of deaths. The procedure for obtaining long run and short run estimates remains as earlier defined while the error correction variant of the extended model is as follows.

$$\Delta sr_{it} = \tau_i \upsilon_{i,t-1} + \sum_{j=1}^{p} \lambda_{ij} \Delta sr_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij} \Delta exr_{t-j} + \sum_{j=0}^{q} \delta_{ij} \Delta op_{t-j} + \sum_{j=0}^{q} \eta_{ij} \Delta covid_{t-j} + \mu_i + \varepsilon_{it}$$

(4)

The error correction term with respect to the extended model is capture via $\upsilon_{i,t-1}$ while the parameter for speed of adjusted is denoted with the term $\tau_i$ .

The two prominent techniques used in the estimation of a dynamic heterogenous panel data model are the Pooled Mean Group (PMG) estimator and the Mean Group (MG) estimator. The difference in the two techniques lies in the estimation procedure. The MG estimator relies on estimating *N* time-series regressions and averaging the coefficients, whereas the PMG estimator relies on a combination of pooling and averaging of coefficients [10]. Nonetheless, the familiar Hausman test is employed to test whether there is any systematic difference between the two estimators. According to the null hypothesis of this experiment, the PMG estimator is the efficient estimator under the null hypothesis. Hence, a non-rejection of the null hypothesis implies the adoption of the PMG estimator while the rejection indicates the adoption of the MG estimator.

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[2] See [38] for details on the specification of the PARDL model

**Table 5**
Regression results.

| Variable | Pre-Epidemic | Epidemic | Pandemic | |
|---|---|---|---|---|
| | | | **Cases** | **Deaths** |
| $er_{it}$ | 0.0174** | 0.1550 | −6.22e-05 | 7.86e-05 |
| | (0.0077) | (0.1630) | (0.0007) | (0.0013) |
| $op_{it}$ | 0.0054 | −0.0024 | −3.66e-05 | −7.67e-05 |
| | (0.0049 | (0.0132) | (0.0001) | (0.0006) |
| $tcc_{it}$ | | | −1.34e-05 | |
| | | | (0.00412) | |
| $tcd_{it}$ | | | | −6.17e-05 |
| | | | | (8.37e-05) |
| $\Delta er_{it}$ | 0.0226*** | −0.0303** | −0.0184 | −0.0171 |
| | (0.0051) | (0.0153) | (0.0431) | (0.0606) |
| $\Delta op_{it}$ | −0.0114 | −0.0092** | −0.0073*** | −0.0104 |
| | (0.0165) | (0.0036) | (0.0028) | (0.0069) |
| $\Delta tcc_{it}$ | | | −0.0076** | |
| | | | (0.0029) | |
| $\Delta tcd_{it}$ | | | | 0.0010 |
| | | | | (0.0039) |
| $ECT_{it-1}$ | −0.8501*** | −0.8090*** | −0.9040*** | −0.9330*** |
| | (0.0658) | (0.0930) | (0.0563) | (0.0531)) |
| Constant | 0.0012 | 0.1040*** | −0.0170*** | −0.0095** |
| | (0.0010) | (0.0264) | (0.0039) | (0.0048) |
| Hausman test($\chi_k^2$) | 2.10(0.3496) | 5.22(0.0736) | 6.23(0.1011) | 1.84(0.6054) |
| Log likelihood | 35,843.54 | 3225.81 | 9676.76 | 8527.46 |
| No. of cross-sections | 12 | 12 | 12 | 12 |
| Number of observation | 15,372 | 780 | 2691 | 2446 |

Note: The values in parenthesis are the standard errors for the estimates but probability values for the Hausman test while ***, ** & * implies significance at 1%, 5% & 10%, respectively. For the Hausman test, the PMG estimator is the efficient estimator under the null while the MG estimator is the efficient estimator under the alternative hypothesis.

## Empirical result and discussion

To understand the extent to which the intensity of the reaction of stock markets in Africa to COVID-19 varies for the different stages of the COVID-19 outbreak, we structure panel regression estimates in Table 5 into pre –COVID, epidemic and pandemic estimates. We further disaggregated the panel regression estimates from the pandemic sample along model that include confirmed number of COVID-19 cases and model that include confirmed number of COVID-19 deaths, respectively. Compared to the epidemic phase of the outbreak where the coefficient on intercept reveal average stock returns in the investigated economies as positive and relatively higher compared to the pre –COVID-19 period, the reverse, however; appears to be the case when the outbreak was declared as pandemic. Saying it differently, we find the average stock returns to be negative in the pandemic phase of the outbreak both in the model that include number of confirmed cases and model with number of deaths.

Our finding tends to find support in Al-Awadhi et al. [2] whose findings also indicate, that both the daily growth in total confirmed cases and in total cases of death caused by COVID-19 have significant negative effects on the Chinese stock markets. However, the fact that the statistical significance of this position is only viable in the context of this study when the indicator for COVID-19 is number of confirmed cases is also in line with the finding of Ali et al. [3]. In this latter study, it was revealed that while the earlier epicentre China has stabilized, the global financial markets on the other have rather gone into a freefall especially in the latter phase of the epidemic.

From the view point of developing African countries, we also find support in Takyi and Bentum-Ennin [42], that the pandemic has restrictive effects on stock market performance in African economies. That said, yet innovative in this study is the fact that we find the significance of the said restrictive effects of COVID-19 on stock markets as statistically viable mainly when COVID-19 is measured as number of confirmed cases. On the whole, we find the statistical evidence of the declining response of stock markets to COVID-19 mainly in the short run and at the pandemic phase of the virus. That is, changes in the international oil prices and exchange rate appear to be responsible for the declining dynamic of stock markets in the African during the epidemic phase of the COVID-19 outbreak.

## Conclusions

That the outbreak of the COVID-19 pandemic posed a major challenge for financial markets is only a commonplace knowledge. Thus, the continual high market risk and the heightened uncertainty engendered by the pandemic have continued to garnered interest in the finance literature. But, despite the increasing efforts to offer evidence -based insights on the dynamic of the effects of the pandemic on finance; it is instructive that developing economies, particularly those in Africa, have continued to receive little or no attention in the literature. Saying it differently, the literature in the context of

the African economies has been at best ad-hoc in nature partially due to the relatively low number of COVID-19 cases in continent compared to the situation in developed and some emerging economies. Motivated by this observation, the present study ranks countries in Africa according to incidence of COVID-19 cases/deaths, and then innovatively tests whether stock markets respond differently to number of COVID-19 confirmed cases compared to number of COVID-19 deaths. We further tests whether stock markets react differently to different phases of COVID-19, namely; pre–COVID period, epidemic period and pandemic period.

First, we show that irrespective of the different phases of the COVID-19 outbreak, South Africa ranked first as the country with the highest incidence of COVID-19 in Africa both in terms of number of confirmed cases and deaths. However, while Morocco and Tunisia ranked second and third in terms of the number of COVID-19 cases, it was Egypt that ranked second in terms of the number COVID-19 deaths. Secondly, we explore a PMG –based panel–ARDL modelling framework to empirically proven; that the declining reaction of stock returns to COVID-19 is mainly driven by COVID-19 number of confirmed cases rather than number of deaths. We also find the declining reaction of stock returns to COVID-19 sensitive to the different phases of the virus. During the epidemic phase of the virus, we find the negative effects of COVID-19 on stock returns mainly attributable to changes in the international oil prices and exchange rates. For instance, the widespread hypothesis of negative reaction of stock returns to COVID-19 also hold for the investigated economies in this study but only when the virus has been fully declared as pandemic.

The aforementioned notwithstanding, our results carry a number of important policy implications. With the increasing spread of the COVID-19 outbreak to African countries; it does become imperative for authorities, central banks, and investment banks in Africa to encourage and engage in effective implementation of economic policies capable of mitigate the negative effects of the pandemic on financial markets. But, the fact that stock returns in Africa to react differently to the different indicators of COVID-19 and across different phases of the virus is an indication, that caution must be exercised not to generalize the effectiveness or otherwise of any policy initiative geared at minimizing the adverse effects of COVID-19 on stock returns Eq. (1)–(4).

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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