Stock Market Responses to the COVID-19 Health Crisis: Evidence From the World’s Largest Economies

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ABSTRACT
The outbreak of the novel COVID-19 pandemic emerged as a major black swan event which has caused shock waves and severely hurt the sentiments of market participants. The pandemic has raised uncertainties and risks all over the world, impacting substantially the world’s 20 largest economies. While the stock markets’ intense reaction to the official news of the pandemic is well known, the reaction of largest world economies during the initial phases of the outbreak until 11th March 2020 is not very well established. Therefore, the present study investigates how stock markets in world’s 20 largest economies have reacted to major events and press releases associated with disease from the beginning of the pandemic (i.e., 31st December 2019 till 11th March 2020). The results of the study suggest that the declaration of the novel COVID-19 as a pandemic was the most devastating event for stock markets. This was confirmed by using various parametric and non-parametric tests. In addition, the last event was further analyzed by observing CARs of various indices individually.

KEYWORDS
Abnormal Returns, COVID-19 Pandemic, Event Study, Stock Market, World Largest Economies

INTRODUCTION
COVID-19 has stunned the globe and is expected to be the greatest economic disruption in the human history. The social and economic effect of the pandemic has been significant and has grabbed everyone’s attention. Since the colossal health crisis has turned into global financial crisis, therefore, the investors have experienced massive losses in a brief amount of time, the uncertainty in market has risen sharply, and the degree of risk has hit almost unparalleled heights (Zhang et al., 2020; Baker et al., 2020). The first case of COVID-19 was registered in Wuhan, China, in December 2019, and has since grown worldwide. As per World Health Organization (WHO), there are 123,419,065 confirmed
cases of COVID and 2,719,163 deaths as of 23rd March, 2021 (available at https://covid19.who.int/). The Spanish flu pandemic (H1N1 virus) killed almost 40 million individuals globally in 1918, nearly a century ago. In a research by Barro et al., 2020, the death rate of Spanish flu is estimated to be higher than COVID-19, however, the economic impact of COVID-19 is projected to be much larger than Spanish flu pandemic. As stringent quarantine policies were implemented by several countries after the COVID-19 outbreak, economic activities were significantly reduced. High level of unemployment and outage of businesses may have long-term effects of COVID-19.

The pandemic has raised uncertainties and risks all over the world, impacting the world’s 20 largest economies i.e., “USA, China, Japan, Germany, India, UK, France, Italy, Brazil, Canada, Russia, South Korea, Australia, Spain Mexico, Indonesia, Netherland, Saudi Arabia, Turkey, and Switzerland” substantially. The nominal GDP of these economies adds up to 84 percent (approximately) of the global economy (International Monetary Fund, 2020) and the number of confirmed COVID-19 cases in these economies is steadily growing. Distress and panic have resulted in considerable losses for the investors. For instance, ‘between 24th and 28th February, 2020, the global stock market lost around US$6 trillion as a result of pandemic’s effects (Ozili and Arun, 2020). Also, after the outbreak, the market value of Standard and Poor (S&P) 500 indexes dropped by 30 percent”. Increased volatility in the market affects the desired rate of return and, as a result, the current market valuation of stocks (Azimili, 2020). Number of empirical researches on stock market reactions to huge systematic shocks are available in the literature. The previous studies have examined the impact of global events on stock market performance such as the SARS disease epidemic (Loh, 2006; Chen et al., 2007), environmental catastrophe (Wang and Kutan, 2013; Tavor and Teitler-Regev, 2019), national news (Ormos and Vazsonyi, 2011) and political events (Nazir et al., 2014; Bash and Alsaifi, 2019). The ongoing coronavirus epidemic will undoubtedly have a negative effect on the global economy and financial markets. During the early stages of studies on COVID-19 and stock market, Zhang et al., (2020), Bora and Basistha (2020), Insaidoo et al., (2020), Singh et al., (2020) found a negative effect of COVID-19 on stock markets.

While the stock markets’ intense reaction to the official news of the pandemic is well known, the reaction of largest world economies during the initial phases of the outbreak until 11th March, 2020 is not very well established. As the result, the present study investigates how stock markets in world’s 20 largest economies have reacted to major events and press releases associated with disease from the beginning of the pandemic i.e., 31st December, 2020 till 11th March, 2020. To the best of authors’ knowledge, this investigation is one of the first to assess the reaction of stock markets with reference to world’s 20 largest economies in the fallout of COVID-19 pandemic. The rest of the paper is structured as follows: Section 2 discusses the review of literature; Section 3 explains the sample and statistical techniques used for empirical analysis; Section 4 discusses the findings of the analysis; Section 5 concludes the study and gives out the implications; and Section 6 details the limitations and future scope of the study.

**REVIEW OF LITERATURE**

With the advent of COVID-19 in the end of 2019, there have been number of studies and discussion about the virus’s cause and effect on almost every area of economy. The studies on COVID-19 and its influence on economies is still emerging, with more research to come, there exists some literature. It’s not shocking that research on past pandemics have been undertaken on how global outbreaks influence the financial markets, considering that major events affect the stock market exchange returns particularly (Zach, 2003). The ongoing research on COVID-19 can be classified into two major aspects, the first being studies that examines the impact of global major events on stock market performance and investors’ behavior. Loh (2006) investigated a significant impact of spread of SARS disease on the stocks of aviation sector in Canada, Hong Kong, China, Thailand and Singapore. She concluded that aviation sector is highly sensitive than the non-aviation sectors of these countries.
Regarding the reaction of investors to animal disease outbreak in Korea was studied by Pendall and Cho (2013). The authors presented that the outbreak led the stock market to respond both in positive and negative way. Using event study methodology, Wang et al., (2013) assessed how outbreak of disease i.e., “ENTEROVIRUS 71, Dengue, SARS and H1N1” influences the performance of stocks of biotechnology companies. The researchers demonstrated that investors rationally analyze the performance of biotechnology companies during such outbreaks. In context of Japan and US, Wang and Kutan (2013) studied the effect of natural disasters on financial markets. The outcomes depicted that there is no effect of natural disasters on composite stock market however, there are substantial wealth effect in insurance sector of both the countries. Examining the effect of uncertain political events on Pakistani stock market returns Nazir et al., (2014) showed that only seven out of 20 events have a statistically significant difference in abnormal returns for two days before and after the event. Similarly, in context of Egypt, Ahmed (2017) investigated the effect of political regime on change of stock price. The results suggested that political regimes have intense effect on the risk-return profile of all sectors. Another study by Gopane and Mmtola (2019) explored the stock market reaction to Mega-Sport events. Mega-sport events included “Rugby World cup, Cricket World cup and FIFA world cup”, the outcome of the research conveyed that stock market reacts positively to hosting mega-sports event for winner country and negatively for loser country. Hadhek et al., (2019) inspected the long-term impact of terrorism on stock market performance. The authors concluded that terrorism has an immediate short-term negative impact on all stock market returns.

The second aspect covers studies analyzing the impact of COVID-19 pandemic on stock market performance. For instance, in Indian context Khusboo et al., (2022) evaluated the impact of COVID 19 and reported massive losses and high volatility in Indian stock market. Ashraf (2020) reviewed the stock market response to the ongoing pandemic. The study showed that market returns declined with increase in number of confirmed cases. Also, market returns reacted more actively to number of confirmed cases compared to number of deaths. Using regression, Ozili and Arun (2020) examined the impact of social distancing strategy implemented to avoid the spreading of COVID-19 across four continents i.e., North America, Africa, Asia and Europe. The research reveals that 30-days social distancing strategy harms the economy as it had a negative effect on the stock prices. According the recent findings, Zhang et al., (2020), using the evidences from 12 countries having the highest confirmed COVID-19 cases claimed that financial market risks have risen dramatically in reaction to the pandemic. In context of US, Baig et al., (2020) studied the effect of COVID-19 pandemic on liquidity and volatility of the market. The researchers indicated that uptick in confirmed COVID-19 cases and deaths is linked with a substantial reduction in liquidity and stability of the market. Similar to this, Ali et al., (2020) assessed the response of financial markets with respect to downturn and uncertainty as COVID-19 apex shifted from China to Europe and then United States. As per the findings, China normalized, while other global markets went into rapid decline, particularly in the later stages of the virus spread. Phan and Narayan (2020) empirically tested the reaction of top 25 countries that were highly infected by COVID-19 based on confirmed cases and deaths on stock market to multiple events in the growth of COVID-19. Authors discovered that most of the countries’ stock market had a negative reaction in the initial days, as the first news about the outbreak was shared with the media. With time the negative reaction turned into positive as the market correct itself. Top most affect countries were analyzed using panel quartile regression by Cepoi (2020). The author performed an empirical study on the association between COVID-19 news and market returns. The study showed that stock market has an asymmetric dependency on COVID-19 related news. Numerous other studies have also concentrated on the confirmed cases of COVID-19 and its impact on market performance (Anh and Gan, 2020; Xu, 2020; Orhun, 2020; Hyun-Jung, 2020).
After exhaustive review of literature, it is clear that COVID-19 pandemic emerged as a major black swan event (He et al., 2020; Mishra, 2020) which has caused shock waves and severely hurt the sentiments of market participants. According to researchers (He et al., 2020) the signs of global recession are clear. In past, it has been well documented that the economic disaster caused by the pandemic surpass any endogenous and extreme events, therefore, it become extremely important to understand the impact of COVID -19 on the stock returns around the world. In addition to that there are chances that this kind of pandemic can occur again in future and the prior information can help researchers to understand the stock market response of such events on market returns around the world. The present study contributes to the second aspect by using event methodology to assess the response of five major events that occurred from the start of COVID-19 to the continuation of the pandemic. Existing literature available in the subject matter does not account for these five events together. The literature majorly estimates the impact of one or two events only. Therefore, this study aims to examines the impact of COVID-19 on the market indices of 20 world’s largest economies (refer Table 1). The study analyses five major events related to the pandemic and also, the severity of those impacts on indices’ returns i.e., short run abnormal returns of market indices.

### Table 1. Stock market Indices of World’s 20 Largest Economies

| Countries     | Stock Exchange                  | Indices                      | Abbreviation |
|---------------|---------------------------------|------------------------------|--------------|
| Australia     | Australian Securities Exchange  | S&P/ASX 200                  | AXJO         |
| Brazil        | Brasil Bolsa Balcão             | Bovespa                      | BVSP         |
| Canada        | Toronto Stock Exchange          | S&P/TSX Composite            | OSPTX        |
| China         | Shanghai Stock Exchange         | Shanghai Composite Index     | SSEC         |
| France        | Paris Stock Exchange            | CAC 40                       | CAC40        |
| Germany       | Frankfurt Stock Exchange        | Deutscher Aktienindex        | GDAXI        |
| India         | National Stock Exchange of India | Nifty 50                    | Nifty 50     |
| Indonesia     | Indonesia Stock Exchange        | IDX Composite                | IDXC         |
| Italy         | BorsaItaliana                   | FTSE MIB                     | FTSEMIB      |
| Japan         | Tokyo Stock Exchange            | Nikkei 225                   | NIS25        |
| Mexico        | Mexican Stock Exchange          | IPC Mexico                   | MXX          |
| Netherland    | Amsterdam stock exchange        | AEX                          | AEX          |
| Russia        | Moscow Exchange                 | MOEX Russia                  | MOEX         |
| Saudi Arabia  | Saudi Stock Exchange            | Tadawul All Share            | TASI         |
| South Korea   | Korea Exchange                  | KOSPI Composite Index        | KOSPI        |
| Spain         | Bolsa de Madrid                 | IBEX 35                      | IBEX         |
| Switzerland   | Swiss Market Index              | SMI                          | SSMI         |
| Turkey        | Borsa Istanbul                  | BIST 100                     | XU100        |
| USA           | The New York Stock Exchange     | Dow Jones Industrial Average | DJI          |
| UK            | London Stock Exchange           | FTSE 100 Index               | FTSE100      |

Source: Authors’ Compilation
DATA AND RESEARCH METHODOLOGY

The present study has considered the 20 largest economies of the world. The largest economies are selected as most of these countries faced huge setbacks while trying to contain the spread of the latest pandemic. These economies contribute around 84 percent in the total world GDP in 2020 (International Monetary Fund, 2020). For the purpose of the study the closing prices of the selected countries indices were collected from investing.com from 1st March 2019 till 30th April 2020. A few current studies (Orhun, 2020; Singh et al., 2020; Liu et al. 2020) also used the same source for data collection and selected stock indices from 15 to 21 countries to analyze the short term response of stock markets to the outbreak of COVID-19.

The important events analysed in the present study are given below:

Event 1 (31.12.2019)
On this day Chinese officials announced a new strain of coronavirus. On the same date Wuhan Municipal Health Commission alerted public of a potential outbreak which was perceived as similar to SARS. Therefore, this date is selected as the official announcement of disease by Chinese Government (WHO timeline COVID-19, 2020).

Event 2 (20.01.2020)
The second event of this study is chosen as 20.01.20, on this day “Zhong Nanshan” (expert group leader of “National Health and Fitness Commission” (NHFC), China) suggested the possibility of the disease to be transmitted among people (Liu et al., 2020). Post this interview the news drawn the attention of the people and became headlines of the media around the world.

Event 3 (30.01.2020)
This date is crucial as “World Health Organization” (WHO) on this day announced the virus as “public health emergency” of international concern. This declaration by WHO grabbed the attention of market participants and public alike, therefore, the date 30.01.2020 is selected for the analysis (WHO timeline COVID-19, 2020).

Event 4 (21.02.2020)
According to Giuffrida (2020), on this day Italy imposed the first lockdown in certain areas of Italy after observing spike in COVID-19 cases. Similarly, on the same day South Korea introduced the “highest level” alert and the region of Daegu was declared as “special care zone”. These events in Italy and South Korea raised high concerns. Therefore, the present study selected the date 21.02.2020 for the analysis.

Event 5 (11.03.2020)
The last event for the study is selected as 11.03.2020. On this day WHO declared the COVID-19 outbreak a pandemic. The WHO officially asked the countries to take concrete steps towards stopping the spread of the deadly virus. After this announcement countries around the world started imposing lockdowns.

A few studies have also considered the above events to examine the impact of COVID-19 on stock markets in global context. For instance, one of the pioneer studies on COVID-19 (Singh et al., 2020) examined the Event 2nd (20.01.2020) and reported negative stock market performance in G20 countries and revealed that the shareholders experienced cumulative average abnormal return up to -42.69% surrounding the event. Similarly, Phan and Narayan (2020) analyzed the stock markets of 25 countries and considered the Event 5th (11.03.2020), the study reported that stock markets of 24 countries out of 25 countries reported negative returns post that event. Ali et al., (2020) also analyzed the major stock markets and commodities markets from epidemic stage to pandemic stage
(December 2020 to March 2021) and found high volatility in the developed markets during that period. Consequently, Orhun (2020) determined the reaction of major stock markets to Event 1st (31.12.2019), Event 3rd (30.01.2020), Event 4th (21.02.2020) and Event 5th (11.03.2020) along with other events. The study reported negative cumulative average abnormal returns for all the selected events except for Event 1st. After thoroughly analyzing the major news events related to COVID-19 pandemic the present study examines the reaction of stock markets to five major events that taken place from the beginning to the evolution of the pandemic.

EVENT STUDY METHODOLOGY

The present study has employed event study methodology to assess the impact of outbreak of COVID-19 across 20 largest economies of the world. The event study methodology has been extensively used by the researchers in past to understand the impact of an event such as “mergers and acquisitions”, stock split and demergers (Wajid et al., 2019; Rani et al., 2016; McWilliams and Siegel, 1997). Recently, various studies have used event study methodology to investigate the impact of the disease on stock returns (Singh et al., 2020; Liu et al., 2020; He et al., 2020). The event of interest in the present study is the outbreak of coronavirus specifically five major events related to COVID-19, therefore those events are considered as “announcement days” of major events for the purpose of this study.

Estimation Period, Event Window and Estimation Model

The Estimation period is used in event study to estimate expected returns which are expected to occur in absence of the event. For this purpose the estimation period is selected which started from 160 days before the announcement of first event and ended 10th day before the first announcement day. Thus comprises 150 trading days. The “event window” contains the event announcement day along with days before and after the event announcement day. Present study chose short term event windows as long event windows may reduce the power of the test statistics and make it difficult to control for confounding events (McWilliams et al., 1997). On par with previous research (Liu et al., 2020; Orhun, 2020) the present study calculates the abnormal returns of windows (-5, 5), (-2, 2), (0, 1), (0, 2), (0, 5), (0, 6) when studying the influence of COVID 19 on the market behaviour. The study uses single factor market model to calculate abnormal returns as this model has been popularly used in the past research and have good predictive power (Brenner, 1979). Under this model, we regress stock returns against a market index for instance Dow Jones Global Index.

Abnormal returns of jth index at period t is estimated as:

$$AR^j_t = R^j_t - E(R^j_t)$$

Where, “ $AR^j_t$" is the abnormal return of $j$th index at period $t$; $R^j_t$ is the actual return of $j$th index at period $t$; $E(R^j_t)$ is the expected return of $j$th index at period $t$’.

The expected returns are computed as per following equation:

$$E(R^j_t) = \alpha_j + \beta_j R^m_t + \varepsilon^j_t$$

Where, “ $R^m_t$” denotes the index ‘$j’ return for period $t$; $\alpha_j$ and $\beta_j$ are the model parameters; $R^m_t$ is the market return for period $t$ and $\varepsilon^j_t$ denotes the error term.”
Cumulative Abnormal Returns (CAR) of index $j$ of period $t$ are calculated as per following equation:

$$CAR_j = \sum_{t}^{t} AR_{j,t}$$

Test statistic enables to arrive at t-statistics is given below:

$$t_{CAAR} = \frac{CAR}{\hat{\sigma}(CAR)_t}$$

Where, “ $\hat{\sigma}(CAR)_t$ is the standard deviation of CAR of period $t$”.

The average abnormal returns are the arithmetic averages of abnormal returns and calculated as follows:

$$AAR_t = \frac{1}{N} \sum_{j=1}^{n} AR^j_t$$

Where $N$ denotes total number of indices

The CAARs explain the market response of the event during a specified time period. The CAAR is the sum of all AARs overtime. CAAR from period ‘s’ to ‘t’ is calculated as per below equation:

$$CAAR_{s,t} = \sum_{t=s}^{t} AAR_t$$

Test statistic enables to arrive at T-statistics is given below:

$$TS_{s,t} = \frac{CAAR_{s,t}}{\frac{1}{n} \sqrt{(t-s+1) \sum_{i=1}^{n} \sigma^2_i}}$$

Where the equation in denominator specifies standard deviation in daily terms.

**Statistical Tests for Significance of Abnormal Returns**

The abnormal returns can be tested through parametric and non-parametric tests. The former assume that residuals follow normal distribution, while the latter do not make such assumptions. It has been widely noticed that the researchers typically use non-parametric tests along with parametric tests to be confident that results are not influenced by outliers (Rani, et al., 2016). Previous studies (Fama, 1976; Brown and Warner,1985) have explained that the potential problem with using daily returns is that they are fat-tailed and depart from normality more often, additionally, several authors (Kang and Stulz, 1996; Corrado and Truong, 2008; Campbell et al., 2010) found robustness issues in event studies involving Asia-Pacific market data and suggested that non-parametric tests are well specified and more powerful while conducting studies on Asia Pacific market data, therefore, the present study...
uses both types of tests to ensure robust results (Kliger and Gurevich, 2014). The present study uses three parametric tests; “Crude dependence adjustment test”, “Cross sectional standard deviation test” and “Patell Z test” and two non-parametric tests i.e. “Corrado Rank test” and “Generalized Sign test” all of them are explained below.

Crude Dependence Adjustment Test (CDA)

Brown and Warner named this test ‘crude dependence test’ because “the test compensate for potential dependence of returns across security events by estimating the standard deviation using time series of sample mean returns from the estimation period” (Rani, et al. 2016, pp. 21). Further this test uses single variance estimate for entire sample. The test statistics of this test is given below:

\[
CDA = \frac{CAAR_i}{(T_2 - T_1)^{1/2} S_{AAR_i}}
\]

Where, “(T_2 – T_1)^{1/2} is the square root of estimation window, T_2 is the latest day of event window, T_1 is the earliest day of event window and S_{AAR} is the standard deviation across firms”.

Cross-Sectional Standard Deviation Test (CSSD)

CSSD considers daily cross-sectional standard deviation instead of sample time series standard deviation. The test statistics of the test is given below:

\[
T_{cross} = \frac{CAAR_i(T, T_2)}{\sigma_{CAAR(T, T_2)}/\sqrt{N}}
\]

Where, “\(\sigma_{CAAR(T_1, T_2)}\) is the variance of CAAR from T_1 to T_2.”

Patell Z Test

Patell (1996) introduced this test, under this test the abnormal returns are standardized by the standard deviation of abnormal returns. This standardization reduces the impact of large returns standard deviations.

\[
CAAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} \frac{AR_i(t)}{S(AR_i)}
\]

Corrado Rank Test

Corrado (1989) proposed this test where we transform abnormal returns into ranks and then tests the null hypothesis of zero abnormal returns. The test statistics is given below:

\[
K_{i, \tau} = rank(AR_{i, \tau})
\]
**Generalized Sign Test**

This test is upgraded version of Sign Test. It examines “whether the number of stocks with positive cumulative abnormal returns in the event window exceeds the number expected in the absence of abnormal performance or not” (Rani et al., 2016, pp. 26). The test statistics of this test is given below:

\[
    t_{GS} = \frac{P_0^+ - P_{est}^+}{\sqrt{P_{est}^+ (1 - P_{est}^+) / N}}
\]

Where, “\(P_0^+\) and \(P_{est}^+\)” are positive cumulative abnormal returns over the event window and \(P_{est}^+\) is the positive cumulative abnormal returns over the estimation window”.

**RESULTS AND DISCUSSION**

This section explains the results of event study for the five major events related to the outbreak of COVID-19 pandemic. Table 2 exhibits the results of CAARs (Cumulative Average Abnormal Returns) for the selected five events along with their significance levels and t-statistics. It can be observed from Table 2 that no significant change in CAARs of global financial markets are visible in relation to the first event, i.e. on (31.12.2019). This may be because at that time the virus was confined to a city in China i.e., Wuhan, and was perceived by participants as seasonal Asian flu (Orhun, 2020), therefore, that event did not have any significant impact on global financial markets returns. The significant negative returns in stock market are visible surrounding second event (20.01.2020), the severity of the disease started to become apparent and global financial markets started to experience significantly negative CAARs which is evident in two selected event windows i.e., in (0, 5) and (0, 6) at 5 percent significance level. As the pandemic intensified and WHO declared the virus as public health emergency of international concern on (30.01.2020) the news started causing panic around the world consequently, significant higher negative CAARs and high t-statistics were observed in global financial markets as can be seen in the Table 2, the CAARs are negative and significant at 1 percent level in three event windows i.e. in (-2, 2), (0, 1) and (0, 2).

Following the large scale spread of the virus, on the fourth event (21.02.2020), Italy initiated the first lockdown, consequently, countries around the world started to impose lockdown and strict measure to contain the virus which inevitably disturbed the normal operations in the affected countries. This perhaps is the reason that global financial markets demonstrated strong negative CAARs and higher t-statistics which can be seen in the results. The CAARs were statistically significant in all the event windows selected for the study at 1 percent significance level. Finally, on 11.03.2020, WHO announced the COVID-19 outbreak a pandemic. It officially asked the countries to take concrete steps towards stopping the spread of the deadly virus. It is worth noting that after this event the countries around the world started to impose strict lockdowns. This particular event had most pronounced impact on the global stock market indices. The CAARs were highly negative and decreased up to 25.90 percent, the decline was noticed in all the selected indices. This event influenced the investors drastically, the sentiments became highly pessimistic which negatively influenced the stock markets around the world. It is significant to consider that due to exaggerated fear and panic trading among the investors post 11.03.2020 the two major stock exchanges in India, National Stock Exchange and Bombay Stock Exchange had to halt the trading by employing circuit breakers on 13th and 23rd March 2020. Similarly, the US stock market also experienced circuit breakers four times in a span of 10 days (Singh et al., 2020).

It can be derived from the results, that globalization has increased the interdependence of financial markets around the world. Besides the rapid spread of the disease and deaths, brought unexpected
Table 2. Results of Event Study

| EVENT 1 (31.12.2019) | Event Windows | CAARs (%) | t-stats |
|-----------------------|---------------|-----------|---------|
| (-5, 5)               | 0.04          | 0.042     |
| (-2, 2)               | -0.79         | -1.170    |
| (0, 1)                | -0.12         | -0.288    |
| (0, 2)                | -0.21         | -0.396    |
| (0, 5)                | 0.23          | 0.307     |
| (0, 6)                | 0.39          | 0.491     |

| EVENT 2 (20.01.2020) | Event Windows | CAARs (%) | t-stats |
|-----------------------|---------------|-----------|---------|
| (-5, 5)               | -0.85         | -0.849    |
| (-2, 2)               | -0.35         | -0.522    |
| (0, 1)                | -0.33         | -0.781    |
| (0, 2)                | -0.87         | -1.652    |
| (0, 5)                | -1.85a        | -2.495    |
| (0, 6)                | -2.00b        | -2.494    |

| EVENT 3 (30.01.2020) | Event Windows | CAARs (%) | t-stats |
|-----------------------|---------------|-----------|---------|
| (-5, 5)               | -1.93         | -1.920    |
| (-2, 2)               | -2.18c        | -3.228    |
| (0, 1)                | -2.13a        | -4.974    |
| (0, 2)                | -2.12a        | -4.044    |
| (0, 5)                | -0.26         | -0.356    |
| (0, 6)                | -0.78         | -0.969    |

| EVENT 4 (21.02.2020) | Event Windows | CAARs (%) | t-stats |
|-----------------------|---------------|-----------|---------|
| (-5, 5)               | -9.92a        | -9.888    |
| (-2, 2)               | -4.17a        | -6.163    |
| (0, 1)                | -3.12a        | -7.286    |
| (0, 2)                | -4.06a        | -7.753    |
| (0, 5)                | -9.63a        | -13.005   |
| (0, 6)                | -9.67a        | -12.087   |

| EVENT 5 (11.03.2020) | Event Windows | CAARs (%) | t-stats |
|-----------------------|---------------|-----------|---------|
| (-5, 5)               | -25.90a       | -25.822   |
| (-2, 2)               | -15.26a       | -22.564   |
| (0, 1)                | -8.79a        | -20.561   |
| (0, 2)                | -9.87a        | -18.842   |
| (0, 5)                | -15.65a       | -21.123   |
| (0, 6)                | -16.09a       | -20.116   |

Note: a, b Denote significance at 1% and 5% level respectively
Source: Authors’ Calculations
shocks which totally altered the investors sentiments in a short period of time. For the purpose of the present study, this event (11.03.2020) is of crucial importance given the drastic negative impact on stock markets, therefore, the researchers tests the robustness of the results by employing other parametric and non-parametric tests on the CAARs surrounding this particular event. Thus, this event (11.03.2020) has been further examined. Firstly, the abnormal returns on the event day was examined then the Cumulative Abnormal Returns (CARs) for the event windows (-5, 5), (-2, 2), (0, 5), (0, 6) and (0, 34) were extensively analysed.

The observed results of the parametric and non-parametric tests on the CAARs are provided in the Table 3. The CAAR value over different event windows are determined to evaluate the most significant event windows, however, as can be seen in the Table 2 that the CAARs are statistically significant in all the event windows at 1 percent significance level under the selected tests though they are most negative in the 11 days event window i.e. (-5, 5) window which also shows the highest negative test statistics for all the selected tests. The results further confirm that the impact of event 5 (11.03.2020) was most striking for the investors across the globe.

Abnormal Returns of Selected Indices

Abnormal Returns of indices on the event date (11.03.2020) are tabulated in Table 4. On the date of the event, most of the selected indices except Italy, Mexico, Netherland, Russia and Spain reported negative ARs. The Stock markets in Canada, USA, Turkey, Brazil and South Korea bore the higher negative impact on the event date.

All the indices demonstrated high fluctuations in abnormal returns from Day 0 to Day 34. The highest fluctuations were reported by Brazilian stock index (BVSP), standard deviation of 6.17 percent, while least was reported by Chinese stock market indices (SSEC), standard deviation of 1.32 percent, the same results are reported by Singh et al., (2020). The Figure 1 demonstrates the abnormal returns of indices for event window (0, 34).

Cumulative Abnormal Return(CARs) of Selected Indices

CARs in the Event Window (-5, 5)

The daily ARs of selected indices were cumulated to calculate Cumulative Abnormal Returns (CARs) for 11 days (-5, 5) event window the results of which are presented in Table 5. It can be seen that all the selected indices showed negative CARs as the result of the update about the outbreak of the pandemic. The Brazilian stock market index, BVSP responded most negatively at this event window, CARs fell by 50.84 percent over 11 trading days. All the selected indices responded negatively and are significant at 1 percent level of significance in the (-5, 5) event window. Although more pronounced

| Event Windows | CAARs (%) | Parametric tests | Non-parametric tests |
|---------------|-----------|------------------|---------------------|
|               |           | CDA t            | CSSD t              | Patell Z | Corrado Rank | G sign Z |
| (-5, 5)       | -25.90    | -20.110*         | -18.231*            | -24.981* | -21.121*     | -15.213* |
| (-2, 2)       | -15.26    | -18.200*         | -15.987*            | -20.118* | -19.81*      | -10.112* |
| (0, 1)        | -8.79     | -10.321*         | -7.650*             | -12.981* | -11.344*     | -3.899*  |
| (0, 2)        | -9.87     | -11.112*         | -7.780*             | -13.121* | -12.111*     | -3.991*  |
| (0, 5)        | -15.65    | -18.543*         | -16.010*            | -20.231* | -19.871*     | -10.126* |
| (0, 6)        | -16.09    | -19.017*         | -16.190*            | -21.761* | -21.281*     | -10.661* |

Note: * Denote significance at 1%
Source: Authors' Calculations
impact was noticed in the stock markets of Brazil, France, Spain, Germany, Netherlands and Italy and least negative impact was seen in the Chinese stock market, SSEC.

**CARs in the Event Window (-2, 2)**

The CARs of stock market indices over 5 trading days surrounding the selected event are presented in Table 6. It can be observed that all the indices showed a significant negative abnormal returns in (-2, 2) event window and are significant at 1 percent level of significance. In the selected event window the same indices Brazil, France, Spain, Germany, Netherlands and Italy showed highly negative impact.

**Figure 1. Abnormal Returns of Indices in World’s 20 largest economies Source: Authors’ Compilation**

| Indices  | Abnormal Return (%) | Indices  | Abnormal Return (%) |
|----------|---------------------|----------|---------------------|
| AXIO     | -4.69               | MXX      | 1.41                |
| BVSP     | -7.51               | AEX      | 0.12                |
| OSPTX    | -13.95              | MOEX     | 0.09                |
| SSEC     | -1.50               | TASI     | -1.20               |
| CAC40    | -0.42               | KOSPI    | -3.38               |
| GDAXI    | -0.60               | IBEX     | 0.09                |
| Nifty 50 | -2.78               | SSMI     | -0.60               |
| IDXG     | -2.39               | XU100    | -7.65               |
| FTSE100  | 0.02                | DJI      | -12.33              |
| N225     | -1.94               | FTSE100  | -1.88               |

*Source: Authors’ Calculation*
same as exhibited (-5, 5) event window. Similarly, in this event window the least negative impact was seen in the Chinese stock market, SSEC as in (-5, 5) event window and is significant at 5 percent level.

**CARs in the Event Window (0, 5)**

Table 7 exhibits the CARs of stock markets indices for 6 trading days (0, 5). It can be seen from the results that Russian stock market, MOEX showed some recovery and seems to absorbed the negative news on COVID-19 event other than that all indices show significantly negative CARs in the (0, 5) event window.

**CARs in the Event Window (0, 6)**

In the event window (0, 6), most of the indices still show significantly negative CARs at 1 percent level of significance (refer Table 8). Although two indices, Saudi Arabia stock exchange (TASI) and

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### Table 5. CAR’s in Event Window (-5, 5)

| Indices | CAR (-5, 5) | t-stats | Indices | CAR (-5, 5) | t-stats |
|---------|-------------|---------|---------|-------------|---------|
| AXJO    | -20.39%     | -9.2549 | MXX     | -13.04%     | -5.386  |
| BVSP    | -50.84%     | -9.2549 | AEX     | -33.60%     | -5.148  |
| OSPTX   | -27.77%     | -16.1765| MOEX    | -13.41%     | -6.211  |
| SSEC    | -11.39%     | -4.8270 | TASI    | -17.98%     | -6.794  |
| CAC40   | -38.71%     | -16.2283| KOSPI   | -20.80%     | -9.167  |
| GDAXI   | -34.58%     | -14.2425| IBEX    | -37.32%     | -9.420  |
| Nifty 50| -22.76%     | -8.6436 | SSMI    | -19.53%     | -9.420  |
| IDXC    | -18.00%     | -8.4089 | XU100   | -29.19%     | -9.074  |
| FTSEMI   | -36.42%    | -14.4846| DJI     | -19.90%     | -8.862  |
| NI225   | -26.81%     | -11.5725| FTSE100 | -25.54%     | -11.473 |

**Note:** * Denote significance at 1%

**Source:** Authors’ Calculations

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### Table 6. CAR’s in Event Window (-2, 2)

| Indices | CAR (-2, 2) | t-stats | Indices | CAR (-2, 2) | t-stats |
|---------|-------------|---------|---------|-------------|---------|
| AXJO    | -8.43%      | -3.828  | MXX     | -12.30%     | -5.079  |
| BVSP    | -19.66%     | -7.281  | AEX     | -21.88%     | -9.862  |
| OSPTX   | -13.74%     | -8.004  | MOEX    | -8.43%      | -3.902  |
| SSEC    | -5.65%      | -2.392  | TASI    | -9.64%      | -3.643  |
| CAC40   | -23.39%     | -9.805  | KOSPI   | -12.63%     | -5.564  |
| GDAXI   | -22.03%     | -9.073  | IBEX    | -25.12%     | -10.995 |
| Nifty 50| -7.34%      | -2.785  | SSMI    | -15.36%     | -7.405  |
| IDXC    | -8.04%      | -3.754  | XU100   | -17.75%     | -5.517  |
| FTSEMI   | -25.89%    | -10.296 | DJI     | -11.31%     | -5.037  |
| NI225   | -19.30%     | -8.330  | FTSE100 | -17.30%     | -7.771  |

**Note:** * Denote significance at 1%

**Source:** Authors’ Calculations
Russian stock exchange (MOEX) showed some improvement as the negative returns are lower than that of other market indices. These two indices are showing sign of faster recovery.

**CARs in the Event Window (0, 34)**

The CARs of stock market indices post the event 11.03.2020 up to 30th April 2020 i.e., for 34 trading days are reported in Table 9. The results show the evidence of recovery of stock markets which started to re-emerge and notably nine indices OSPTX, GDAXI, NI225, AEX, MOEX, TASI, SSMI, XU100 and DJI showed the improvement, Canadian and Saudi Arabian stock market indices reported significantly positive CARs of 14.81 percent and 13.10 percent and are significant at 1 percent level of significance, similarly, Russian and USA stock market indices reported significantly positive CARs of 8.72 percent and 9.10 percent respectively and are significant at 5 percent level of significance. On the other hand two indices i.e. Nifty 50 and IDXC, reported significantly negative CARs at 1 percent level of significance.

### Table 7. CAR's in Event Window (0, 5)

| Indices | CAR (0, 6) | t-stats | Indices | CAR (0, 6) | t-stats |
|---------|-----------|---------|---------|-----------|---------|
| AXJO    | -19.41% a | -11.043 | MXX     | -8.14% a  | -4.212  |
| BVSP    | -32.47% a | -15.076 | AEX     | -14.97% a | -8.462  |
| OSPTX   | -16.88% a | -12.328 | MOEX    | 0.67%     | 0.391   |
| SSEC    | -8.08% a  | -4.295  | TASI    | -5.44% a  | -2.577  |
| CAC40   | -19.70% a | -10.350 | KOSPI   | -28.75% a | -15.881 |
| GDAXI   | -19.57% a | -10.107 | IBEX    | -16.87% a | -9.257  |
| Nifty 50| -22.69% a | -10.804 | SSMI    | -4.99% a  | -3.019  |
| IDXC    | -21.61% a | -12.653 | XU100   | -18.00% a | -7.015  |
| FTSEMiB | -14.65% a | -7.306  | DJI     | -16.71% a | -9.332  |
| NI225   | -19.94% a | -10.791 | FTSE100 | -13.68% a | -7.706  |

**Note:** a Denote significance at 1%

**Source:** Authors' Calculations

### Table 8. CAR's in Event Window (0, 6)

| Indices | CAR (0, 5) | t-stats | Indices | CAR (0, 5) | t-stats |
|---------|-----------|---------|---------|-----------|---------|
| AXJO    | -16.57% a | -10.182 | MXX     | -7.50% a  | -4.194  |
| BVSP    | -34.04% a | -17.071 | AEX     | -19.19% a | -11.717 |
| OSPTX   | -14.72% a | -11.613 | MOEX    | 3.40% b   | 2.134   |
| SSEC    | -9.63% a  | -5.523  | TASI    | -2.57%    | -1.313  |
| CAC40   | -22.08% a | -12.534 | KOSPI   | -20.30% a | -12.114 |
| GDAXI   | -21.62% a | -12.058 | IBEX    | -18.41% a | -10.912 |
| Nifty 50| -20.25% a | -10.414 | SSMI    | -10.14% a | -6.620  |
| IDXC    | -16.98% a | -10.737 | XU100   | -18.42% a | -7.755  |
| FTSEMiB | -16.87% a | -9.084  | DJI     | -13.20% a | -7.962  |
| NI225   | -18.51% a | -10.816 | FTSE100 | -15.35% a | -9.335  |

**Note:** a, b Denote significance at 1% and 5% level respectively

**Source:** Authors' Calculations
level of significance and BVSP & MXX reported significantly negative CARs at 5 percent level of significance. Figure 2 exhibits the CARs of (0, 34) event window. Three timelines of events are demonstrated in this figure which also show the CARs fluctuations surrounding the selected events.

CONCLUSION AND MANAGERIAL IMPLICATIONS

The COVID-19 pandemic has inevitably affected the economies and financial markets across the globe. In view of this, the study analyses the performance of world’s 20 largest economies’ stock market indices considering five major developments in relation to the global pandemic spread. The results

Table 9. CAR’s in Event Window (0, 34)

| Indices    | CAR(0, 34) | t-stats | Indices    | CAR(0, 34) | t-stats |
|------------|------------|---------|------------|------------|---------|
| AXJO       | -6.07%     | -1.544  | MXX        | -9.92% b   | -2.296  |
| BVSP       | -9.84% b   | -2.042  | AEX        | 3.60%      | 0.910   |
| OSPTX      | 14.81% a   | 4.838   | MOEX       | 8.72% b    | 2.264   |
| SSEC       | -2.91%     | -0.691  | TASI       | 13.10% a   | 2.775   |
| CAC40      | -3.67%     | -0.861  | KOSPI      | -0.05%     | -0.011  |
| GDAXI      | 1.64%      | 0.378   | IBEX       | -7.93%     | -1.944  |
| Nifty 50   | -13.00% a  | -2.766  | SSMI       | 2.48%      | 0.670   |
| IDXC       | -11.50% a  | -3.012  | XU100      | 0.65%      | 0.113   |
| FTSEMIB    | -4.10%     | -0.914  | DJI        | 9.10% b    | 2.271   |
| NII25      | 1.67%      | 0.405   | FTSE100    | -1.10%     | -0.278  |

Note: a, b Denote significance at 1% and 5% level respectively

Source: Authors’ Calculations

Figure 2. CAR’s of Indices in World’s 20 largest economies Source: Authors’ Compilation
of the study reveal that the stock market responded negatively to the COVID-19 news. Out of the five major events selected for the study, the drastic negative impact on stock market indices were seen to be related to the last event when the disease officially moved from epidemic to pandemic stage, on (11.03.2021) WHO announced the COVID-19 outbreak a pandemic. The results of this event were further confirmed by using various parametric and non-parametric test. In addition, the last event was further analyzed by observing CARs of various indices individually. The results suggest that COVID-19 pandemic had a significant negative impact across the 20 world’s largest stock markets indices. It has been noticed that surrounding the major news related to announcement of COVID-19, Chinese stock market (SSEC) was performing better than other market indices while, there were clear sign of quick recovery in case of Russian stock exchange (MOEX). The results support the findings of Ali et al., (2020) which states that China normalized, while other global markets went into rapid decline, particularly in the later stages of the virus spread.

At last, the study found evidence of recovery of stock market indices by the end of April 2020, nine out of 20 market indices showed improvement, notably Canadian, Russian, Saudi Arabian and US stock market indices improved significantly although Indian and Indonesian stock market were still showing downward trending. The same has been explicated by Bora et al., (2020) that the returns of Indian stock markets reached to the bottom-line post the pandemic news. While, Phan et al., (2020) discovered that most of the countries’ stock markets had a negative reaction in the initial days following the news of the pandemic, but with time, the negative reaction turned into positive as the market corrected itself.

Managerial Implications

COVID-19 is considered as a major black swan event and the precise intensity of its impact is still unknown and under investigation. The findings suggest that the declaration of novel COVID-19 as a pandemic was the most devastating event for stock markets. On the other hand, this panic mode of financial markets globally has practical implications for investors, financial analysts and fund managers. The results are significant for equity investors, fund managers and governments. The study can assist them to take better decisions in case of reoccurrence of COVID - 19-like pandemic in the future. It suggests that the stock market overreacts due to crisis and as more information becomes available to people, the market eventually backtracks and corrects itself. The same has been demonstrated by Singh et al., (2020) and Phan et al., (2020). Additionally, the study recommends stock market regulators and government officials to boost the confidence of the investors by issuing further notifications in times of panic selling mode in the financial markets. Furthermore, this research can be extended to check the long term impact of COVID-19 when long term data will be available.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study is based on the impact of five major events related to COVID-19 on stock markets and considers only the short-term impact due to the persistence of the disease and unavailability of long-term data, hence future studies can focus on the long-term impact of COVID-19 on stock markets returns. Similarly, another limitation of the study is that it does not analyse specific sectors of the economy and considers overall stock market performance, therefore, future study can be done examining the impact of COVID-19 on specific sectors.

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