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Stock market reaction to the COVID-19 pandemic: an event study

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Abstract

The COVID-19 pandemic created unprecedented challenges for communities and economies around the world. Based on 13 leading global stock indices, the event study method is adopted in this research to explore the impact of the COVID-19 pandemic on the performance of the stock market indices in the short term. Regression results show that the global stock markets performed poorly in response to the COVID-19 pandemic. The findings of the event study imply that the stock markets reacted rapidly and negatively to the COVID-19 pandemic when lockdown restrictions were announced to contain the spread of the novel coronavirus. The Asian stock indices experienced more negative abnormal earnings than the stock indices of the countries outside Asia. Moreover, investor sentiments act as a wedge between financial investment decisions, returns, and fear of uncertainty caused by the pandemic. Furthermore, the panic experienced by investors may be an effective transmission channel through which the COVID-19 outbreak affects the returns on the stock market indices.

Keywords Abnormal return · COVID-19 pandemic · Financial performance · Investor sentiment · Lockdown · Stock index

1 Introduction

According to the WHO, the novel coronavirus spreads quickly among people during close contact because of its transmission via small droplets when coughing, sneezing, and talking. In addition, the virus can be spread before symptoms appear

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and is most contagious during the first few days after the onset of symptoms. To contain the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), various countries around the world implemented nonpharmaceutical interventions, including stay-at-home orders, quarantines, and societal restrictions, which were referred to as lockdowns. Interventions have been carried out on an unprecedented scale since the start of the COVID-19 pandemic. Lockdown restrictions severely affected public health, society, the economy, and finance, but medical experts and economists advocated lockdown interventions, which significantly reduced virus transmission (Flaxman et al. 2020).

The COVID-19 pandemic and implementation of lockdowns affected the global economy more profoundly and significantly than other crises. The evolution of the COVID-19 pandemic as well as strict lockdown restrictions, which disrupted economic activities, had an adverse effect on the global economy, resulting in the second global recession and stock market crash. Supply chain losses caused by the initial COVID-19 lockdowns are significantly associated with the number of countries that implemented a lockdown policy and the duration, rather than the strictness, of the policy (Guan et al. 2020). As the COVID-19 pandemic led to a significant contraction of supply (a drop in the labor supply and product outputs) and demand (a drop in consumption), it eventually transformed into financial and economic turmoil (Goldstein et al. 2021). Aside from unemployment, product prices increased owing to low production combined with high demand, resulting in high inflation and recession. Majority of countries suffered from the further economic recession due to a substantial decrease in international trade (Ji et al. 2022). According to the World Bank's conservative estimation of economic costs, the global economy contracted by 4.3% in 2020, which is a setback equivalent to that caused by the two world wars and Great Depression (The Economist 2021). With fear of the social and economic impacts of COVID-19 growing, financial markets plunged (The Economist 2020).

In addition, after the Great Recession, the US GDP experienced a significant annual decrease by approximately 3.5% in 2020, since the end of the second world war, and the country's unemployment rate plummeted to 14.7% by April 2020 (Goldstein et al. 2021). The economy of numerous countries is suffering owing to the uncertainty caused by the evolution of the virus. While the estimated cost of the SARS outbreak in 2003, which was confined mainly to China, was between USD 30 and 100 billion for the world economy (Keogh-Brown and Smith 2008), the International Monetary Fund predicted that the global economy will suffer from losses amounting to USD 12.5 trillion until 2024 owing to the COVID-19 pandemic. In addition to the significant economic losses, the number of COVID-19 cases and deaths is larger than that of other major historical epidemics. For example, SARS, which emerged in China, was first identified in February 2003, then spread to four other countries, with a total of 8,096 confirmed cases, including 774 deaths. However, according to the WHO, SARS-CoV-2 spread quickly to six WHO regions around the world, and as of April 14, 2022, 500,186,525 confirmed cases of COVID-19 had been reported, including 6,190,349 deaths (World Health Organization 2020).

A series of key events occurred in relation to the progress of the COVID-19 pandemic and lockdown policy of various countries. On January 20, 2020, China's National Health Commission confirmed that SARS-CoV-2 can be transmitted from human to human. On January 23, at 2:00 a.m., Wuhan authorities announced that Wuhan City would be closed from January 23, 10:00 a.m. onwards to curb the transmission of SARS-CoV-2 from its source. Owing to the high infection and fatality rates of the novel coronavirus, the WHO announced the SARS-CoV-2 outbreak as a Public Health Emergency of International Concern on January 30, 2020, which could threaten countries with a vulnerable health system, and as a pandemic on March 11, 2020. On the same day, Health Minister Roberto Speranza announced that all flights between Italy and China would be suspended until further notice in an attempt to prevent the number of COVID-19 cases from increasing (Crisis 24, January 31, 2020). To prevent the number of COVID-19 cases from increasing and reduce the number of deaths, on Sunday, February 23, the Italian government placed nearly 50,000 residents of 11 municipalities in Northern Italy under quarantine and implemented a national lockdown on March 10.

With the number of confirmed cases and deaths increasing in European countries, on February 10, the Health Protection (Coronavirus) Regulations 2020 was implemented, effective immediately, to impose restrictions on individuals at risk of transmitting the novel coronavirus (Department of Health and Social Care, February 10, 2020). On March 12, 2020, the UK prime minister Boris Johnson stated that from March 13, 2020, onwards, individuals with COVID-19 symptoms should stay home for at least 7 days to protect others and mitigate the spread of the virus (Prime Minister's statement on the coronavirus, March 12, 2020). In response to the surge in the number of cases, Boris Johnson announced the first United Kingdom-wide coronavirus lockdown on March 23, 2020.

This study evaluates whether the COVID-19 pandemic significantly affected the performance of 11 leading global stock indices and explores the extent and direction of the pandemic on the performance of the stock indices. The results show that the outbreak of COVID-19 is a significant negative shock to the global stock markets. The Asian and European stock markets reacted quickly owing to the increasing number of confirmed cases, especially the Chinese stock markets, leading to stock returns dropping significantly on the first day after the event. The second dramatic plunge occurred on February 24, 2020, when the Italian lockdown was announced. This study provides empirical results showing that investors' pessimistic attitudes, as a form of transmission of fear, played an important role in the stock market fluctuations during the pandemic. The results of this study also echo those of Al-Qudah and Houcine (2022) and Liu et al. (2020) regarding the impact of the COVID-19 pandemic on stock markets, indicating that investors' accumulative panic acts as an effective mediator and transmission channel.

This study contributes to the literature in several ways. First, it expands the investigation on the effects of unexpected events and catastrophes on financial markets (Al-Awadhi et al. 2020; Al-Qudah and Houcine 2022). Second, it documents how

stock markets reacted to the COVID-19 pandemic. The rest of this paper is organized as follows. Section 2 reviews the literature, and Sect. 3 describes the methodology of the event study. Section 4 introduces the data sources and sample for processing, and Sects. 5, 6, and 7 present the main results and conclusions.

2 Literature review

The COVID-19 pandemic is fundamentally different from financial and economic crises. While financial and economic crises are, by nature, structural problems or defects in finance and the economy, the COVID-19 pandemic is, by nature, uncertain, that is, when the crisis will end and when major or small economies will bounce back from the current recession are unknown. Research suggested that investors' sentiments derived from unexpected shocks can affect their investment behavior and the performance of stock markets. Unexpected shocks, panic, and fear caused by epidemics can trigger investors' panic selling in response to the crisis (Burch et al. 2016; He et al. 2020). Chen et al. (2020) confirmed that fear of COVID-19 can aggravate the volatility of stock markets. Liu et al. (2020) pointed out that investors' pessimism toward economic conditions and fear of uncertainty because of the fatal virus can lead to negative abnormal returns (ARs). Baker et al. (2012) found that strong sentiments cause low returns on stocks difficult to value and arbitrage, and private capital flows are an effective medium for disseminating investor sentiments across countries.

The effects of previous epidemics and crises on the economy and stock markets were examined in previous studies. Chen et al. (2018) showed that catastrophic epidemics, such as the SARS outbreak, can undermine the integration of financial markets based on the difference-in-differences method. The empirical results of Del Giudice and Paltrinieri (2017) indicated that retail investors' overreaction to Ebola and the Arab Spring and behavior obviously impacted mutual fund flows, controlling for market returns, fund performance, and expenses. Ichev and Marinč (2018) suggested that the Ebola outbreak and its intense media coverage had a significant effect on the stocks of companies located in the geographic proximity of the provenance of the Ebola virus disease and financial markets. In 2016, the Zika virus dragged the global stock market down by 6% a month after the virus triggered a pandemic, whereas two years later, the outbreak of the Ebola virus caused global stocks to drop more than 7% (Nova 2020).

Spulbar et al. (2020) observed significantly positive volatility in five stock markets, that is, in Hungary, the United States, India, Canada, and Germany, in response to the global financial crisis. Al-Rjoub and Azzam (2012) examined the relationship between crises and stock returns in all sectors and found a significant decrease in stock prices and high volatility during the 2008–2009 crash. Theresa and Johnson (2016) determined that the global financial crisis affected the Nigerian stock market significantly and negatively based on a regression model.

Numerous studies examined the impact of the COVID-19 pandemic on financial markets. Disruptions in the global supply chain and massive reductions in the labor supply owing to COVID-19 and lockdowns resulted in a significant drop in

outputs, especially in manufacturing goods and services, which generated stock market uncertainty (Baldwin and Evenett 2020). Ali et al. (2020) showed that financial markets around the world suffered as COVID-19 spread from China to Europe and further to the United States. Liu et al. (2020) suggested that the disastrous outbreak of SARS-CoV-2 had short-term effects on 21 leading stock market indices, resulting in considerable and rapid volatility across stock markets, especially those of Asian countries, after the declaration of the COVID-19 pandemic. Employing the GARCH-MIDAS model, Bai et al. (2020) examined how the infectious disease affected stock market movements in the United States, United Kingdom, China, and Japan and how the pandemic significantly caused the stock markets to volatilize permanently, with the exception of the Chinese stock markets.

The contraction of economic activities led significantly to soaring credit spreads and drops in liquidity in the corporate bond market; thus, persistent disruptions in debt markets and surges in credit spreads have an adverse effect on financial systems (Haddad et al. 2021). Pak et al. (2020) showed that the increase in the number of confirmed COVID-19 cases in developed countries since 2020 has led to a significant decrease in financial and oil markets. In other words, the value of leading stock market indices decreased by a quarter, which was accompanied by a drop in oil prices by more than 65% by April 24, 2020. The increasing number of confirmed COVID-19 cases had a negative impact on stock returns and induced a downward spiral in the performance of stock markets in response to the pandemic (Al-Qudah and Houcine 2022). Based on the fixed effects panel approach and vector autoregression (VAR) method, Beirne et al. (2020) found that the stocks, bonds, capital outflows, and exchange rates of emerging economies in Asia and Europe experienced the highest volatility owing to the COVID-19 shock.

Many studies focused on how COVID-19 lockdown policies affected stock markets. More than 90 countries/regions required their citizens to stay at or work from home during the peak of the COVID-19 pandemic. Eleftheriou and Patsoulis (2020) explored how the returns on 45 stock indices reacted to COVID-19 containment interventions and suggested that the intensity of a lockdown policy negatively affects stock market returns using spatial econometric techniques. Baig et al. (2021) pointed out that pessimistic sentiments and pharmaceutical interventions, including restrictions and lockdowns, can lead to a deterioration in the liquidity and stability of the equity market. Aggarwal et al. (2021) proved that strict lockdowns negatively affect stock market returns by updating growth forecasts and have a positive effect on returns by updating market risk premiums.

3 Event study

An event study is based on the assumption of an efficient market hypothesis, that is, the market is reasonable, and the effect of events can immediately be reflected in the asset prices of financial markets, thereby explaining the effect of information disclosure on stock returns and the essential reaction because financial investors' evaluations and expectations are affected by announcements or events, resulting in changes in stock asset demand and supply and further causing stock prices to

fluctuate irregularly. Based on the assumption of rationality of financial markets, the event study methodology is widely employed to measure the effect of an event on a firm's stock returns and capture reactions to media reports and events.

3.1 Market model

To appraise the impact of COVID-19 on stock performance, a market model, which is a measure of ARs, is introduced in this study. The normal returns during the pre-event period can be obtained using ordinary least squares (OLS).

$$R_{j,t} = \alpha_j + \beta_j R_{m,t} + \varepsilon_{j,t}, \tag{1}$$

where $R_{j,t} = \ln(p_{j,t}/p_{j,t-1})$ is the return on the j_{th} index on day t; α_j is the intercept term; β_j is the systematic risk measuring the sensitivity of the single stock return $R_{j,t}$ to the market index; $R_{m,t}$, which is the realized market index return on day t, is derived from the Dow Jones Index by $R_{m,t} = \ln(p_{m,t}/p_{m,t-1})$; and $\varepsilon_{j,t}$ is the statistic disturbance.

The estimated coefficients $\hat{\alpha}_j$ and $\hat{\beta}_j$ are generated by the OLS. Therefore, the estimated and ARs can be calculated by the following equations.

$$E(R_{j,t}) = \hat{\alpha}_j + \hat{\beta}_j R_{m,t}, \tag{2}$$

$$AR_{j,t} = \epsilon_{j,t}^* = R_{j,t} - ER_{j,t} = R_{j,t} - \left(\hat{\alpha}_j + \hat{\beta}_j R_{m,t}\right). \tag{3}$$

For index j on day t, $E(R_{j,t}) = \hat{\alpha}_j + \hat{\beta}_j R_{m,t}$ is the expected return, $R_{j,t}$ is the actual return, and $AR_{j,t}$ is the AR within the event window. The market return on day t is $R_{m,t}$. The OLS are effective under the assumption of the error term having a constant variance. Stock market returns are not normally distributed, especially in extreme events. The t-statistic would be inflated and result in an imprecise estimation. To control for heteroscedasticity, the AR with a nonconstant variance should be standardized by its standard deviation as $SAR_{jt} = {AR_{jt}} \Big/ \sqrt{Var(AR_{jt}R_{mt})}$. For the sample index on day t, the average AR (AAR) is calculated as $AAR_t = \frac{1}{N} \sum_{j=1}^{N} AR_{j,t}$, where N is the number of sample observations, and t equals 0,1,2 …. The aggregation of the cumulative abnormal returns (CAR) and cumulative average abnormal returns (CAARs) of index i from t_0 to t_1 in the event window can be extracted from $CAR_j(t_0, t_1) = \sum_{t=t_0}^{t_1} AR_{j,t}$ and $CAAR_j(t_0, t_1) = \sum_{t=t_0}^{t_1} AAR_{j,t}$, respectively (MacKinlay, 1997).

3.2 Testing procedure and test statistics

The null hypothesis H_0 states that the COVID-19 outbreak had no effect on the selected stock indices. The alternative hypothesis is H_1, stating that the COVID-19 outbreak caused a significant deviation, from zero stock returns. To be precise, H_1 states that the COVID-19 outbreak had a significant negative effect on stock returns (Anh and Gan 2020; Al-Awadhi et al. 2020). The test statistic of any day t, that is, t-statistic

$= \frac{1}{stard} \sum_{i=1}^{n} CAR_i$ in the event window for all the stock indices, is used to determine whether the CARs are significant. A t-test is conducted to evaluate the statistical significance of the CARs and calculate the empirical results with varied event windows and estimated windows to strengthen the robustness test. The test statistic $\widehat{SCAR}_{i_{(T_1,T_2)}}$, which follows student t with a $(T_1 - T_0) - 2$ degree of freedom, is constructed. Similarly, given a sample including N events, $\overline{CAR}_{(T_1,T_2)} \sim N\left(0, \tilde{\sigma}^2_{(T_1,T_2)}\right)$ is the CAAR from window (T_1, T_2), and $\overline{CAR}_{(T_1,T_2)} = \frac{1}{N}\widehat{CAR}_{i(T_1,T_2)}$. Campbell et al. (1997) claimed that the nonparameter test tends to use the test statistic $J_1 = \frac{\overline{CAR}_{(T_1,T_2)}}{(\hat{\sigma}^2_{(T_1,T_2)})^{\frac{1}{2}}} \sim N(0,1)$ to examine whether stock market returns are statistically significantly different from zero. The expected value of the CAR is zero in the absence of ARs.

4 Data sources and sample

In this study, 13 leading stock indices from different countries and regions are selected to explore the response of the stock markets to the COVID-19 outbreak (see Table 1). Data on the stock indices' daily closing prices from April 23, 2019 to April 17, 2020 are collected from the https://www.investing.com/ website portal. The event date should be the day of the lockdown announcement, because the abnormal behavior of the investors on the market is visible at the exact moment of receiving information on the lockdown. In this study, the event date is set to January 23, 2020, when news of the Wuhan lockdown was released to the public, and the timeline of the event study covers an estimation window from April 23, 2019 to January 22, 2020, and a post-event window from January 24, 2020 to April 17, 2020. In an attempt to further prevent the spread of the virus, minimize suffering, and save lives,

Table 1 Selected indices representing the most affected countries (source: https://finance.yahoo.com/; https://www.investing.com/)

Country	Stock Index	Symbol
France	Cotation Assistee en Continu 40 Index	FCHI
Germany	Deutsche Aktien Xchange Performance Index	GDAXI
Italy	FTSE Italia All Share Industries	FII
United Kingdom	Financial Times Stock Exchange 100 index	FTSE100
Russia	Moscow Exchange Russia Index	IMOEX.ME
United States	Dow Jones Industrial Average Index	DJI
United States	Chicago Board Options Exchange Volatility Index	VIX
United States	Standard &Poor's 500 Index	GSPC
Canada	S&P/Toronto Stock Exchange Composite Index	GSPTSE
Hong Kong, China	Hang Seng Index	HIS
Shanghai, China	Shanghai Composite Index	SSEI
Japan	Nikkei 225 Index	N225
Korea	Korea Composite Stock Price Index	KS11

Italy and the United Kingdom successively announced their lockdown policy, imply-ing the serious deterioration of the pandemic situation worldwide and in European countries. Therefore, key dates when national lockdown measures were announced, that is, January 23, 2020, in Wuhan; January 30, 2020, in Italy; and February 10, 2020, in the United Kingdom, are examined in the analysis.

The estimation of the ARs is based on the market model, where the Dow Jones Industrial Average Index, which is representative of the overall performance of global stock markets, is defined as the benchmark index. The estimation window of 196 trading days is defined as (–196, –1), and the CARs are estimated through five event windows consisting of trading day intervals (–3, 3), (0, 10), (0, 20), (21, 40), and (41, 61). The results from the varied-length event windows show not only the pandemic response speed but also the stock price trends in the stock markets.

Table 2 presents the descriptive analysis of the returns on the leading indices, including the mean, standard deviation, and minimum and maximum returns before and after January 23, 2020. All the indices experienced a drop in the mean returns as well as an increase in the standard deviation of daily returns during the post-event period. Meanwhile, all the minimum returns on the stock market indices in the post-event window are lower than those in the pre-event window. Instead, the maximum returns after the event date exceed the maximum in the estimation window. This result means that COVID-19 had a considerable negative impact on all the stock indices, and the financial market reacted negatively to media reports on the Wuhan lockdown. The stock indices of the Asian and European countries experienced con-siderable losses owing to the change in the epicenter of the COVID-19 pandemic from Asia to Europe.

5 Event study results

The ARs on the dates of the announcement of a lockdown policy and succeeding days are shown in Table 3, revealing how the stock markets reacted to such dates. The stock indices of the Asian and European countries/regions experienced negative ARs owing to their rapid response to the COVID-19 outbreak. The most significant drop in earnings can be seen in the HIS and SSEI of China on the first day after the event. The Chinese stock markets seem to experience the most serious financial losses, with the ARs on the HIS and SSEI decreasing by –1.464% and –2.7444%, respectively.

Table 3 also shows the wide scope of the damage and further losses experienced by the leading stock indices. Officials announced lockdown on January 30, 2020, in Italy and on February 10, 2020, in the United Kingdom to control the spread of the virus. On January 30, 2020, the WHO announced the COVID-19 outbreak as a Pub-lic Health Emergency of International Concern, which can threaten countries with a vulnerable health system. All the indices are negative and experienced more losses in their reaction to media reports compared with their ARs on the event date. All the stock markets with negative ARs reacted rapidly to the Italian lockdown news and WHO announcement of the COVID-19 pandemic on January 30, 2020, whereas the majority of the stock markets recovered rapidly, showing positive ARs the follow-ing day. No significant changes can be seen in the ARs on the sample stock indices

Table 2 Descriptive analysis of returns on the selected indices

Pre-event period: April 23, 2019 to January 22, 2020

Variable	Mean	Std. Dev.	Min	Max
FCHI	0.0003708	0.0083455	–0.0363548	0.022799
GDAXI	0.0005103	0.0085083	–0.0315633	0.028163
GSPTSE	0.0002786	0.0043749	–0.0188234	0.0095089
HIS	–0.0002854	0.0100841	–0.0294071	0.038251
KS11	0.0001068	0.0080247	–0.0309157	0.0185459
N225	0.0003927	0.0079342	–0.0219608	0.0252201
IMOEXME	0.0010487	0.0071472	–0.0201771	0.023948
FTSES100	0.0000332	0.007186	–0.032839	0.0222716
SSEI	–0.0002259	0.009656	–0.0600678	0.0304874
GSPC	0.0006371	0.0075685	–0.0302302	0.0212059
DJI	0.000465	0.0074962	–0.0309337	0.0204346
FII	0.0001257	0.0110148	–0.0332584	0.0317388

Post-event period: January 24, 2020 to April 17, 2020

Variable	Mean	Std. Dev.	Min	Max
FCHI	–0.0046424	0.0325833	–0.1309835	0.0805608
GDAXI	–0.0037886	0.0323979	–0.1305486	0.1041429
GSPTSE	–0.0033557	0.0393348	–0.131758	0.1129453
HIS	–0.0022162	0.0199164	–0.0498489	0.0492499
KS11	–0.0026186	0.0287846	–0.0876697	0.0825127
N225	–0.002933	0.0254183	–0.0627357	0.0773138
IMOEXME	–0.0035151	0.0274565	–0.0864601	0.0743494
FTSES100	–0.0042675	0.0294925	–0.1151243	0.086668
SSEI	–0.0007784	0.0174357	–0.0803916	0.0309795
DJI	–0.0030278	0.0416065	–0.1384181	0.1076433
GSPC	–0.0023891	0.038956	–0.1276522	0.0896832
FII	–0.005658	0.0378914	–0.182766	0.0681062

Source: authors' calculation; the event date is January 23, 2020

on February 10, 2020, when the United Kingdom released news related to their lockdown.

A graph of the ARs reflecting the fluctuations in the ARs on all the selected stock markets during the (0, 61) event window is a simple and effective way to measure the possible effects of a specific event. Guidolin and La Ferrara (2007) showed that the downward shape of ARs illustrates a negative shock to stock prices. The ARs of the Asian stock market indices experienced a sharp drop on the day of the event, because the COVID-19 outbreak was confined to Asia (see Fig. 1a). The performance of the European stock markets was relatively stable when the virus spread only across Asia, though the ARs on the stock indices experienced a decrease on the day of the event (see Fig. 1b). Owing to the change in the epicenter of the COVID-19 pandemic from Asia to Europe, evidently, the stock indices experienced

considerable AR fluctuations after the Italian government announced quarantine restrictions on February 23. The figure also shows that the indices exhibited high volatility 27 days after the event, which means that the markets tried to rebalance themselves after reacting to the event.

The statistical significance of the CARs is presented in Tables 4, 5, 6, 7, and 8 to determine whether the COVID-19 outbreak had an effect on the 11 selected stock market indices for five event windows, that is, the trading day intervals (–3, 3), (0, 10), (0, 20), (21, 40), and (41, 61). The CARs on the stock indices in Table 4, including the HIS, N225, SSEI, GSPTSE, and IMOEX.ME, are significant, thereby indicating that the stock indices were negatively affected by the COVID-19 outbreak, especially those of the Asian countries. During the (-3, 3) window, the performance of the Chinese and Japanese stock markets is the most affected by the news of the lockdown in Wuhan, with the CAR value of the SSEI, HIS, and N225 being -0.027, -0.029, and -0.034, respectively. For the (0, 10) event window, approximately 80% of the indices demonstrate negative CARs, whereas some stock indices (i.e., SSEI, GSPTSE, and IMOEX.ME) experienced statistically significant financial losses (Table 5).

Table 6 shows that the CARs of the Chinese stock indices are positive but statistically insignificant in the (0, 20) event window, indicating the lack of response to the event, whereas the N225 of Japan, KS11 of Korea, FTSES100 of the United Kingdom, FII of Italy, and IMOEX.ME of Russia display significantly negative CARs, which means that the stock markets continue to respond to the COVID-19 outbreak, with the number of confirmed cases and deaths in the United Kingdom, Italy, Japan, Korea, and Russia increasing rapidly.

Table 3 ARs on key time points and one day after the event

Index	ARs					
	Jan 23, 2020	Jan 24, 2020	Jan 30, 2020	Jan 31, 2020	Feb 10, 2020	Feb 11, 2020
GSPC	0.00182698	–0.0035753	–0.00127325	0.00248171	0.00151769	–0.00283054
FCHI	–0.00585472	0.01328459	–0.01743466	0.00518079	0.00647972	0.00095219
GDAXI	–0.00895976	0.01816997	–0.01757945	0.00219441	0.00971607	0.00176948
GSPTSE	0.00152423	–0.00089399	–0.00308074	–0.00130252	0.00197435	–0.00079251
HIS	–0.01464169	0.00373373	–0.02748379	0.00193176	0.01293338	0.00613373
KS11	–0.00916749	0.00127792	–0.01816218	–0.0089666	0.00996661	0.00478795
N225	–0.01007106	0.001808	–0.01825339	0.0124194	–0.00032667	0.00575877
IMOEXME	–0.01123949	0.00236308	–0.00864832	–0.00515429	0.01050892	0.00433099
FTSES100	–0.00776131	0.0140265	–0.01596087	–0.00054004	0.00728035	–0.00056187
SSEI	–0.027444	0.0013128	–0.00044014	0.00393729	0.00416968	0.00735561
FII	–0.00529052	0.02488806	–0.02832326	0.00955246	0.00967483	0.00129455

Source: authors' calculation; the event date is January 23, 2020; national lockdown announcements were released on January 23, 2020, in Wuhan; January 30, 2020, in Italy; and February 10, 2020, in the United Kingdom
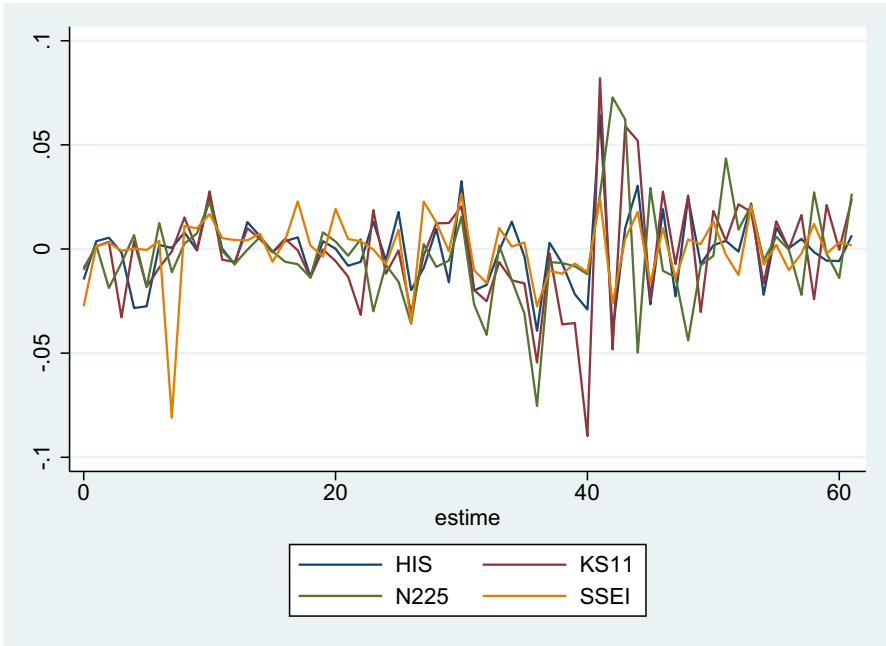
(a) ARs on Asian stock market indices
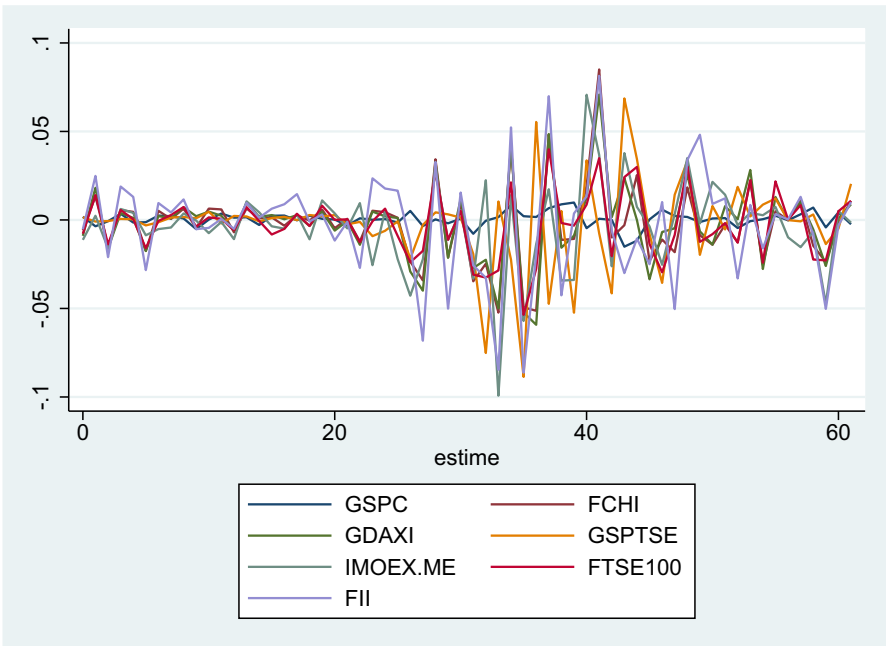
(b) ARs on stock market indices of countries outside Asia

Table 4 CARs in (-3, 3) event window

Index	CAR (−3, 3)	T-test	P-value
GSPC	0.003465	1.4999	0.1843
FCHI	−0.012447	−1.3808	0.2168
GDAXI	−0.000163	−0.0149	0.9885
GSPTSE	0.004911***	4.3088	0.00504
HIS	−0.029007*	−2.1539	0.0747
KS11	−0.028684	−1.9342	0.1012
N225	−0.034290***	−3.9434	0.0075
IMOEX.ME	−0.026758**	−2.9143	0.0268
FTSES100	−0.011381	−1.2545	0.2564
SSEI	−0.026867*	−2.2083	0.0693
FII	0.010808	0.6664	0.5264

Source: authors' calculation

*, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

The deterioration of the epidemic situation prompted the affected countries to implement effective nonpharmaceutical interventions or lockdowns, which led to investors' pessimistic attitudes toward the global economy and financial market. The (21, 40) event window has several key time points, including the 22nd (i.e., the next day after the Italian announcement of quarantine restrictions), 33rd (i.e., the Italy-wide lockdown), and 35th (i.e., announcement of a 7-day isolation order) event dates. Table 7 shows that except for the GSPC of the United States, all the CARs on the stock indices are negative and statistically significant, thereby implying that the COVID-19 pandemic had the worst effect on the stock markets. In addition, the statistically significant CARs during the (21, 40) event are the lowest among the five event windows.

Table 5 CARs in (0, 10) event window

Index	CAR (0,10)	T-test	P-value
GSPC	−0.001251	−0.4721	0.6461
FCHI	−0.000722	−0.0754	0.9412
GDAXI	−0.002366	−0.2276	0.82410
GSPTSE	0.005237**	2.6211	0.02370
HIS	−0.027685	−1.7623	0.10570
KS11	−0.0189920	−1.1859	0.26090
N225	−0.0111110	−0.8465	0.41530
IMOEX.ME	−0.0368230***	−5.1737	0.0003
FTSES100	−0.0101390	−1.1325	0.2817
SSEI	−0.0633380**	−2.3167	0.0408
FII	0.0179380	1.0958	0.2965

Source: authors' calculation

*, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Table 6 CARs in (0, 20) event window

Index	CAR (17, 32)	T-test	*P*-value
GSPC	0.010365***	4.4497	0.0002
FCHI	0.007395	0.9891	0.3338
GDAXI	0.006613	0.8187	0.4221
GSPTSE	0.017052***	9.3962	0.00001
HIS	–0.017449	–1.4198	0.1705
KS11	–0.032515**	–2.6623	0.0145
N225	–0.030312***	–2.9368	0.0078
IMOEX.ME	–0.035265***	–4.7087	0.0001
FTSES100	–0.013710*	–1.8728	0.0752
SSEI	–0.003824	–0.1811	0.8581
FII	–0.044939**	–3.5464	0.0019

Source: authors' calculation

*, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Table 8 reveals that while the GSPC and FII exhibit negative CARs, the GDAXI, GSPTSE, HIS, SSEI, KS11, and N225 have significant positive CARs, indicating that COVID-19, as a negative shock, had no adverse effect on the profitability of the stock markets of China, Japan, Korea, Germany, and Canada when the pandemic situation was alleviated. The Chinese stock markets appear to bounce back from the COVID-19 pandemic owing to the reduced number of confirmed cases in Mainland China.

Table 9 exhibits the daily CAARs and AARs of the selected stock indices. The results show that the majority of the CAARs is statically significant, and the CAARs drop over time, from –0.0018 on day 1 to –0.1293 on day 61. It can be seen that two sharp drops occur in the stock markets on day 0 and day 27. A similar pattern can be seen in the Asian and Italian markets. The variations in the AARs and CAARs are illustrated in Fig. 2, which shows an overall downward pattern, stagnation from day

Table 7 CARs on stock indices in (21, 40) event window

Index	CAR (21, 40)	T-test	*P*-value
GSPC	0.023946***	5.1695	0.00004
FCHI	–0.161976***	–5.4891	0.00002
GDAXI	–0.108707***	–3.5112	0.0021
GSPTSE	–0.236166***	–7.0118	0.0000
HIS	–0.113403***	–6.5790	0.00000
KS11	–0.327633***	–12.4694	0.0000
N225	–0.304714***	–15.0555	0.0000
IMOEX.ME	–0.227545***	–6.3160	0.0000
FTSES100	–0.144105***	–6.4097	0.0000
SSEI	–0.044048***	–2.9125	0.0086
FII	–0.205342***	–4.8014	0.0001

Source: authors' calculation

***indicates significance at the 1% level

Table 8 CARs in (41, 61) event window

Index	CAR (41, 61)	T-test	P-value
GSPC	−0.010061*	−1.9480	0.0649
FCHI	0.008244	0.3381	0.7386
GDAXI	0.066641***	2.9579	0.0075
GSPTSE	0.086403***	3.5802	0.0017
HIS	0.065723***	2.9387	0.0078
KS11	0.231379***	7.4861	0.0000
N225	0.151319***	4.9098	0.00007
IMOEX.ME	0.034533	1.6511	0.1135
FTSES100	0.011788	0.5770	0.5700
SSEI	0.023341*	1.8241	0.0824
FII	−0.002909	−0.0945	0.9256

Source: authors' calculation

* and ** indicate significance at the 10% and 5% level, respectively

15 to day 26, and two plunges consistent with the results in Table 9. A significant different movement pattern starts on day 28 between the CAAR and AAR lines.

6 Analysis of OLS regression and empirical results

6.1 Financial variables and specific models

Based on the time series data for the 13 stock indices from February 21, 2020 to April 17, 2020, OLS are used to identify the impact of the COVID-19 pandemic and transmission channel on the stock market indices (Liu et al. 2020). The performance of the major stock indices after the declaration of the pandemic is captured by the OLS regression model in the (0, 61) time window, and AR is defined as the dependent variable. The global market systematic risks as well as country-specific systematic risks are controlled using the DJI returns and daily returns of each stock index, respectively. As the panel data have time-dimension and cross-section-dimension characteristics, they may have unobserved and observed factors. In other words, the country-level and year fixed effects designated as ρ_i and φ_t are inherent in the selected stock market indices.

The outbreak of COVID-19 attracted considerable attention in Asian countries, so classifying the stock indices into Asia and outside Asia and testing the regional impact of the outbreak are necessary. The Asia dummy variable equals 1 if the country of the stock market indices belongs to Asia, and 0 otherwise. Therefore, variables such as the logarithm of the number of confirmed cases, Asia dummy variable, earnings of each stock index controlling for the country-specific systematic risks, and return on the market benchmark controlling for the global market systematic risks are introduced into the model, and the equation is specified below.

$$AR_{i,t} = \alpha + \beta_1 \ln case_{it} + \beta_2 Return_{it} + \beta_3 MarketRe_{it} + \beta_4 Asia + \rho_i + \varphi_t + \varepsilon_{it}.$$

$$(4)$$

Table 9 CAARs and AARs

Date	AAR	CAAR	*P*-value	Date	AAR	CAAR	*P*-value
0	−0.008825	−0.008825	0.8799	31	−0.023166	−0.099336	0.0801
1	0.006945	−0.001880	0.9743	32	−0.024118	−0.097454	0.0984
2	−0.008174	−0.010054	0.8634	33	−0.027085	−0.111540	0.0563
3	0.000210	−0.009843	0.8662	34	0.012746	−0.098794	0.0909
4	0.000401	−0.009441	0.8716	35	−0.039362	−0.138156	0.0180
5	−0.014240	−0.023681	0.6853	36	−0.028282	−0.166438	0.0044
6	0.001975	−0.021706	0.7103	37	0.015208	−0.151229	0.0096
7	−0.007730	−0.029436	0.6144	38	−0.013933	−0.165163	0.0047
8	0.006857	−0.022579	0.6992	39	−0.015270	−0.180433	0.0020
9	0.000077	−0.022501	0.7002	40	0.001047	−0.179386	0.0021
10	0.008932	−0.013568	0.8164	41	0.045349	−0.134036	0.0218
11	0.000866	−0.012702	0.8279	42	−0.013051	−0.147087	0.0118
12	−0.004336	−0.017039	0.7706	43	0.022039	−0.125048	0.0323
13	0.006717	−0.010321	0.8598	44	0.011377	−0.113670	0.0517
14	0.002563	−0.007757	0.8943	45	−0.013144	−0.126815	0.0300
15	−0.000732	−0.008490	0.8844	46	−0.004186	−0.131001	0.0249
16	0.000650	−0.007839	0.8932	47	−0.010855	−0.141856	0.0152
17	0.004284	−0.003554	0.9515	48	0.017210	−0.124646	0.0329414
18	−0.004797	−0.008351	0.8863	49	−0.004122	−0.128768	0.0275715
19	0.003949	−0.004402	0.9399	50	0.003026	−0.125742	0.0314330
20	0.000155	−0.004246	0.9420	51	0.006755	−0.118987	0.0417539
21	−0.002790	−0.007036	0.9041	52	−0.002716	−0.121703	0.0373019
22	−0.007803	−0.014839	0.7995	53	0.015252	−0.106451	0.0685370
23	−0.000006	−0.014845	0.7994	54	−0.012059	−0.118510	0.0425796
24	−0.000181	−0.015027	0.7970	55	0.008750	−0.109760	0.0603701
25	−0.000349	−0.015377	0.7924	56	−0.001792	−0.111553	0.0562932
26	−0.024542	−0.039920	0.4945	57	0.002406	−0.109146	0.0618207
27	−0.015932	−0.155852	0.0089	58	−0.003043	−0.112190	0.0549011
28	0.016857	−0.138995	0.0249	59	−0.016089	−0.128279	0.0281667
29	−0.011265	−0.140260	0.0138	60	−0.001063	−0.129342	0.0268878
30	0.013091	−0.137169	0.0294	61	0.010538	−0.118803	0.0420704

6.2 Regression results

First, regression is conducted on the AR on ln case (*confirmed cases*), then, the other variables (return, market return, and Asia) are added one by one. In this case, the value of the mean variance inflation factor, which is used to check for the problem of multicollinearity among the variables, is 6.31, showing that no collinearity exists in the regression model. The cross-section heterogeneity and dependence test results indicate the existence of individual heterogeneity and correlation. The Hausman test is also conducted to determine whether the sample model prefers fixed effects. Obtaining effective estimators using the 975 sample observations is feasible.
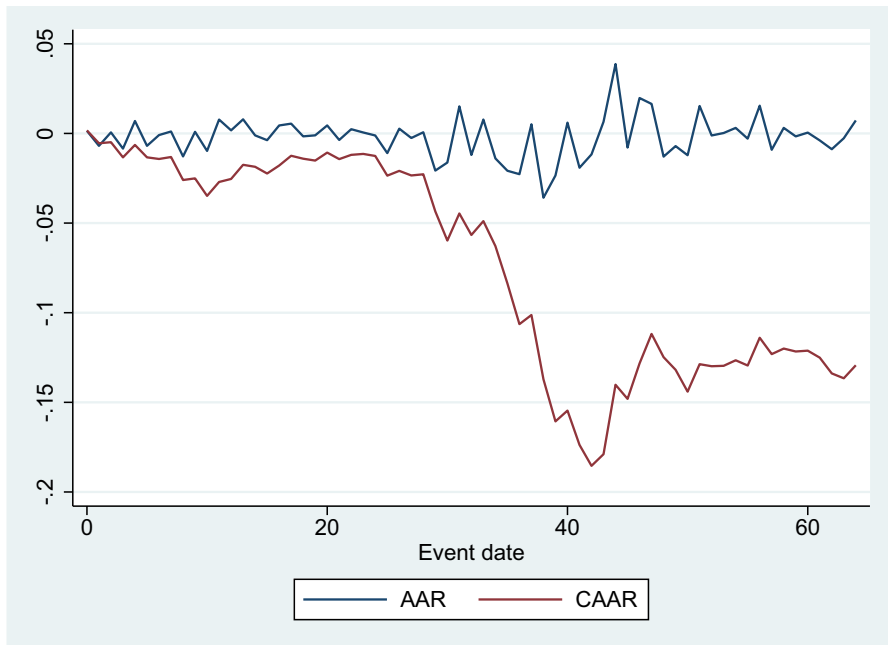
Fig. 2 Changes in AAR and CAAR from day 0 to 61

Table 10 indicates that the daily ARs on the stock market indices are negatively associated with the number of confirmed cases at the onset of the COVID-19 pandemic, meaning that the international stock markets are sensitive to the evolution of the novel coronavirus. The negative coefficient of the Asia dummy variable is indicative of the Asian stock indices experiencing more financial losses than the stock indices of the other countries, which is consistent with the findings of the event study.

6.3 Transmission channel of effect of COVID-19 outbreak on stock indices

The impact of the COVID-19 outbreak on financial investment behavior is mediated by internal transformation processes. A pandemic transmits uncertainty to the economy, increases stock investors' fears, and induces pessimistic sentiments on expected returns. PH and Rishad (2020) argued that investors' irrational sentiments significantly lead to excessive stock market volatility. To verify the mediating effect, investors' fear measured in the VIX, which is a real-time market index signifying the market's expectations on a 30-day forward-looking volatility, is introduced into the regression. The VIX is set as the mediator, and three regression paths are conducted to test the mediation effect (Baron and Kenny 1986; Liu et al. 2020) following Eqs. (5), (6), and (7).

$$AR_{i,t} = \alpha + \beta_1 \ln case_{it} + \beta_2 \, Control_{it} + \rho_i + \varphi_t + \varepsilon_{it.} \tag{5}$$

$$VIX_{it} = \alpha + \beta_1 \ln case_{it} + \rho_i + \varphi_t + \varepsilon_{it.} \tag{6}$$

Table 10 OLS regression results

	Model 1	Model 2	Model 3	Model 4
Variables	AR	AR	AR	AR
ln*case*	−0.00286**	−0.00138**	−0.000985**	−0.000985**
	(−0.00136)	(0.000556)	(0.000413)	(0.000413)
Return		0.636**	0.865053**	0.865053**
		(0.0418)	(0.02403)	(0.02403)
Market Re			−0.448**	−0.448**
			(0.02835)	(0.02835)
Asia				−0.00342*
				(0.00185)
Constant	0.01643	0.0532*	0.00353	0.00652**
	(0.010067)	(0.003148)	(0.002368)	(0.00238)
Observations	975	975	975	975
R-squared	0.201	0.612	0.801	0.801
Year control	yes	yes	yes	yes
Country control	yes	yes	yes	yes

Robust standard errors are in parentheses

* and ** indicate significance at the 10% and 5% level, respectively

$$AR_{i,t} = \alpha + \beta_1 \ln case_{it} + \beta_2 VIX_{it} + \beta_3 Control_{it} + \rho_i + \varphi_t + \varepsilon_{it.} \qquad (7)$$

Table 11 shows that all the coefficients of the independent variables are significant in path (5), whereas the coefficient of the number of confirmed cases is

Table 11 Mediation effect of VIX

		(6)	(7)	(8)
	Variables	AR	VIX	AR
	ln *case*	−0.000985**	2.864221**	−0.000423
		(0.000413)	(0.700741)	(0.0004658)
	Return	0.865053**		0.8697**
		(0.02403)		(0.02467)
	Market Re	−0.448**		−0.496**
		(0.02835)		(0.03147)
	VIX			−0.000295**
				(0.0001061)
	Constant	0.00353	−0.524371	0.0014085
		(0.002368)	(2.652357)	(0.002059)
	Observations	975	948	948
	R-squared	0.801	0.863	0.835
	Year control	yes	yes	yes
	Country control	yes	yes	yes

Source: authors' calculation

** and * indicate that the coefficients are statistically significant at the 5% and 10% level, respectively

significant in path (6). However, the coefficients of VIX and confirmed number of cases are significant and insignificant in path (7), respectively, after VIX is added to the regression model. Thus, VIX is an ideal mediator, and the cumulative panic and uncertainty owing to the pandemic and economy enable fear of the COVID-19 pandemic to be transmitted to the financial markets.

7 Conclusions

In this study, the effect of the COVID-19 pandemic on the performance of major stock markets is illustrated. From an investor's perspective, investment risks caused by an unexpected shock are as important as management operation activities specific to firms to analyze the returns on stock indices. The main results indicate that the COVID-19 pandemic, as a significant negative shock, has an adverse impact on the performance of the stock market indices of the affected areas. The ARs on the stock markets experienced two plunges when China and Italy announced lockdown measures. The Asian stock markets, especially the SSEI and HIS, experienced a huge drop in their ARs and CARs on the first day of the event, but the Chinese markets recovered gradually from their financial losses as the number of confirmed COVID-19 cases decreased. The number of confirmed cases seems to have a significant negative effect on the performance of the stock indices. In terms of the ARs, the Asian indices suffered greater losses than the indices of the countries outside Asia. Finally, owing to the high degree of globalization and intensively integrated value chain, investors' pessimistic sentiments toward their investments play an important role in transmitting fear during the COVID-19 pandemic.

In addition to nonpharmaceutical interventions, the results imply that investors, bankers, and financial analysts may need to set up different trading strategies to avoid losses. Overreaction to the pandemic prompts investors to sell stocks to reduce possible financial losses, so financial market regulators could impose limitations on short selling or repurchase their own stock shares. Based on the analysis of the performance of the stock market indices, government officials and bank authorities should implement measures to help different sectors survive this difficult time, including fiscal stimuli (i.e., issuing new government bonds and subsidies) and monetary policies (i.e., interest rate cuts; Pragyan et al. 2020). Maintaining functioning healthcare systems and economies is important for authorities, which will enable firms to run well and obtain earnings with certainty.

This study describes and analyzes the complex problem of the COVID-19 pandemic but only notes the effect of investors' sentiments on the performance of the leading stock indices as well as how they interactively affect global stock markets. The examination of the performance of the stock indices has certain limitations. Many factors affecting the returns on the stock indices may be ignored, including investors' stock market preferences and experiences and firms' specific and individual characteristics, owing to difficulties in collecting such data. Another limitation is the use of short estimation and post-event windows. As the pandemic developed, other trails were present in the data. Thus, studying the long-term effect of COVID-19 on the profitability of stock markets would be worthwhile.

References

Aggarwal S, Nawn S, Dugar A (2021) What caused global stock market meltdown during the COVID pandemic–lockdown stringency or investor panic? Financ Res Lett 38:101827. https://doi.org/10.1016/j.frl.2020.101827

Al-Awadhi AM, Al-Saifi K, Al-Awadhi A, Alhamadi S (2020) Death and contagious infection diseases: Impact of the COVID-19 virus on stock market returns. J Behav Exp Financ 27:1–5. https://doi.org/10.1016/j.jbef.2020.100326

Ali M, Alam N, Rizvi SAR (2020) Coronavirus (COVID-19)–an epidemic or pandemic for financial markets. J Behav Exp Financ 27:100341. https://doi.org/10.1016/j.jbef.2020.100341

Al-Qudah AA, Houcine A (2022) Stock markets' reaction to COVID-19: Evidence from the six WHO regions. J Econ Stud 49(2):274–289. https://doi.org/10.1108/JES-09-2020-0477

Al-Rjoub SA, Azzam H (2012) Financial crises, stock returns and volatility in an emerging stock market: the case of Jordan. J Econ Stud 39(2):178–211. https://doi.org/10.1108/01443581211222653

Anh DLT, Gan C (2020) The impact of the COVID-19 lockdown on stock market performance: Evidence from Vietnam. J Econ Stud 48(4):836–851. https://doi.org/10.1108/JES-06-2020-0312

Baldwin RE, Evenett SJ (2020) COVID-19 and trade policy: Why Turning Inward Won't Work. A VoxEU.org eBook, CEPR Press.

Bai L, Wei Y, Wei GW, Li XF, Zhang SY (2020) Infectious disease pandemic and permanent volatility of international stock markets: a long-term perspective. Financ Res Lett 40:101709. https://doi.org/10.1016/j.frl.2020.101709

Baig A, Butt HA, Haroon O, Rizvi SAR (2021) Deaths, panic, lockdowns and US equity markets: the case of COVID-19 Pandemic. Financ Res Lett 38:101701. https://doi.org/10.1016/j.frl.2020.101701

Baron RM, Kenny DA (1986) The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol 51(6):1173–1182. https://doi.org/10.1037//0022-3514.51.6.1173

Baker MP, Wurgler JA, Yuan Y (2012) Global, local, and contagious investor sentiment. J Financ Econ 104:272–287. https://ssrn.com/abstract=1364911

Beirne J, Renzhi N, Sugandi E, Volz U (2020) Financial market and capital flow dynamics during the Covid-19 pandemic. ADBI Working Paper Series. No.1158, June 2020

Burch TR, Douglas RE, Michael RF (2016) Who movers markets in a sudden marketwide crisis? Evidence from 9/11. J Financ Quant Anal 51(2):463–487. https://www.jstor.org/stable/43862324

Campbell JY, Lo AW, MacKinlay AC (1997) The econometrics of financial markets. Princeton University Press, Princeton, NJ

Chen C, Liu L, Zhao N (2020) Fear sentiment, uncertainty, and bitcoin price dynamics: the case of COVID-19. Emerg Mark Financ Trade 56(10):2298–2309. https://doi.org/10.1080/1540496X.2020.1787150

Chen MP, Lee CC, Lin YH, Chen WY (2018) Did the SARS epidemic weaken the integration of Asian stock markets? Evidence from smooth time-varying cointegration analysis. Econ Research-Ekonomska Istraživanja 31(1):908–926. https://doi.org/10.1080/1331677X.2018.1456354

Del Giudice A, Paltrinieri A (2017) The impact of the Arab Spring and the Ebola outbreak on African equity mutual fund investor decisions. Res Int Bus Financ 41:600–612. https://doi.org/10.1016/j.ribaf.2017.05.004

Eleftheriou K, Patsoulis P (2020) COVID-19 lockdown intensity and stock market returns: a spatial econometrics approach. Working Paper No. 100662, University Library of Munich, Munich. https://mpra.ub.uni-muenchen.de/100662/

Flaxman S, Mishra S, Gandy A et al (2020) Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. Nature 584:257–261. https://doi.org/10.1038/s41586-020-2405-7

Goldstein I, Koijen RS, Mueller HM (2021) COVID-19 and its impact on financial markets and the real economy. Rev Financ Stud 34(11):5135–5148. https://doi.org/10.1093/rfs/hhab085

Guan D, Wang D, Hallegatte S et al (2020) (2020) Global supply-chain effects of COVID-19 control measures. Nat Human Behav 4:577–587. https://doi.org/10.1038/s41562-020-0896-8

Guidolin M, La Ferrara E (2007) Diamonds are forever, wars are not: Is conflict bad for private firms? Am Econ Rev 97(5):1978–1993. https://www.jstor.org/stable/30034595

Haddad V, Moreira A, Muir T (2021) When selling becomes viral: Disruptions in debt markets in the COVID-19 crisis and the Fed's response. Rev Financ Stud 34:5309–5351

He Q, Liu J, Wang S, Yu J (2020) The impact of COVID-19 on stock markets. Econ Pol Stud 8(3):275–288. https://doi.org/10.1080/20954816.2020.1757570

Health Secretary announces strengthened legal powers to bolster public health protections against coronavirus. GOV.UK. https://www.gov.uk/government/news/health-secretary-announces-strengthened-legal-powers-to-bolster-public-health-protections-against-coronavirus. Accessed 5 May 2022.

Ichev R, Marinč M (2018) Stock prices and geographic proximity of information: Evidence from the Ebola outbreak. Int Rev Financ Anal 56:153–166. https://doi.org/10.1016/j.irfa.2017.12.004

Italy: Council of Ministers issue state of emergency due to 2019-nCoV as of January 31 /update 1. Crisis 24. 31 Jan 2020. Available at https://crisis24.garda.com/alerts/2020/01/italy-council-of-ministers-issue-state-of-emergency-due-to-2019-ncov-as-of-january-31-update-1. Accessed 3 May 2022

Ji X, Dong F, Zheng C, Bu N (2022) The influences of international trade on sustainable economic growth: an economic policy perspective. Sustainability 14(5):2781. https://doi.org/10.3390/su14052781

Keogh-Brown MR, Smith RD (2008) The economic impact of SARS: how does the reality match the predictions? Health Policy 88(1):110–120. https://doi.org/10.1016/j.healthpol.2008.03.003

Liu H, Manzoor A, Wang C, Zhang L, Manzoor Z (2020) The COVID-19 outbreak and affected countries stock markets response. Int J Environ Res Public Health 17(8):2800. https://doi.org/10.3390/ijerph17082800

MacKinlay AC (1997) Event studies in economics and finance. J Econ Lit 35(1):13–39. http://www.jstor.org/stable/2729691

Nova A (2020) History shows stocks typically rebound from disease outbreaks before long. CNCB Web. https://www.cnbc.com/2020/02/24/past-disease-outbreaks-show-investors-shoud-ignore-the-noise-of-coronavirus.html. Accessed 24 Dec 2020 and 6 May 2022

Pak A, Adegboye OA, Adekunle AI, Rahman KM, McBryde ES, Eisen DP (2020) Economic consequences of the COVID-19 outbreak: the need for epidemic preparedness. Front Public Health 8:241. https://doi.org/10.3389/fpubh.2020.00241

PH H, Rishad A (2020) An empirical examination of investor sentiment and stock market volatility: Evidence from India. Financ Innov 6:34. https://doi.org/10.1186/s40854-020-00198-x

Pragyan D, Davide F, Jonathan O, Nour T (2020) The economic effects of COVID-19 containment measures. IMF Working Paper No. 20/158. https://www.imf.org/en/Publications/WP/Issues/2020/08/07/The-Economic-Effects-of-COVID-19-Containment-Measures-49571. Accessed 26 Jun 2021

Prime Minister's statement on coronavirus (COVID-19): 12 March 2020. GOV.UK. https://www.gov.uk/government/speeches/pm-statement-on-coronavirus-12-march-2020. Accessed 1 May 2022

Spulbar C, Trivedi J, Birau R (2020) Investigating abnormal volatility transmission patterns between emerging and developed stock markets: a case study. J Bus Econ Manag 21(6):1561–1592. https://doi.org/10.3846/jbem.2020.13507

The Economist (2020) Tracking the economic impact of covid-19 in real time. 14th March. https://www.economist.com/united-states/2020/03/14/tracking-the-economic-impact-of-covid-19-in-real-time. Accessed 6 May 2021

The Economist (2021) What is the economic cost of COVID-19? 7th January. https://www.economist.com/finance-and-economics/2021/01/09/what-is-the-economic-cost-of-covid-19. Accessed 5 May 2021

Theresa EO, Johnson NN (2016) Impact of global financial crisis on Nigerian stock market. Afr Res Rev 10(1):166–177. https://doi.org/10.4314/afrrev.v10i1.13

World Health Organization (2020) https://covid19.who.int/