On the effects of Covid-19 pandemic on stock prices: an imminent global threat

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Abstract
With the advent of the global COVID-19 pandemic, various world economies have been adversely affected. Occurrences such as plummeting equities, crippling global economic activities and surge in market volatility amongst others have become prevalent across the world. Assessing the economic impact of this crisis becomes expedient from a policy standpoint as the crisis unfolds with extreme speed. To this end, we employ the Autoregressive Distributed Lag approach to examine possible relationship between the pandemic and stock prices for global and some selected countries, namely China, France, Italy and the United States. We find evidence that the effect of COVID-19 observed cases on stock prices is rather varying across countries and limited, the spillover effects orchestrated through the recent oil and financial market volatility cannot be overlooked. Given the speed of occurrences, there is need for governments all over the world to be more proactive in striving for a breakthrough over the virus otherwise, in the coming weeks the global economy may receive a surge of the pandemic.

Keywords COVID-19 · Stock price · Market volatility · Bound test · Coronavirus

1 Introduction
The COVID-19 influenza was first reported in Wuhan, Hubei Province, China, on December 31, 2019, and it has since then spread to over 200 countries with over 260 million cases and about 5.2 million deaths as of 6th December 2021. The outbreak is mostly concentrated in North America, Europe, and Asia. This pandemic has triggered different reactions across the globe. At the end of October 2021, most locked down across countries have been eased, with little to no movement and travel restrictions, however, with the discovery of new variants comes the implementation of different containment measures. For example, with the Omicron variant, which was first discovered in South Africa in November 2021,
different countries around the world are reintroducing locked down measures by issuing travel ban and movement restrictions on countries that are associated with the new variant to contain the spread, and the world is wondering the magnitude of disruption the virus will cause to the global economy across different financial markets, businesses, and investments.

These prolonged restrictions have caused severe disruption in global supply chains. Given that corporations across the globe are interdependent for input, expertise and subsequently sales of goods and services. Transport being restricted and limited between countries has further worsened the global economic activities. Most essentially, panic among companies, corporations and individuals has created market anomalies and distortions in the normal consumption patterns. Global financial markets have also been responsive to the changes and global stock indices have plunged.

At the beginning of February 2020, many investors were confident that the outbreak would ease, given that number of cases were levelling off, however, as the cases increases, initial optimism began to subside. Fearing that the outbreak might adversely affect economic growth, traders are opting to sell their shares and investors have been deterred from buying stocks (Rudden 2020). Since the stock market mirrors the level of activities in an economy as well as how investors perceive an economy. The current COVID-19 has created uncertainty in the mind of investors. The impact on the stock market is becoming glaring as equities are plummeting and market volatility rocketed upwards around the world. By extension, it has been observed that the market reacts to news, whether good or bad, as good news was observed to push the price up while negative news drives the price down, as currently evident in some stock prices behaviour. In the United States, recent volatility levels surpass those last seen in October 1987 and December 2008 and, before that, in late 1929 and the early 1930s.

Major stock indexes have plummeted amid the outbreak, though, the US and European markets were relatively late to appreciate the severity of the coronavirus. A close look at Fig. 1 shows that S&P composite index increased in value throughout January and experienced a dip throughout February and March and has since April 2020 increased marginally despite the virus spreading across the country but with a slight

![Fig. 1 Plot of S&P 500 Composite index and number of COVID-19 cases in the US. Sources: DataStream, WHO reports, Global Financial Indicator—daily updates](image-url)
On the effects of Covid-19 pandemic on stock prices: an imminent decline in June 2020. However, for the year 2021, the index experienced an upward trend mostly with minor decline in September and late November. In Europe, the France CAC 40 and FTSE MIB as seen in Figs. 2 and 3 respectively also increases throughout January up until mid-February and has been declining since ending of February, the period associated with the initial and increasing discovery of COVID-19 cases, however, both markets started experiencing improvement from March 2020 and has since maintained a relatively stable upward trend with a slight decline in October 2020, August 2021, and Late November 2021. Asian markets were the earliest to react, declining throughout late January 2020 as seen in Fig. 4, the Shanghai SE B index has since been maintaining a downward trend till June 2020, and as of July 2020, the index experienced a relatively stable position throughout. The use of lockdown in containing the spread of the virus has had an adverse effect on the demand for crude oil causing an excess supply of the product in the market. The glut in crude oil, as well as the Russia-Saudi Arabia price war, leads to a significant drop in crude oil prices by almost $30 per barrel from an average price in excess of $60 per barrel in January 2020 to less than $30 in ending of March 2020. This has further worsened the oil volatility index as seen in Fig. 5, which peaked in April 2020, with spikes in February, March and October 2020. However, the index was relatively stable throughout the year 2021, with minor spikes in March, August and Late November 2021 (Fig. 6).

Examining the factors influencing stock prices has been thoroughly researched in the literature of financial economics, factors such as money supply, inflation rate, interest rates, exchange rate, etc. as being the main determinants of stock prices in almost every country (Bahmani-Oskooee and Saha 2019; Fasanya et al. 2021a). Some examples of studies that have included these variables are, Niel and Lee (2001), Phylaktis and Ravazzolo (2005), Kutty (2010), Boonyanam (2014), Bahmani-Oskooee and Saha (2016), and Bahmani-Oskooee and Saha (2019). While there are some existing studies on how a pandemic affects major macroeconomic indicators, such as trade, tourism, global output, and the financial market. Some of these studies are Lars and Werner (2006), McKibbin and Sidorenko (2006), Peckham (2013) and Zhang et al. (2020). There is also growing

\[ \text{Fig. 2 Plot of France CAC 40 index and number of COVID-19 cases in France. Sources: DataStream, WHO reports, Global Financial Indicator—daily updates} \]
literature on COVID-19 as one of the factors influencing various macroeconomic fundamentals such as stock prices (see also, Fasanya et al. 2021b). We consider the effect of this imminent global threat on the stock market of highly prevalence countries while controlling for both oil and stock volatility index, by employing the Autoregressive Distributed lag (ARDL) to estimate both long-run and short-run relationship.

The motivation for this study is as follows. Firstly, Studies (Oliyide et al. 2021; Heyden and Heyden 2021; Akhtaruzzaman et al. 2021; Salisu et al. 2021; Fasanya et al. 2021c) have shown that stock markets respond to news and information related to COVID-19. Secondly, COVID-19 pandemic has increased uncertainty in stock market, reduce stock returns (Oliyide et al. 2021; Padhan and Prabheesh 2021). Thirdly, effects on countries, industries and firms of COVID-19 is heterogeneous (Oliyide et al. 2021; Iyke 2020; He et al. 2020a,

Fig. 3 Plot of FTSE MIB index and number of COVID-19 cases in Italy. Sources: DataStream, WHO reports, Global Financial Indicator—daily updates

Fig. 4 Plot of Shanghai SE index and number of COVID-19 cases in China. Sources: DataStream, WHO reports, Global Financial Indicator—daily updates
b). Fourthly, the countries of China,1 France, Italy and US have all passed through the first, second and third wave of COVID-19 and currently passing through the fourth wave of the virus.2 Stock markets of these countries are highly connected to each other and to the rest of the world. These stock markets play important roles in global stock market.

Following the introduction, the rest of this paper is organized as follows: a review of the literature and the methodology of the study are detailed in sections two and three respectively. Section four discusses the empirical results, while section five conclude the study.

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1 The Chinese market is included due to being the first known infections from SARS-CoV-2 were discovered.

2 As at the time of conducting the research, April 10, 2020, these countries have displayed consistent increase in both COVID cases and deaths announced. However, we omitted other countries that fell into these categories due to sufficient data (Chhibber-Goel et al. 2021; Worldometers.info).
2 Review of related studies

An array of studies has examined the long-run and short-run relationship between stock price index and major macroeconomic indicator such as exchange rate, inflation rate and policy uncertainty. While some observed there exist long run relationship among these variables, others could not reach that conclusion.

Several studies have examined the relationship among different macroeconomic fundamentals with mixed findings. Stock market and prices respond to changes in dividend and time-varying component of dividend growth have large effects on stock prices (Barsky and De long 1993). Policy uncertainty causes adverse short run effects on stock prices (Bahmani-Oskooee and Saha 2019). On the relationship between stock prices and exchange rate for G-7 countries, Neih and Lee (2001) observed no long-run significant relationship between these two economic fundamentals but a different result was found in Kutty (2010) where there is evidence of short run relationship. Needless to say, there is evidence of short run asymmetric effect of nominal exchange rate on stock prices (Bahmani-Oskooee and Saha 2016). On the signs of effect between stock and foreign exchange markets, Phylaktis and Ravazzolo (2005) showed a positive relationship between the two markets implying that the US stock market is a channel for such relationship and the financial crisis has a transitory effect on the long run comovement of the markets.

On the contrary, using a multivariate cointegration approach for Thailand, Boonyanam (2014) found long run relationship between stock prices and monetary variables of consumer price index, narrow money, nominal bilateral exchange rate and 14 days repurchased rate with no short run adjustment towards equilibrium, however, narrow money and interest rate have significant short run effect on stock price. Using a VAR model, Rapach (2002) found little or no evidence of a negative long-run real stock price reacts to a permanent inflation shock and inflation does not erode the long-run real value of stocks.

We go further to examine studies that have investigated the effects of a Pandemic on the economy, this became necessary since the focus of this study is on a Pandemic. Jonung and Roeger (2006) examined production lost due to illness and death during pandemic in Europe using reductions in GDP growth and/or decline in the level of GDP in trade and tourism. Comparing the result to similar studies for the United States and Canada, pandemic would most likely not be a severe threat to the European economy, though it is huge toll on human suffering. However, McKibbin and Sidorenko (2006), finds that mild pandemic has significant consequences for global economic output and as the scale of the pandemic increases, so do the economic costs.

Aloui et al. (2011) examined the financial interdependency of some selected (BRIC) emerging markets with the US using a multivariate copula and found strong evidence of time-varying dependence between each of the BRIC markets and the US markets. The dependency structure of commodity-price dependent markets is stronger than finished-product export-oriented markets. There is also high levels of dependence persistence for all market pairs during both bullish and bearish markets.

In addition, Ramelli and Wagner (2020), explored the feverish stock price reaction to COVID-19 where they examined how the markets adjust to the sudden emergence of previously neglected risks, and result suggest that the health crisis has morphed into an economic crisis, particularly as the aggregate market has been underperforming since the outbreak, which is amplified through financial channels. Using a text based method, (Baker et al. 2020) argues that no previous infectious disease outbreak, including the Spanish Flu, has impacted the stock market as powerfully as the COVID-19 pandemic, when the
COVID-19 causes stock returns to fluctuate significantly (Oliyide et al. 2021; Periola-Fatunsin et al. 2021), has negative effect on stock market returns (Padhan and Prabheesh 2021; Heyden and Heyden 2021), increase stock markets contagion and crash risk (Akhtaruzzaman et al. 2021; Liu et al. 2021). Akhtaruzzaman et al. (2021) examined financial contagion between China and G7 countries. Chinese stock returns are significantly negatively related to both the daily growth in total confirmed cases and the daily growth in total cases of death caused by COVID-19 (Al-Awadhi et al. 2020). Heyden and Heyden (2021) examined short term stock market reactions of US and European stocks at the beginning of the COVID-19 pandemic. Stock markets are volatile with large fluctuations, having asymmetric dependencies with COVID-19 related information which leads to a decrease in return across middle and upper quantiles (Cepoi 2020). However, firms with larger size, more leverage, more cash flows, less returns on asset and more internationalization are more resilient to stock declines during COVID-19 (Song et al. 2021). Government policy responses due to COVID-19 had a heterogeneous effect on country stock returns (Bannigidadmath et al. 2021). Financial markets respond to COVID-19 related information (Heyden and Heyden 2021; Fasanya et al. 2021d) and the recent changes in asset prices and expectations suggest that the pandemic’s effects are not regarded to be temporary (Pagano et al. 2020). Cepoi (2020) examined stock market’s reaction to coronavirus news in the UK, US, Germany, France, Spain and Italy at the early stage of the virus. However, cases of the virus since this period has increased with new variants. With various variants of the virus, more information relating to the virus is available, additional and diverse policies is been implemented, it is therefore expected that stock markets, like every other sphere of the economy would exhibit some forms of reactions to these development.

3 Methodology and data

3.1 Data sources and description

This study covers stock market indexes, financial volatility, oil price volatility and COVID-19 using daily data from January 1, 2020–December 3, 2021. The data on COVID-19 are obtained from DataStream and WHO. The stock market indexes (China—Shanghai SE index; France—CAC 40 index; USA—S&P 500; Italy—FTSE MIB) are taken from DataStream and Global Financial Data while the financial volatility (VIX) and oil price volatility (OVX) are extracted from the DataStream and Chicago Board Options Exchange (CBOE).

3.2 Methodology

The autoregressive distributed lag (ARDL) model which could be referred to as the bounds test is used to empirically show the short and long run relationships between COVID-19 cases, financial volatility, oil price volatility and stock market behaviour. This technique is used for this paper for several reasons. First, the bounds test allows the cointegration relationship to be estimated by OLS once the lag order of the model is identified. Second, the regressors can either be I(0), purely I(1) or mutually cointegrated. Pre-testing of the order of integration is however necessary following the study by Ouattara (2004) that the Pesaran
et al. (2001) F-statistics values are not valid when series are I(2) because the cointegrating relationships are only based on series are at levels or first difference. Third, both long and short run parameters can be estimated from the models simultaneously. The model for this study is therefore specified as below from Eq. (1).

\[
\Delta SP_t = \gamma + \sum_{i=1}^{p} \alpha_i \Delta SP_{t-i} + \sum_{i=0}^{q_1} \beta_i \Delta CVD_{t-i} + \sum_{i=0}^{q_2} \delta_i \Delta OVX_{t-i} + \sum_{i=1}^{q_3} \pi_i \Delta VIX_{t-i} \\
+ \theta_1 SP_{t-1} + \theta_2 CVD_{t-1} + \theta_3 OVX_{t-1} + \theta_4 VIX_{t-1} + \epsilon_t
\]  

Equation (1) is the ARDL model, with the aim is to test the hypothesis that \( H_0: \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0 \) against the hypothesis that \( \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0 \), this test, using the Wald F-statistic will inform us whether there is a long run relationship or not. The coefficients in Eq. (1), represents the coefficients in the long run, while the coefficients of the differenced parts in Eq. (1) represent the short run relationship.

The error correction term indicates the speed of the adjustment which restores equilibrium in the dynamic model. The ECM coefficient shows how quickly variables return to equilibrium and it should have a statistically significant coefficient with a negative sign. Error correction technique corrects for disequilibrium between short run and long run behaviour of the dependent variable. Since disequilibrium may exist in the short run, there is need to tie the value of the dependent variable to its long run value. The error term from the co integrating initial regression is thus called ‘equilibrium error’. The error correction model can be classified as

\[
\Delta SP_t = \gamma + \sum_{i=1}^{p} \alpha_i \Delta SP_{t-i} + \sum_{i=0}^{q_1} \beta_i \Delta CVD_{t-i} + \sum_{i=0}^{q_2} \delta_i \Delta OVX_{t-i} \\
+ \sum_{i=1}^{q_3} \pi_i \Delta VIX_{t-i} + \sigma ECM_{t-1} + \nu_t
\]

After the estimation, we equally perform series of diagnostic tests to check for the validity of our results.

4 Empirical analysis

This section examines the characteristics of the variables used in the study. It examines the time-series properties of the variables used, it examines the pre-test and estimation methods by presenting the results generated from the test in the previous section. The descriptive statistics show the statistical qualities of the data used for estimation (Table 1).

The table above shows that World COVID has the highest average values followed by the US COVID cases and then France COVID cases. This is not surprising since World COVID is the summation of all the COVID cases as seen in all countries of the world. A close look at the maximum values reveals that World COVID cases, US COVID and France COVID are the maximum while France COVID, US COVID and Italy COVID have the minimum values at 0. The Standard deviation to mean ratio of Italy, US and France COVID indicate high coefficient of variation, however, the stock indexes show a low level of coefficients given their respective standard deviation is lower than the expected threshold of 0.5, implying that the COVID cases in all the countries under investigation are more
Table 1  Descriptive statistic of the variables

| Source                  | Authors computation, 2021 |
|-------------------------|---------------------------|
| WORLD COVID             |                           |
| CHINA COVID             |                           |
| ITALY COVID             |                           |
| FRANCE COVID            |                           |
| US COVID                |                           |
| FRANCE INDEX            |                           |
| ITALY INDEX             |                           |
| US INDEX                |                           |
| CHINA INDEX             |                           |
| OVX                     |                           |
| VIX                     |                           |
| Mean                    | 16.819                    |
| Max                     | 19.394                    |
| Min                     | 3.296                     |
| Std. Dev                | 3.320                     |
| Skewness                | -2.177                    |
| Kurtosis                | 7.825                     |
| J-B                     | 885.145                   |
| Prob                    | 0.000                     |
| Obs                     | 703                       |
volatile than the other variables. The table further reveals that 9 of the 11 variables used are skewed negatively, while the kurtosis value reveals that all variables except three are greater than the threshold of 3, they are highly peaked, that is leptokurtic. Both the kurtosis and skewness statistical result shows an indication of a normal distribution of the series used, however, research has shown that both test are insufficient to confirm if the series are normally distributed. Therefore, the Jarque–Bera statistics combines both skewness and kurtosis properties, as it provides a better comprehensive information about normality of series.

The result of the unit root are presented in Tables 2 and 3. Table 2 shows the Phillip Perron for levels and at first difference with the integration order, that is, showing the number of times a series is differenced before becoming stationary. Both tables shows that series are stationary either at level or first difference. In specific, Table 3, which gives the ADF result shows that World COVID, China COVID, US COVID, France COVID and SPX VIX are stationary at levels while others are stationary at first difference, similarly, Table 2 shows World COVID, China COVID, US COVID and SPX VIX are stationary at level while others are stationary at first difference.

Having observed from the tests of unit root above that the series are a stationary at first difference, or at level, implying that variables are either I(0) or I(1), it is therefore important to determine whether there is presence of long-run relationship among the series or not. Hence, the Autoregressive Distributed Lag (ARDL) bounds test is employed, and the result is presented below.

The ARDL Bounds test shown in Table 4, Panel B, reveals a long run relationship for all the models considered at 5% significant level, hence, both the long-run and short-run model are appropriate. The Short-run estimates from Panel A shows that the number of COVID cases has a negative and significant effect these stock indexes: S&P, France CAC 40, and FTSE MIB. Specifically, a percentage change in US COVID cases and France COVID Cases decreases the US stock index and France CAC 40 by 0.016% and 0.015% respectively. While World COVID cases only has a negative significant effect on Shanghai stock market index, as a percentage change in the number of World COVID cases decreases the stock price index by 0.011%. Interestingly, Figs. 1, 2, 3 and 4 which exhibits the trend of the stock price indexes reveals that except for China, the other indexes actually appreciated in value until late February to early March before they begin to experience decline and afterwards steady upwards trend. It worth noting that since the Pandemic originated from China, the severity and effect on stock price index would also be more predominant there initially. However, these other Countries have also experiencing the impact of the Pandemic as most of these countries have attained the peak of the Pandemic, while the Pandemic is far becoming showing signal for things to come for most of the other countries.

In summary, the short-run estimates show that the number of COVID cases has a negative influence on the stock price indexes either at World cases or country specific for all the countries under investigation except for Italy in which it has no significant influence. Likewise, financial market volatility seems to play a prominent role in stock prices movement as they all appear significant across all countries. VIX has a negative significant impact at both cases except for China, which has no significant initial effect when considering China’s COVID cases. Furthermore, OVX, appears to have a significant negative effect across all the models estimated which is expected as unprecedented movement in crude oil prices change the behaviour of investors portfolio decisions.

The Long-run results show that World COVID cases have a positive significance on Italy Price index, while China has a negative influence (see, He et al. 2020a, b) and no significant influence in United States (see, Ngwakwe 2020; Zhang et al. 2020) and France index.
Table 2  Phillips–Perron unit root test results

| Variable     | AT LEVEL                                                                 | AT 1ST DIFFERENCE                                                                 |
|--------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|              | Constant Constant and trend None | Constant Constant and trend None | Constant Constant and trend None | Order of integration |
| CHINA COVID  | $-7.8485^* [0.0000]$ $-7.0550^* [0.0000]$ $0.6381 [0.8538]$ | $-15.963^* [0.0000]$ $-16.317^* [0.0000]$ $-15.8075^* [0.0000]$ | I(0) |
| WORLD COVID  | $-9.03501^* [0.0000]$ $-7.34907^* [0.0000]$ $1.5235 [0.9689]$ | $-16.058^* [0.0000]$ $-16.7623^* [0.0000]$ $-15.6045^* [0.0000]$ | I(0) |
| US COVID     | $-5.0169^* [0.0000]$ $-3.1459*** [0.0969]$ $1.0870 [0.9282]$ | $-15.7262^* [0.0000]$ $-16.7535^* [0.0000]$ $-14.8692^* [0.0000]$ | I(0) |
| FRANCE COVID | $-4.6641^* [0.0001]$ $-3.0304 [0.1249]$ $1.1275 [0.9331]$ | $-17.6350^* [0.0000]$ $-18.2864^* [0.0000]$ $-16.9603^* [0.0000]$ | I(1) |
| ITALY COVID  | $-3.5620^* [0.0069]$ $-2.6825 [0.2443]$ $0.7234 [0.8708]$ | $-21.7944^* [0.0000]$ $-21.6620^* [0.0000]$ $-21.8194^* [0.0000]$ | I(1) |
| FRANCE INDEX | $-1.1423 [0.7003]$ $-3.0403 [0.1223]$ $0.2861 [0.7684]$ | $-23.0550^* [0.0000]$ $-23.0726^* [0.0000]$ $-23.0722^* [0.0000]$ | I(1) |
| ITALY INDEX  | $-1.4145 [0.5759]$ $-2.9635 [0.1437]$ $0.1968 [0.7431]$ | $-24.5150^* [0.0000]$ $-24.5129^* [0.0000]$ $-24.5335^* [0.0000]$ | I(1) |
| US INDEX     | $-0.6774 [0.8498]$ $-3.2583*** [0.0746]$ $1.0637 [0.9252]$ | $-30.1422^* [0.0000]$ $-30.1371^* [0.0000]$ $-30.0356^* [0.0000]$ | I(1) |
| CHINA INDEX  | $-0.9843 [0.7601]$ $-2.8916 [0.1661]$ $0.4445 [0.8098]$ | $-21.4612^* [0.0000]$ $-21.5863^* [0.0000]$ $-21.4820^* [0.0000]$ | I(1) |
| OVX          | $-2.4267 [0.1349]$ $-2.8783 [0.1705]$ $0.1866 [0.7401]$ | $-23.1659^* [0.0000]$ $-23.1407^* [0.0000]$ $-23.1808^* [0.0000]$ | I(1) |
| SPX VIX      | $-2.8368*** [0.0539]$ $-3.3167*** [0.0647]$ $0.1755 [0.7368]$ | $-25.9430^* [0.0000]$ $-25.9229^* [0.0000]$ $-25.9547^* [0.0000]$ | I(0) |

Source: Authors Compilation, 2021

The Phillips–Perron test statistics are reported, with probability values are presented in square brackets. *, **, and *** indicate 1%, 5%, and 10% level of statistical significance respectively.
### Table 3 Augmented Dickey–Fuller unit root test results

| Variable     | AT LEVEL                  | AT 1ST DIFFERENCE              | Order of integration |
|--------------|---------------------------|--------------------------------|----------------------|
|              | Constant | Constant and trend | None | Constant | Constant and trend | None |                     |
| CHINA COVID  | -9.7059* [0.000]         | -14.323* [0.000]             | 0.0357 [0.6938]      | -8.5801* [0.000]      | -8.5318* [0.000]      | -8.6004* [0.000]     | I(0)                |
| WORLD COVID  | -6.2182* [0.000]         | -5.7658* [0.000]             | 2.1071 [0.9920]      | -6.5006* [0.000]       | -7.4086* [0.000]       | -5.9497* [0.000]     | I(0)                |
| US COVID     | -4.5740* [0.0000]        | -3.9934* [0.0095]            | 0.2988 [0.7719]      | -3.5159* [0.0080]      | -4.2152* [0.0045]      | -2.8319* [0.0046]    | I(0)                |
| FRANCE COVID | -5.5341* [0.0000]        | -5.3367* [0.0001]            | 0.3671 [0.7902]      | -4.5212* [0.0002]      | -5.1198* [0.0001]      | -3.8636* [0.0001]    | I(0)                |
| ITALY COVID  | -4.2446* [0.0006]        | -2.7855 [0.2033]             | 1.3715 [0.9576]      | -20.287* [0.0000]      | -20.648* [0.0000]      | -6.8551* [0.0000]    | I(1)                |
| FRANCE INDEX | -1.1600 [0.6929]         | -3.2039 [0.0848]             | 0.2443 [0.7567]      | -13.6097* [0.0000]     | -13.6540* [0.0000]     | -13.619* [0.0000]    | I(1)                |
| ITALY INDEX  | -1.3626 [0.6013]         | -3.0162 [0.1287]             | 0.1708 [0.7354]      | -13.3725* [0.0000]     | -13.3971* [0.0000]     | -13.3841* [0.0000]   | I(1)                |
| US INDEX     | -0.8761 [0.7955]         | -3.8469** [0.0150]           | 0.8127 [0.8872]      | -6.0509* [0.0000]      | -6.0639* [0.0000]      | -5.9963* [0.0000]    | I(1)                |
| CHINA INDEX  | -1.0767 [0.7263]         | -2.9803 [0.1388]             | 0.4096 [0.8011]      | -21.4306* [0.0000]     | -21.4991* [0.0000]     | -21.4468* [0.0000]   | I(1)                |
| OVX          | -2.6005 [0.0935]         | -3.0311 [0.1247]             | 0.0963 [0.7128]      | -22.9583* [0.0000]     | -22.9356* [0.0000]     | -22.9746* [0.0000]   | I(1)                |
| SPX VIX      | -2.7421*** [0.0677]      | -3.3051*** [0.0666]          | 0.2196 [0.7497]      | -25.9167* [0.0000]     | -25.8957* [0.0000]     | -25.9307* [0.0000]   | I(0)                |

Source: Authors Compilation, 2021

The Augmented Dickey–Fuller test statistic are reported, with probability values are presented in square brackets. *, **, and *** indicate 1%, 5%, and 10% level of statistical significance respectively.
### Table 4: Short-run and Long-run estimates

|                  | US                        | FRANCE                  | CHINA                    | ITALY                     |
|------------------|---------------------------|-------------------------|--------------------------|---------------------------|
|                  | World cases | Country specific | World cases | Country specific | World cases | Country specific | World cases | Country specific |
| **Panel A: Short-run estimates** |            |                  |            |                  |            |                  |            |                  |
| \( \Delta SP_{t-1} \) | \(-0.186^* \) (\(-5.202\)) | \(-0.172^* \) (\(-3.829\)) | \(0.075^{**} \) (\(1.712\)) | \(0.085^{***} \) (\(1.929\)) | \(-0.135^* \) (\(-3.072\)) | \(-0.115^* \) (\(-2.612\)) |
| \( \Delta SP_{t-2} \) | \(0.140^* \) (\(4.108\)) | \(0.221^* \) (\(4.963\)) | \(-0.011^{**} \) (\(-2.034\)) | \(-0.135^* \) (\(-4.238\)) | \(-0.016^* \) (\(-2.857\)) | \(-0.016^* \) (\(-2.857\)) |
| \( \Delta CDw \) | \(0.040^* \) (\(4.293\)) | \(-0.017^* \) (\(-2.979\)) | \(-0.015^{**} \) (\(-2.263\)) | \(-0.015^{**} \) (\(-2.263\)) | \(-0.015^* \) (\(-2.974\)) | \(-0.017^* \) (\(-3.132\)) |
| \( \Delta CD_{us} \) | \(-0.113^* \) (\(-18.633\)) | \(-0.109^* \) (\(-18.178\)) | \(-0.026^{***} \) (\(-4.567\)) | \(-0.026^{***} \) (\(-4.567\)) | \(-0.026^{***} \) (\(-4.567\)) | \(-0.026^{***} \) (\(-4.567\)) |
| \( \Delta CD_{us} \) | \(-0.016^* \) (\(-2.857\)) | \(-0.016^* \) (\(-2.857\)) | \(-0.025^* \) (\(-4.437\)) | \(-0.025^* \) (\(-4.437\)) | \(-0.025^* \) (\(-4.437\)) | \(-0.025^* \) (\(-4.437\)) |
| \( \Delta OVX \) | \(-0.016^* \) (\(-2.974\)) | \(-0.017^* \) (\(-3.132\)) | \(-0.008^* \) (\(-2.148\)) | \(-0.007^{**} \) (\(-2.922\)) | \(-0.015^{**} \) (\(-2.024\)) | \(-0.018^* \) (\(-2.488\)) |
| \( \Delta OVX_{t-1} \) | \(-0.022^* \) (\(-2.989\)) | \(-0.022^* \) (\(-3.082\)) | \(-0.045^* \) (\(-4.885\)) | \(-0.053^* \) (\(-5.357\)) | \(-0.052^* \) (\(-5.288\)) | \(-0.052^* \) (\(-5.288\)) |
| \( \Delta OVX_{t-2} \) | \(0.013^{**} \) (\(2.380\)) | \(0.026^* \) (\(3.622\)) | \(0.030^* \) (\(4.318\)) | \(0.028^* \) (\(4.123\)) | \(0.034^* \) (\(4.508\)) | \(0.033^* \) (\(4.512\)) |
Table 4 (continued)

|                | US                  | FRANCE              | CHINA               | ITALY                |
|----------------|---------------------|---------------------|---------------------|---------------------|
|                | World cases         | Country specific    | World cases         | Country specific    |
| ΔOVX_{t-3}     | −0.016* (−3.157)    | −0.016** (−2.843)   | −0.067* (−4.369)    | −0.086* (−4.993)    |
| Adjusted R²    | 0.995               | 0.996               | 0.981               | 0.980               |
| ECT(−1)        | −0.147* (−6.498)    | −0.134* (−5.435)    | −0.057* (−4.146)    | −0.0484* (−3.876)   |
| Adjusted R²    | 0.995               | 0.996               | 0.981               | 0.980               |
| ECT(−1)        | −0.147* (−2.843)    | −0.134* (−2.843)    | −0.057* (−4.146)    | −0.0484* (−3.876)   |
| Panel B: Long-run estimates
| CDw            | −0.014* (−2.513)    | −0.026* (3.085)     | −0.014* (−2.513)    | −0.026* (3.085)     |
| CDus           | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    |
| CDfr           | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    |
| CDch           | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    |
| CDit           | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    | −0.014* (−3.540)    |
| VIX            | −0.184* (−7.816)    | −0.176* (−5.828)    | −0.266* (−4.275)    | −0.230* (−4.827)    |
| OVX            | −0.035** (−2.327)   | −0.029** (−1.670)   | −0.141* (−3.615)    | −0.137** (−2.957)   |
| C              | 8.887* (209.767)    | 8.679* (157.351)    | 9.346* (79.540)     | 9.222* (94.865)     |
| Bound F-Stat   | 13.142*             | 9.330*              | 5.943*** (26.035)   | 4.676** (25.338)    |
| B-G LM TEST    | 0.648 [0.421]       | 1.729 [0.142]       | 1.591 [0.205]       | 1.007 [0.316]       |
| Heteroskedasticity: ARCH | 47.603 [0.00] | 32.144 [0.00] | 14.431 [0.00] | 2.724 [0.09] |
| CUSUM          | Stable              | Stable              | Stable              | Stable              |

T-statistics are presented in parenthesis and probability values are presented in square brackets. *, **, and *** indicate 1%, 5%, and 10% level of statistical significance respectively.
Specifically, a percent change in the number of World COVID cases increases the stock price indexes by 0.026% in Italy, while it reduces the stock price index in China by 0.014%. Country specific COVID cases, appears to have a negative significant impact in France and Italy, as a percent change in the country specific COVID cases brings about 0.014 and 0.016% increase in the stock price index respectively, while China COVID cases and United States COVID Cases has no significant long run effect on the stock price index. Intuitively, the pandemic has decreased investors’ confidence level in the stock market as the market uncertainty was very high in the French and Italian markets (Liu et al. 2021; Iyke 2020), however the United States and Chinese markets over the long term with increasing COVID cases and deaths have been able to absorb the shocks due to the strong base of their markets globally, country-specific COVID-19 restriction measures like lockdowns and the confidence investors have on these markets especially after their responses to earlier crises such as the 2018 global financial crisis. Our result is corroborated by the findings of Ngwakwe (2020) that, the pandemic has differential effects in different stock markets. In the study, DJIA stock returns were decreased, SSE increased, however, S&P 500 index and Euronext 100 revealed insignificant effects. Oil volatility (OVX) also has a negative significant effect across all the models estimated, except for the France CAC 40 and FTSE MIB. This is counter-intuitive for United States, French and Italian markets especially with the fact that United States is a net exporter of oil while the other two countries are net importer of the commodity. Historically, the United States has been a net importer of petroleum. During 2020, COVID-19 mitigation efforts caused a drop in oil demand within the United States and internationally. International petroleum prices decreased in response to less consumption, which diminished incentives for key petroleum-exporting countries to increase production. This shift allowed the United States to export more petroleum in 2020 than it had in the past (EIA 2021). Similarly, the Financial Volatility Index (VIX) exhibits a significant negative impact across all models except for the Shanghai stock market index. The intuition behind this is that, the market is relatively calm now but is more responsive to volatility in the oil and the financial markets even with the presence of the global health threat.

We further subjected our models to diagnostic testing to ascertain if they satisfy the assumptions of a classical regression model. The Breusch–Godfrey LM test indicates that there is no presence of autocorrelation, as shown in Table 4, panel c which reveals that the null hypothesis of no serial correlation cannot be rejected at 5% significance level. We could not reject the ARCH test null hypothesis, of no heteroscedasticity between the error series at 5% for all models examined. In terms of stability of the models, we use the CUSUM and CUSUMSQ to test for stability, all the models are stable using the CUSUM.

By and large, we observe that even if the direct effect of COVID-19 observed cases on stock prices is rather varying across countries and lame, the spillover effects orchestrated through the recent oil market volatility and that of the financial markets cannot be overlooked. Given the rate of growth of this deadly and infectious virus, there is need for governments all over the world to be more proactive in striving for a breakthrough over the virus otherwise, the in the coming weeks the global economy may receive a surge of the pandemic.

5 Conclusion

This paper examines the effect of number of COVID-19 cases on stock price indexes in the United States, France, China and Italy, using data spanning from January 1, 2020 to December 3, 2021. The unit root test reveals that the integration order of the series are
either one or zero, and consequently, we use the Autoregressive Distributed Lag Model (ARDL) to estimate the long-run and short-run relationship in the models. We estimated eight different models; each country’s stock price index against the number of World COVID cases and the country’s specific COVID cases. The study reveals the following findings; there exists both long-run and short-run relationship in the models. The short-run estimates shows that the number of COVID cases has a negative significant influence on the stock price indexes either at World cases or country specific for all the countries under investigation except for Italy in which it has no significant influence. Likewise, VIX has a negative significant impact at both cases except for China, which has no significant effect. Furthermore, OVX, appears to have a significant negative effect across all the models estimated. Similar result also exists in the long run, where the number of country specific COVID cases significantly exhibit a negative influence on France CAC 40 and FTSE MIB stock indexes. Though financial volatility index (VIX) exhibits negative effects across the models in the short-run and long run with the exception of China which has no significant effect, the Oil volatility index (OVX) exhibits a unanimous negative effect across all the models estimate both in the short-run, with US and China only exhibiting negative effects in the long-run. In order to manage the impact of COVID-19 on the economy, policy measures should be jointly coordinated across fiscal and monetary policy in order to reduce the negative economic consequences of the Pandemic. Secondly government needs to manage information sharing and news around the Pandemic on the policy measures taken, most especially, the newspaper accounts and the role of the media.

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**Declarations**

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