# "The performance of the Indian stock market during COVID-19"

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# THE PERFORMANCE OF THE INDIAN STOCK MARKET DURING COVID-19

## Abstract

The current empirical study attempts to analyze the impact of COVID-19 on the performance of the Indian stock market concerning two composite indices (BSE 500 and BSE Sensex) and eight sectoral indices of Bombay Stock Exchange (BSE) (Auto, Bankex, Consumer Durables, Capital Goods, Fast Moving Consumer Goods, Health Care, Information Technology, and Realty) of India, and compare the composite indices of India with three global indexes S&P 500, Nikkei 225, and FTSE 100. The daily data from January 2019 to May 2020 have been considered in this study. GLS regression has been applied to assess the impact of COVID-19 on the multiple measures of volatility, namely standard deviation, skewness, and kurtosis of all indices. All indices' key findings show lower mean daily return than specific, negative returns in the crisis period compared to the pre-crisis period. The standard deviation of all the indices has gone up, the skewness has become negative, and the kurtosis values are exceptionally large. The relation between indices has increased during the crisis period. The Indian stock market depicts roughly the same standard deviation as the global markets but has higher negative skewness and higher positive kurtosis of returns, making the market seem more volatile.

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## INTRODUCTION

The novel coronavirus, i.e., COVID-19, which is a human transmitted disease, was first detected in December 2019 in Wuhan, China, and then it spread at an exploratory rate in the rest of the world (Wuhan Municipal Health Commission, 2019). With the kind of risk associated with COVID-19 to the public health, the World Health Organization (WHO) has confirmed this pandemic as an international emergency on March 11, 2020.

As most of the countries are/were required to lockdown their economies to fight against COVID-19, and governments were/are struggling to put together exceptional medical and economic aid packages along with the contingency strategies, it is apparent that the decisive impact of this pandemic is far above public health concerns alone (Bakhshi & Chaudhary, 2020). The impact on public health has resulted in the economy's poor financial performance and thus affected the stock market's performance. For any economy, the stock market's performance plays a vital role and indirectly indicates the country's potential and shareholders' confidence. It is difficult to predict the return in the short run, becoming even more challenging during the financial crisis (Totir & Dragotă, 2011). Understanding the stock market is necessary to remain very cautious and alert, especially during crisis times when the company's fundamentals do not play a bigger role, but the greater role is played by the macroeconomic factors (Hoshi & Kashyap, 2004). As it is known, a better understanding of the stock mar-

ket is a key to overcome short-term investment challenges, and it is more crucial during the financial crisis and becomes magnificent when this financial crisis is due to pandemic.

This paper's remaining sections present the literature review, purpose, methodology of the study, results, discussion, and conclusion.

## 1. LITERATURE REVIEW

The impact of COVID-19 is not comparable with any other financial/global crises or pandemic because the challenges are much higher than any other previous crises as this crisis is equally impacting the much more integrated globe without much focus only on low-middle income economies, with the lowest historical rate of interest, and much higher spillover effects (Fernandes, 2020). COVID-19 has the potential to crash any economy if it is not managed properly (Anjorin, 2020; Feinstein et al., 2020) or until there is a vaccine against it (Okhuese, 2020). Due to the impact of lockdown on many businesses, the total loss can be to the extent of 0.5% of global GDP (F. R. Ayittey, M. K. Ayittey, Chiwero, Kamasah, & Dzuvor, 2020). Researchers do similar estimations for individual countries like for the US (Alfaro, Chari, Greenland, & Schott, 2020), Germany (Michelsen, Baldi, Dany-Knedlik, Engerer, Gebauer, & Rieth, 2020), China (Ruiz Estrada, 2020), Saudi Arabia (Albulescu, 2020), and the world (Fernandes, 2020). The impact of the decrease in the countries' GDP is very much reflected in the stock market's financial performance. Due to estimated losses and fall in the stock market, there is a need for major policy interventions, both fiscal and monetary, and economic aids to protect human health, economic losses, and financial health of the stock market against COVID-19 (Gourinchas, 2020). Apart from these, the International Monetary Fund (IMF) predicted that the COVID-19 pandemic would bring the deepest global crisis since the Great Depression of 1929 (FAZ, 2020). Many governments have reacted and offered the best possible financial aids, including Australia, New Zealand, India, and many more, to protect their economy from any recession. The EU has also taken action to arrange liquidity for the needed companies (Boot et al., 2020); similarly, aid to the extent of USD 2 trillion is planned by the US government (Megginson & Fotak, 2020).

Due to the lockdown and slowdown of many economies worldwide, the recent stock market movement shows a significantly negative outlook, with the MSCI world index recording a drop of over 25+ percent (Onvista, 2020). COVID-19 pandemic has caused the stock market's highest volatility out of all the pandemics so far (Baker et al., 2020). There is huge volatility in the US (Alfaro et al., 2020), China (Al-Awadhi et al., 2020), global financial market (Zhang, Hu, & Ji, 2020), major stock indexes from 64 countries (Ashraf, 2020).

Many researchers have suggested that volatility in the stock market is highly associated with uncertainty in the market, which is the main element in any stock market investment decision. The findings have suggested that volatility is one of the most reliable risk predictors (Green & Figlewski, 1999). Higher volatility relates to a greater chance of a bear market, whereas lower volatility relates to greater chances of a bull market (Ang & Liu, 2007).

In investment, volatility is "the degree of variation over a period of a trading price" (Glosten, Jagannathan, & Runkle, 1993). The higher the volatility, the higher the stock price fluctuation in the short term, so an increase in volatility increases the risk. Lower volatility indicates that stock value does not fluctuate much in the short term (Glosten et al., 1993). The most commonly used measure of volatility is the standard deviation, but the challenge with standard deviation is its limitation, based on the assumption that returns are normally distributed. Another measure is skewness, which is not based on the normal distribution assumption, so skewness works on the data set's extremes rather than concentrating on the average return. Short-term and medium-term investors should focus more on extremes as their investment objective is not long-term to average out (Chang et al., 2013). Kurtosis, like skewness, is another measure to be used when the tails have extreme values. A large kurtosis indicates a high degree of investment risk, so there are high chances of either high returns or small returns (Mei, Liu, Ma, & Chen, 2017). The higher moments, i.e., skewness and kurtosis, are also priced in the Indian market (Chaudhary,

Misra, & Bakhshi, 2020). The Jarque-Bera test is a tool to test the goodness-of-fit of sample data to know whether the skewness and kurtosis match a normal distribution. If Jarque-Bera value is far-off from zero, it indicates that the sample does not possess a normal distribution (Thadewald & Büning, 2007).

Since January 2020, most researchers are working on finding the impact of COVID-19 on various parameters like health, economy, packages, climate change, reverse migration, and many more, including the stock market. Few researchers have conducted this study for different countries but mainly on composite indices of the developed market. There are very few studies on emerging markets, but very few studies have been conducted considering sectoral indices. None of the studies are conducted pertaining only to the Indian stock market, considering composite and sectoral indices.

## 2. AIMS

This paper aims to analyze the impact of the COVID-19 on the return volatility of the Indian stock market in the context of standard deviation, skewness, and kurtosis, taking two composite indices, i.e., BSE 500 and BSE Sensex, and eight sectoral indices of BSE, i.e., Auto, Bankex, Consumer Durables, Capital Goods, Fast Moving Consumer Goods, Health Care, Information Technology, and Realty. Another objective is to compare the composite index BSE 500 of India with three global indexes S&P 500 of the US, Nikkei 225 of Japan, and FTSE 100 of the UK.

To be more concise, the current study enhances the basic concept of how markets respond to the abrupt risk assessment. In this study, an attempt is made to study market predictability indicators, mainly volatilities in return during the crisis (from January 2020 to May 2020) and before the crisis (December 2019 and earlier) using GLS regression.

## 3. METHODOLOGY

In this study, the investigation was done using the daily price data taken from the BSE website for the two composite indices, i.e., BSE 500, BSE Sensex, and eight sectoral indices, i.e., BSE

Auto (Transportation Equipment Sector), BSE Bankex (Banks Sector), BSE CD (Consumer Durable Sector), BSE CG (Capital Goods Sector), BSE FMCG (Fast Moving Consumer Goods Sector), BSE HC (Health Care Sector), BSE IT (Information Technology Sector), and BSE Realty (Real Estate Sector) from January 2019 to May 2020. All the sectors taken for analysis are important and constitute a major part of the Indian stock market composite indices. The daily price data were also collected for the composite indices, namely, S&P 500 (representing the United States stock market), Nikkei 225 (representing the Japanese stock market), and FTSE 100 (representing the United Kingdom stock market) for the same period from Yahoo Finance to compare the performance of Indian composite index with the global indices mentioned earlier.

### 3.1. Descriptive statistics

Descriptive statistics are used to measure the central tendency (mean and median) and variation (standard deviation, skewness, kurtosis). Standard deviation is more suitable in the normal distribution, so skewness was also used to measure the symmetry of distribution, and measured kurtosis was used to examine the heaviness of distribution. Jarque-Bera test was done to confirm that the return follows the normal distribution or not. Histograms and bell curve are plotted from the descriptive statistics to show the behavior of the frequency of index returns during the COVID-19 period and before the COVID-19 period for the indices of the Indian stock market. The descriptive statistics have been disclosed for two periods before the crisis (August – December 2019) and during the crisis (January – May 2020), after monitoring for equivalent window lengths for the sub-samples. The following formulae were used for computation:

1. Return:

$$r_{it} = \ln\left(\frac{P_{it}}{P_{i,t-1}}\right), \tag{1}$$

where $r_{it}$ is the return on index $i$, $P_{it}$ is the price on index $i$, $P_{i,t-1}$ is the price on index $i$ at the end of the day $t$–1.

2. Standard deviation:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(r_i - \overline{r})^2}, \qquad (2)$$

where $n$ is the number of returns, $r_i$ is the $i$ return, $\overline{r}$ is the mean return, and $\sigma$ is standard deviation of returns.

3. Skewness:

$$S = \frac{\left(\frac{1}{n}\right)\sum_{i=1}^{n}(r_i - \overline{r})^3}{\sigma^3}, \qquad (3)$$

where $S$ is the measure of skewness, $n$ is the number of returns, $r_i$ is the $i$ return, $\overline{r}$ is the mean return, and $\sigma$ is standard deviation of returns.

4. Kurtosis:

$$K = \frac{\left(\frac{1}{n}\right)\sum_{i=1}^{n}(r_i - \overline{r})^4}{\sigma^4}, \qquad (4)$$

where $K$ is the measure of kurtosis, $n$ is the number of returns, $r_i$ is the $i$ return, $\overline{r}$ is the mean return, and $\sigma$ is standard deviation of returns. The kurtosis for a normal distribution is 3. The excess kurtosis is calculated by subtracting 3 from the above formula. In this study, the descriptive statistics show kurtosis and excess kurtosis has been calculated in the regression.

5. Jarque-Bera test:

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right], \qquad (5)$$

where $n$ is the number of observations, $S$ is the measure of skewness, and $K$ is the measure of kurtosis.

6. Coefficient of correlation:

A cross-correlation matrix representing the correlation between returns for each index is also computed using the following formula:

$$\rho_{xy} = \frac{Cov(x, y)}{\sigma_x \cdot \sigma_y}, \qquad (6)$$

where $Cov(x, y)$ covariance of index $x$ and $y$, $\sigma_x$ is standard deviation of index $x$, and $\sigma_y$ is standard deviation of index $y$.

## 3.2. Basic regression models

For regression, the entire daily data from January 2019 to May 2020 were taken. A simple regression has been applied to assess the impact of COVID-19 on the multiple measures of volatility, namely, standard deviation, skewness, and kurtosis of indices return from January 2019 to May 2020, wherein a dummy variable equal to 1 for the coronavirus period (January – May 2020) was considered. The influence of COVID-19 on the index volatility was analyzed using GLS regression. The generalized least squares (GLS) estimator is more effective than OLS under autocorrelation and heteroscedasticity. Standard deviation, skewness, and kurtosis of all index returns are estimated based on 30 days of rolling data.

1. Model 1: In model 1, the standard deviation is taken as a dependent variable for each index (BSE 500, BSE Sensex, BSE Auto, BSE Bankex, BSE CD, BSE CG, BSE FMCG, BSE HC, BSE IT, BSE Realty) and the independent variable COVID as the dummy variable. The value of dummy variable is taken as "1" for COVID-19 period, i.e., from January 2020 to May 2020, and "0" for the pre-COVID-19 period (January 2019 – December 2019):

$$SD_t = a_0 + a_1 COVID_t + \mu_t, \qquad (7)$$

where $SD_t$ is the standard deviation for the index at time $t$, and COVID is a dummy variable equal to 1 for the COVID-19 period (January 2020 – May 2020) and 0 for the pre-COVID-19 period, $\mu_t$ is the error term at time $t$.

2. Model 2: In model 2, the skewness is taken as a dependent variable for each index (BSE 500, BSE Sensex, BSE Auto, BSE Bankex, BSE CD, BSE CG, BSE FMCG, BSE HC, BSE IT, BSE Realty) and the independent variable COVID as the dummy variable. The value of dummy variable is taken as "1" for the COVID-19 period, i.e., from January 2020 to May 2020, and "0" for the pre-COVID-19 period (January 2019 – December 2019):

$$S_t = a_0 + a_1 COVID_t + \mu_t, \qquad (8)$$

where $S_t$ is the skewness for the index at time $t$, and COVID is a dummy variable equal to 1 for the COVID-19 period (from January 2020 to May 2020) and 0 for the pre-COVID-19 period, and, $\mu_t$ is the error term at time $t$.

3.  Model 3: In model 3, the kurtosis is taken as a dependent variable for each index (BSE 500, BSE Sensex, BSE Auto, BSE Bankex, BSE CD, BSE CG, BSE FMCG, BSE HC, BSE IT, BSE Realty) and the independent variable COVID as the dummy variable. The value of dummy variable is taken as "1" for COVID-19 period, i.e., from January 2020 to May 2020, and "0" for the pre-COVID-19 period. (January 2019 – December 2019):

$$K_t = a_0 + a_1 COVID_t + \mu_t, \qquad (9)$$

where $K_t$ is the kurtosis for the index at time $t$, and COVID is a dummy variable equal to 1 for the COVID-19 period (January 2020 – May 2020) and 0 for the pre-COVID-19 period, and, $\mu_t$ is the error term.

## 4. RESULTS AND DISCUSSION

Table 1 presents the descriptive analysis using the daily returns for each index, including two composite (BSE 500, BSE Sensex) and eight sectoral

(BSE Auto, BSE Bankex, BSE CD, BSE CG, BSE FMCG, BSE HC, BSE IT, and BSE Realty) indices of the Indian stock market.

The period taken has been divided into two, i.e., before the crisis and during the crisis, after monitoring identical window length for the sub-samples. It is observed that the minimum value for all the indices from January to May 2020 occurred on 23 March 2020, which constituted one of the worst days in the history of the Indian stock market. In a single day, BSE 500 and BSE Sensex plunged by 13-14%. All the sectoral indices finished in red on that day, with the banking sector and capital goods sector plummeting by 18.40% and 16.1%, respectively. All indices show lower mean daily return, rather be specific, negative returns in the crisis period than before the crisis five-month period. Indeed, the only sector during the crisis period to get a positive return was health care. Having analyzed the return behavior, the risk measures in Table 1 depict the Indian stock market to be more volatile in the crisis period than in the pre-crisis period. The standard deviation, being the primary measure of risk, of all indices was larger during the COVID-19 time compared to the pre-COVID-19 period. This is possibly due to investors' being more sensitive to fear of COVID-19, resulting in an increase in volatility in the overall Indian stock market during the crisis. The standard deviation of return of all the indices has gone up in the range of 1.8-3 times during the crisis compared to the pre-crisis period.

**Table 1.** Descriptive statistics

| Descriptive Statistics | BSE 500 | BSE Sensex | BSE Auto | BSE Bankex | BSE CD | BSE CG | BSE FMCG | BSE HC | BSE IT | BSE Realty |
|---|---|---|---|---|---|---|---|---|---|---|
| **5 months (before the crisis) (August 2019 – December 2019)** | | | | | | | | | | |
| Mean | 0.0009 | 0.0010 | 0.0018 | 0.0011 | 0.0011 | −0.0004 | 0.0003 | 0.0006 | −0.0002 | 0.0010 |
| Median | 0.0014 | 0.0010 | −0.0015 | 0.0018 | 0.0008 | −0.0018 | −0.0001 | 0.0009 | 0.0015 | 0.0036 |
| Maximum | 0.0520 | 0.0519 | 0.0940 | 0.0789 | 0.0719 | 0.0763 | 0.0419 | 0.0238 | 0.0231 | 0.0436 |
| Minimum | −0.0197 | −0.0208 | −0.0396 | −0.0268 | −0.0545 | −0.0325 | −0.0190 | −0.0246 | −0.0727 | −0.0619 |
| Std. dev. | 0.0097 | 0.0098 | 0.0173 | 0.0157 | 0.0132 | 0.0148 | 0.0090 | 0.0085 | 0.0128 | 0.0163 |
| Skewness | 1.4198 | 1.4313 | 1.3976 | 1.4227 | 0.6987 | 2.1182 | 1.5505 | −0.1903 | −1.9446 | −0.5625 |
| Kurtosis | 9.8150 | 9.5211 | 10.1878 | 9.0491 | 12.8220 | 11.8684 | 9.0913 | 3.3397 | 12.0358 | 4.7878 |
| JB statistics | 227.11 | 211.33 | 247.83 | 186.20 | 410.10 | 402.48 | 194.67 | 1.08 | 403.21 | 18.59 |
| Probability | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.00 | 0.00 |
| Observations | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **5 months (during the crisis) (January 2020 – May 2020)** | | | | | | | | | | |
| Mean | −0.0023 | −0.0024 | −0.0027 | −0.0050 | −0.0027 | −0.0031 | −0.0005 | 0.0015 | −0.0009 | −0.0048 |
| Median | 0.0000 | −0.0019 | 0.0003 | −0.0031 | −0.0011 | −0.0024 | −0.0002 | 0.0018 | 0.0019 | −0.0012 |
| Maximum | 0.0749 | 0.0859 | 0.0976 | 0.1017 | 0.0686 | 0.0699 | 0.0792 | 0.0857 | 0.0803 | 0.0603 |
| Minimum | −0.1379 | −0.1410 | −0.1433 | −0.1840 | −0.1244 | −0.1618 | −0.1101 | −0.0865 | −0.0969 | −0.1121 |
| Std. dev. | 0.0274 | 0.0295 | 0.0316 | 0.0376 | 0.0253 | 0.0291 | 0.0240 | 0.0219 | 0.0277 | 0.0303 |
| Skewness | −1.3995 | −1.0903 | −0.6455 | −1.0124 | −1.2360 | −1.7858 | −0.4121 | −0.6293 | −0.5259 | −1.0947 |
| Kurtosis | 9.1957 | 8.2560 | 7.4003 | 7.9798 | 8.5576 | 11.3185 | 9.0356 | 8.7106 | 5.9670 | 5.0127 |
| JB statistics | 194.51 | 136.27 | 88.50 | 121.61 | 155.70 | 344.89 | 156.16 | 143.90 | 41.70 | 37.22 |
| Probability | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 |

BSE Sensex shows the highest increase of 3.02 times. The BSE Bankex index reports the highest standard deviation of returns (0.03756, annualized: 59.39%), though it has gone up by 2.4 times in the crisis period compared to the pre-crisis period. The lowest standard deviation of return has been observed in the health care sector (0.02186, annualized: 34.57%), and it has gone up by 2.58 times in the crisis period compared to the pre-crisis period. The skewness values in this have shifted to negative values during the crisis compared to general positive skewness for all indices before the crisis. Furthermore, the kurtosis values are exceptionally large, indicating that the returns follow a leptokurtic distribution. Though comparing the two periods, kurtosis value has declined for some of the indices. Finally, the results of the Jarque-Bera test are also highly significant, confirming that all the indices are not normally distributed for both periods. The only exception to this is the health care sector showing normal distribution of return in the pre-crisis period.

To get perfect and profound knowledge about movement and frequencies of stock return during COVID-19 and pre-COVID-19 period, the results were exhibited showing the frequency and normal distribution of index returns during the crisis period (from January to May 2020) (Figures 1(k)-1(t)) and before the crisis (Aug-Dec 2019) (Figures 1(a)-1(j)). The two-time period figures for all indices (composite and sectoral) depict larger standard deviation, negative skewness, and higher kurtosis values in January – May 2020 compared to August – December 2019.
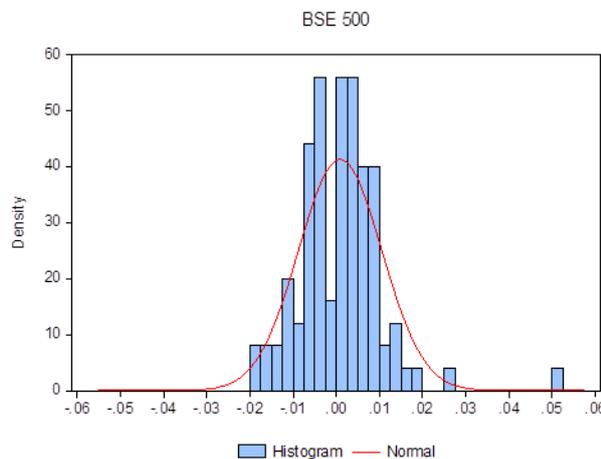


**Figure 1(a).** BSE 500
(August – December 2019)
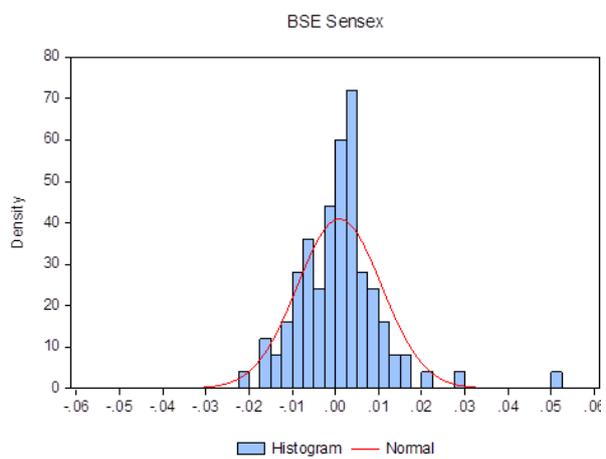
**Figure 1(b).** BSE Sensex
(August – December 2019)
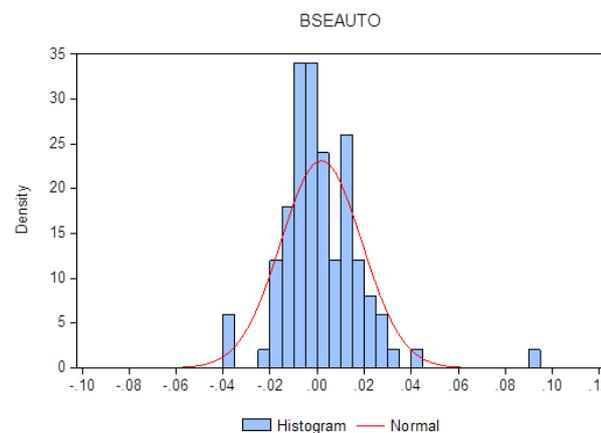
**Figure 1(c).** BSE Automobiles
(August – December 2019)
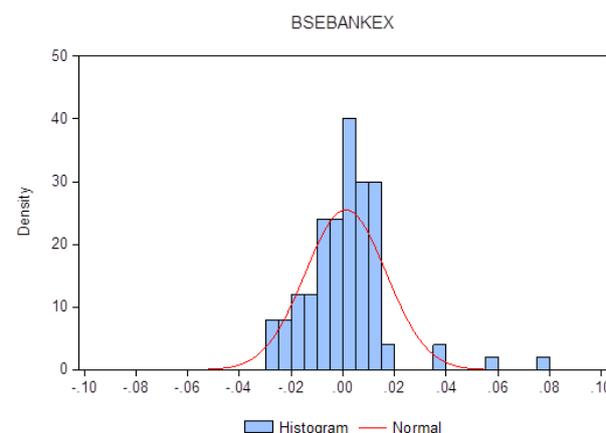
**Figure 1(d).** BSE Bankex
(August – December 2019)

**Figure 1.** Frequency and normal distribution of stock returns during the crisis period and the pre-crisis period
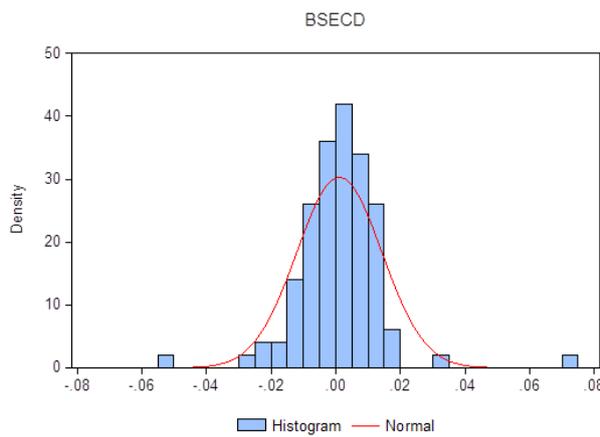
**Figure 1(e).** BSE Consumer Durables
(August –December 2019)
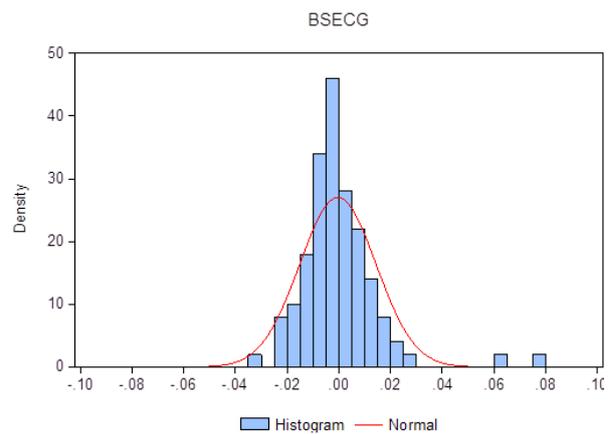
**Figure 1(f).** BSE Capital Goods
(August – December 2019)
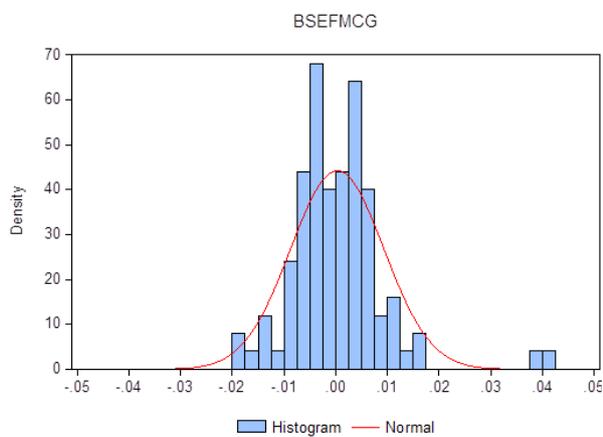
**Figure 1(g).** BSE Fast Moving Consumer Goods
(August – December 2019)
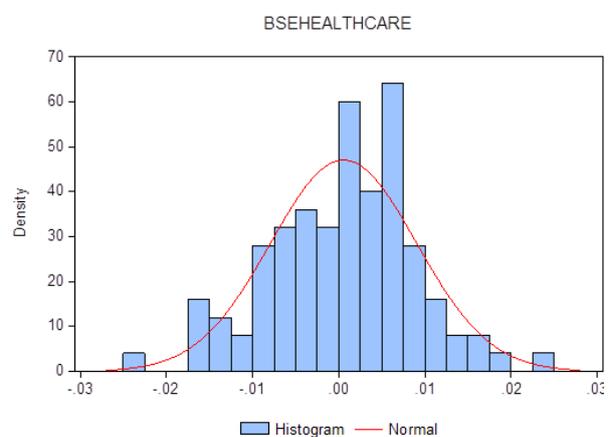
**Figure 1(h).** BSE Health Care
(August – December 2019)
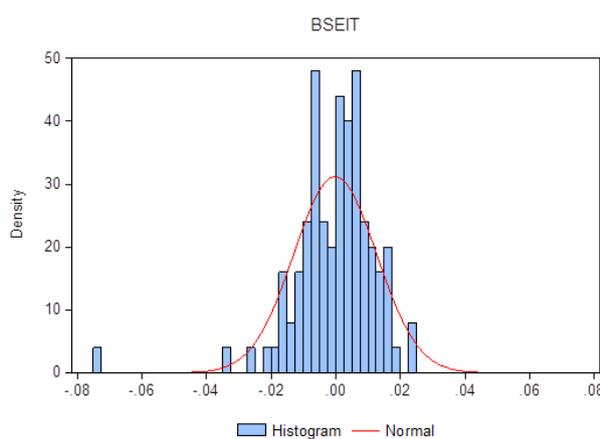
**Figure 1(i).** BSE Information Technology
(August –December 2019)
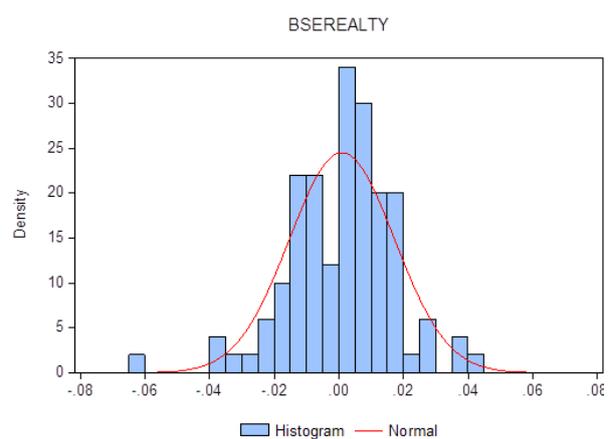
**Figure 1(j).** BSE Realty
(August – December 2019)

**Figure 1 (cont.).** Frequency and normal distribution of stock returns during the crisis period
and the pre-crisis period
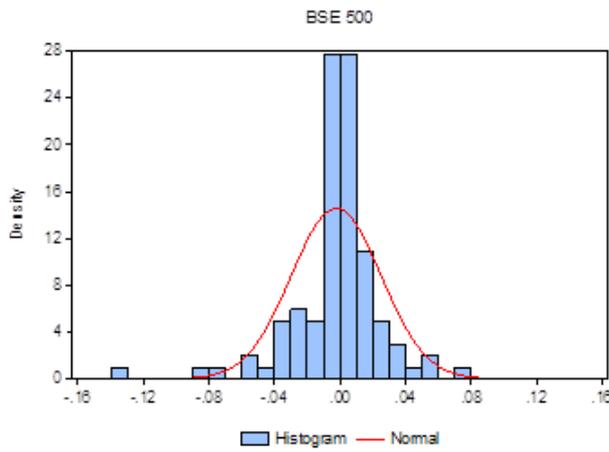
**Figure 1(k).** BSE 500
(January – May 2020)
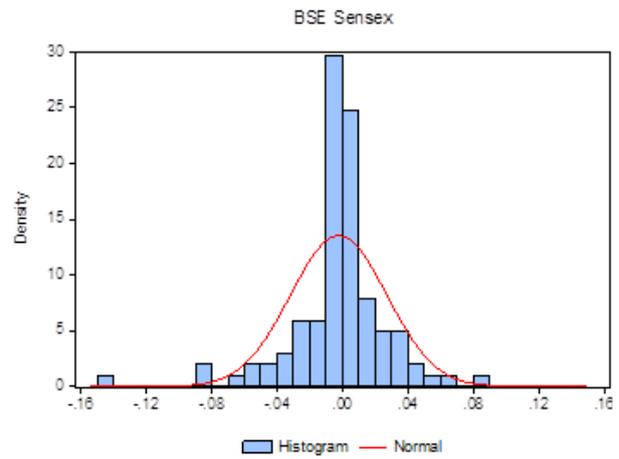
**Figure 1(l).** BSE Sensex
(January – May 2020)
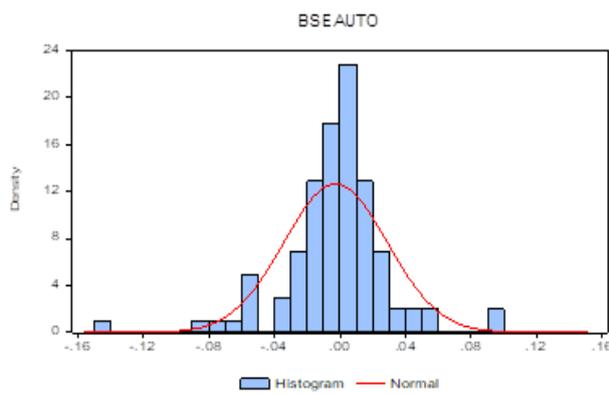
**Figure 1(m).** BSE Automobiles
(January – May 2020)
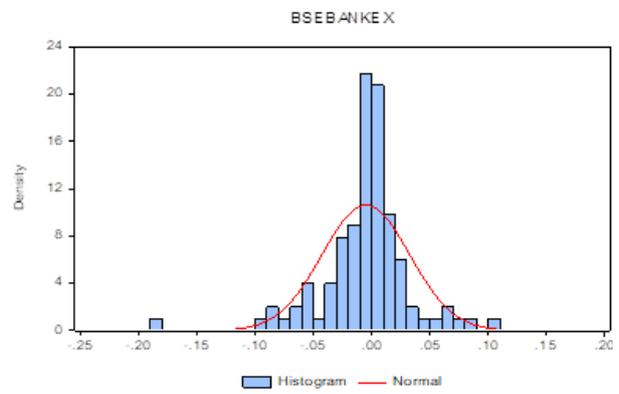
**Figure 1(n).** BSE Bankex
(January – May 2020)
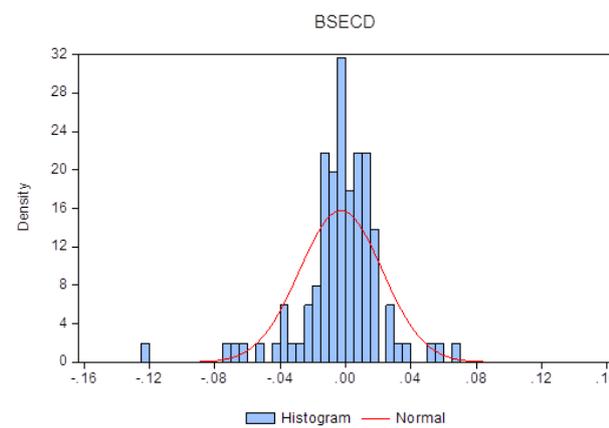
**Figure 1(o).** BSE Consumer Durables
(January –May 2020)
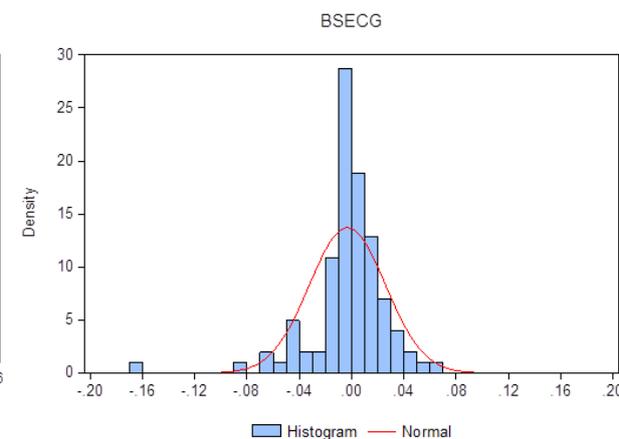
**Figure 1(p).** BSE Capital Goods
(January –May 2020)

**Figure 1 (cont.).** Frequency and normal distribution of stock returns during the crisis period
and the pre-crisis period
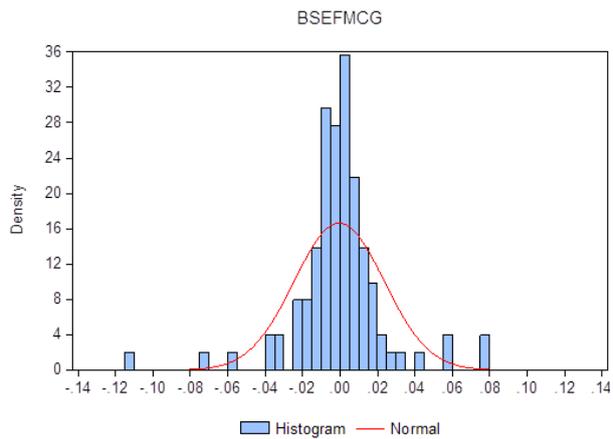
**Figure 1(q).** BSE Fast Moving Consumer Goods
(January – May 2020)
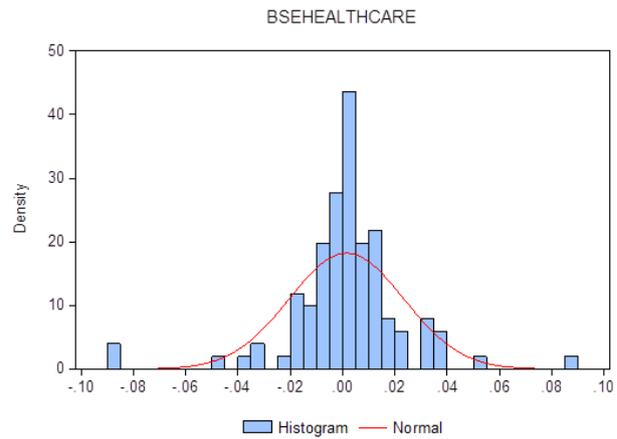


**Figure 1(r).** BSE Health Care
(January – May 2020)
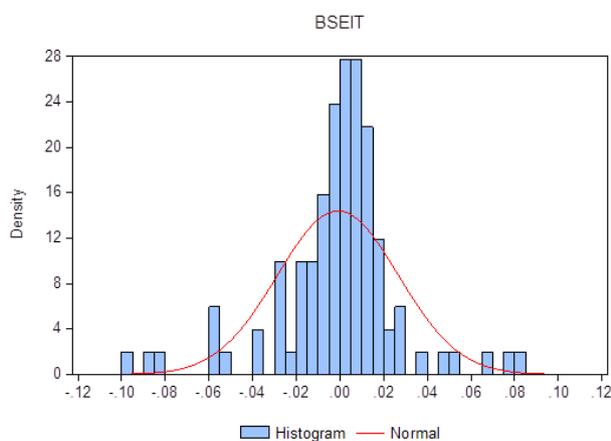


**Figure 1(s).** BSE Information Technology
(January –May 2020)
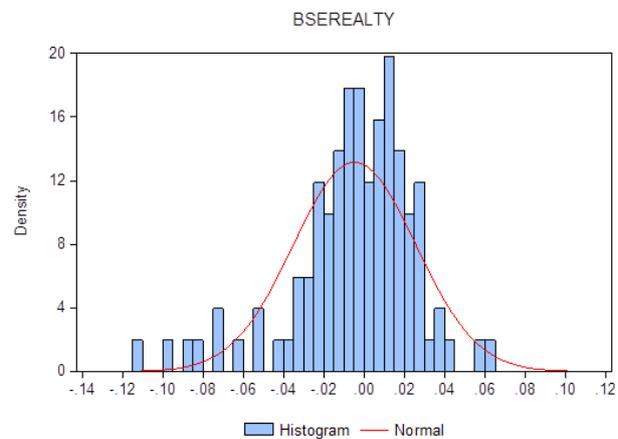


**Figure 1(t).** BSE Realty
(January – May 2020)

**Figure 1 (cont.).** Frequency and normal distribution of stock returns during the crisis period
and the pre-crisis period

Furthermore, Table 2 contains the highlights of periodic returns for the quarter during the crisis (January – March 2020) and the quarter before the crisis (October – December 2019) then as only 5 months were available for during the crisis, so returns are computed for five months during the crisis (January – May 2020) and 5 months before the crisis (August – December 2019). It also reveals that the indices of the banking sector (–39.48%), realty (–37.98%), and capital goods (–27.58%) did the poorest concerning periodic returns from January to May 2020. The health care sector (16.21%) has shown positive returns, and FMCG (–4.93%) has witnessed the lowest loss during a similar period. In this table, periodic re-

turns of the first three months (January – March 2020) of the crisis period also have been disclosed. Comparing the periodic returns, April – May 2020 has helped all the indices to bounce with altered strength technically.

Overall, the banking and realty sectors fixed for the relatively weakest rebound, while the health care, auto, and information technology exhibited the strongest strength in the rebound. The table also shows that the best performing sector before the crisis (August – December 2019) period was the Automobiles sector (19.49%), and the worst-performing was the Capital goods sector (–1.77%).

**Table 2.** Highlights of periodic returns

| Indices | Periodic returns (%) | | | |
|---|---|---|---|---|
| | October – December 2019 | January – March 2020 | August – December 2019 | January – May 2020 |
| | (3 months before the crisis) | (3 months during the crisis) | (5 months before the crisis) | (5 months during the crisis) |
| BSE 500 | 6.98 | −29.29 | 10.70 | −20.90 |
| BSE Sensex | 7.70 | −28.66 | 11.44 | −21.50 |
| BSE Auto | 10.74 | −41.57 | 19.49 | −23.37 |
| BSE Bankex | 13.26 | −39.71 | 14.24 | −39.48 |
| BSE CD | −3.32 | −21.49 | 11.71 | −23.09 |
| BSE CG | −8.42 | −35.54 | −1.77 | −27.58 |
| BSE FMCG | −2.12 | −10.54 | 3.57 | −4.93 |
| BSE HC | 8.67 | −9.77 | 6.69 | 16.21 |
| BSE IT | 0.45 | −17.51 | 0.29 | −9.65 |
| BSE Realty | 19.95 | −40.52 | 11.45 | −37.98 |

The correlation matrix in Table 3 for two periods, i.e., August – December 2019 and January –May 2020, reveals that the indices' relationship is growing during COVID-19 period.

The indices values come nearer and less dispersed during COVID-19 period. Similar findings were reported by Akter and Nobi (2018).

Tables 4, 5, and 6 display the effect of COVID-19 on index volatility using GLS regression. As heteroscedasticity was present in the data, GLS model was used to correct it.

The regression analysis results revealed a significant positive correlation between the coronavirus and the standard deviations for both the compos-

**Table 3.** Correlation matrix

| Indices | BSE 500 | BSE Sensex | BSE Auto | BSE Bankex | BSE CD | BSE CG | BSE FMCG | BSE HC | BSE IT | BSE Realty |
|---|---|---|---|---|---|---|---|---|---|---|
| **5 months (before the crisis) (August 2019 – December 2019)** | | | | | | | | | | |
| BSE 500 | 1.00 | 0.99 | 0.83 | 0.91 | 0.65 | 0.87 | 0.81 | 0.64 | 0.10 | 0.70 |
| BSE Sensex | 0.99 | 1.00 | 0.81 | 0.90 | 0.60 | 0.85 | 0.79 | 0.58 | 0.16 | 0.67 |
| BSE Auto | 0.83 | 0.81 | 1.00 | 0.71 | 0.64 | 0.71 | 0.66 | 0.56 | 0.03 | 0.57 |
| BSE Bankex | 0.91 | 0.90 | 0.71 | 1.00 | 0.57 | 0.82 | 0.71 | 0.52 | −0.13 | 0.70 |
| BSE CD | 0.65 | 0.60 | 0.64 | 0.57 | 1.00 | 0.62 | 0.59 | 0.37 | −0.17 | 0.37 |
| BSE CG | 0.87 | 0.85 | 0.71 | 0.82 | 0.62 | 1.00 | 0.78 | 0.49 | −0.05 | 0.58 |
| BSE FMCG | 0.81 | 0.79 | 0.66 | 0.71 | 0.59 | 0.78 | 1.00 | 0.50 | −0.02 | 0.46 |
| BSE HC | 0.64 | 0.58 | 0.56 | 0.52 | 0.37 | 0.49 | 0.50 | 1.00 | 0.06 | 0.50 |
| BSE IT | 0.10 | 0.16 | 0.03 | −0.13 | −0.17 | −0.05 | −0.02 | 0.06 | 1.00 | −0.02 |
| BSE Realty | 0.70 | 0.67 | 0.57 | 0.70 | 0.37 | 0.58 | 0.46 | 0.50 | −0.02 | 1.00 |
| **5 months (during the crisis) (January 2020 – May 2020)** | | | | | | | | | | |
| BSE 500 | 1.00 | 0.99 | 0.91 | 0.95 | 0.89 | 0.89 | 0.83 | 0.77 | 0.84 | 0.88 |
| BSE Sensex | 0.99 | 1.00 | 0.89 | 0.95 | 0.88 | 0.86 | 0.81 | 0.74 | 0.86 | 0.86 |
| BSE Auto | 0.91 | 0.89 | 1.00 | 0.86 | 0.89 | 0.83 | 0.69 | 0.68 | 0.72 | 0.82 |
| BSE Bankex | 0.95 | 0.95 | 0.86 | 1.00 | 0.86 | 0.85 | 0.69 | 0.62 | 0.75 | 0.85 |
| BSE CD | 0.89 | 0.88 | 0.89 | 0.86 | 1.00 | 0.81 | 0.70 | 0.62 | 0.68 | 0.81 |
| BSE CG | 0.89 | 0.86 | 0.83 | 0.85 | 0.81 | 1.00 | 0.72 | 0.67 | 0.65 | 0.83 |
| BSE FMCG | 0.83 | 0.81 | 0.69 | 0.69 | 0.70 | 0.72 | 1.00 | 0.79 | 0.74 | 0.72 |
| BSE HC | 0.77 | 0.74 | 0.68 | 0.62 | 0.62 | 0.67 | 0.79 | 1.00 | 0.65 | 0.63 |
| BSE IT | 0.84 | 0.86 | 0.72 | 0.75 | 0.68 | 0.65 | 0.74 | 0.65 | 1.00 | 0.67 |
| BSE Realty | 0.88 | 0.86 | 0.82 | 0.85 | 0.81 | 0.83 | 0.72 | 0.63 | 0.67 | 1.00 |

**Table 4.** Regression analysis: model 1 – for COVID-19 and standard deviation of the index returns

| Particulars | BSE 500 | BSE Sensex | BSE Auto | BSE Bankex | BSE CD | BSE CG | BSE FMCG | BSE HC | BSE IT | BSE Realty |
|---|---|---|---|---|---|---|---|---|---|---|
| Constant | 0.0084* | 0.0085* | 0.0148* | 0.0123* | 0.0115* | 0.0126* | 0.0080* | 0.0090* | 0.0110* | 0.0153* |
|  | (14.1065) | (12.9968) | (22.368) | (14.9056) | (22.2066) | (21.0864) | (15.3192) | (19.9894) | (19.0791) | (31.5808) |
| COVID | 0.0134* | 0.0148* | 0.0106* | 0.0168* | 0.0091* | 0.0110* | 0.0116* | 0.0090* | 0.0117* | 0.0105* |
|  | (12.6316) | (12.8267) | (9.0765) | (11.4485) | (9.8835) | (10.436) | (12.6414) | (11.2547) | (11.4796) | (12.2318) |
| Adj. $R^2$ | 0.3348 | 0.3417 | 0.2053 | 0.2922 | 0.2348 | 0.2552 | 0.3352 | 0.2852 | 0.2934 | 0.3206 |
| F-test | 159.56 | 164.52 | 82.38 | 131.07 | 97.68 | 108.91 | 159.8 | 126.67 | 131.78 | 149.62 |
| p-value (F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Note:* Figures in ( ) indicate the value of *t*-statistics, * significant at 1% level; ** significant at 5% level.

ite and all eight sectoral index returns (see Table 4). This implies that COVID-19 has led to an increase in Indian stock market volatility. Similar findings were reported by Yousef (2020). Furthermore, the largest coefficient in the case of the composite index is for BSE Sensex. It is observed that large-capitalization companies depict more standard deviation than the mid and small-capitalization companies, thus leading to a higher coefficient for BSE Sensex as compared to BSE 500. The coefficient of BSE Bankex is highest among all sectoral indices taken for the study and more than both the composite index. This indicates that the banking index is the most volatile in this current time of the pandemic. With COVID-19 situation intensifying in the country and higher chances of the lockdown getting extended, albeit, with some additional relief, the investors continue to shy away from banking stocks on concerns that these events will lead to higher bad loans. The least volatile index, as seen in Table 4, is BSE HC. Indian healthcare has been relatively resilient to the COVID disruption and is poised to gain from favorable currency tailwinds.

The results of the regression analysis, in general, reveal a significant negative correlation between the coronavirus and the skewness of the indices return (see Table 5). Comparatively, BSE 500 has higher negative skewness than BSE Sensex in this time of the pandemic. This means that the mid and small-capitalization stocks depict higher negative skewness than the large-capitalization stocks in the current COVID-19 times. The capital goods sectoral index depicts the highest negative coefficient. The Capital goods sector in India was already suffering because of the slowness in the overall economy, and COVID-19 has collided with when the sector is fighting poor order drifts from both the government and the private sector. Along with this, there is an issue of the liquidity crisis, and with the economy in lockdown, it would increase further pressure on the already hard-pressed working capital requirement of companies. Due to the requirement of funds for other fixed obligations, the government and private sectors are postponing the capital expenditures, thus making the Capital goods sector more volatile. Being a defensive sector, the FMCG sectoral index has also turned more volatile with a relatively larger standard deviation and negative skewness in these COVID-19 times.

**Table 5.** Regression analysis: model 2 – for COVID-19 and skewness of the index returns

| Particulars | BSE 500 | BSE Sensex | BSE Auto | BSE Bankex | BSE CD | BSE CG | BSE FMCG | BSE HC | BSE IT | BSE Realty |
|---|---|---|---|---|---|---|---|---|---|---|
| Constant | 0.3896* | 0.4556* | 0.5053* | 0.2337* | −0.4578* | 0.4808* | 0.2150* | −0.3447* | −0.3459* | −0.1383* |
|  | (8.1417) | (9.6264) | (10.1786) | (4.6275) | (−4.8521) | (8.0090) | (4.1353) | (−6.7148) | (−5.3076) | (−2.9848) |
| COVID | −1.1058* | −0.9901* | −0.9009* | −0.7991* | 0.3097*** | −1.3191* | −0.4573* | 0.0247 | 0.0393 | −0.8622* |
|  | (−13.0653) | (−11.8263) | (−10.2605) | (−8.9441) | (1.8557) | (−12.4232) | (−4.9719) | (0.2725) | (0.3410) | (−10.5203) |
| Adj. $R^2$ | 0.3501 | 0.3060 | 0.2487 | 0.2005 | 0.0077 | 0.3274 | 0.0700 | −0.0029 | −0.0028 | 0.2583 |
| F-test | 170.70 | 139.86 | 105.28 | 80.00 | 3.44 | 154.34 | 24.72 | 0.07 | 0.12 | 110.68 |
| p-value (F) | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.79 | 0.73 | 0.00 |

*Note:* Figures in ( ) indicate the value of *t*-statistics, * significant at 1% level; ** significant at 5% level; *** significant at 10% level.

**Table 6.** Regression analysis: model 3 – for COVID-19 and kurtosis of the index returns

| Particulars | BSE 500 | BSE Sensex | BSE Auto | BSE Bankex | BSE CD | BSE CG | BSE FMCG | BSE HC | BSE IT | BSE Realty |
|---|---|---|---|---|---|---|---|---|---|---|
| Constant | 1.0506* | 1.1071* | 1.3824* | 0.9488* | 4.4344* | 1.3779* | 1.0124* | 0.7833* | 2.1720* | 0.7208* |
| | (8.1925) | (9.1861) | (10.8026) | (9.6321) | (16.5771) | (8.4756) | (9.4229) | (6.1135) | (9.6132) | (4.6202) |
| COVID | 0.8755* | 0.5552** | −0.3076 | 0.6477* | −2.7314* | 1.4951* | 0.3332*** | 1.0418* | −1.2440* | 1.9749* |
| | (3.8595) | (2.6041) | (−1.3591) | (3.7174) | (−5.7726) | (5.1992) | (1.7536) | (4.5965) | (−3.1128) | (7.1566) |
| Adj. $R^2$ | 0.0423 | 0.0180 | 0.0027 | 0.0391 | 0.0931 | 0.0763 | 0.0065 | 0.0601 | 0.0268 | 0.1375 |
| $F$-test | 14.90 | 6.78 | 1.85 | 13.82 | 33.32 | 27.03 | 3.08 | 21.13 | 9.69 | 51.22 |
| $p$-value ($F$) | 0.00 | 0.01 | 0.18 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 |

*Note:* Figures in ( ) indicate the value of *t*-statistics, * significant at 1% level; ** significant at 5% level; *** significant at 10% level.

The results of the regression analysis, in general, reveal a significant positive correlation between the coronavirus and the kurtosis of the indices return (see Table 6). When comparing the composite indices, BSE 500 depicts a higher positive coefficient than BSE Sensex. In the sectoral indices, the capital goods sectors reflect increasingly higher kurtosis in COVID-19 times, which is even higher than the composite indices. There is a significant decline in kurtosis value for the consumer durable and the information technol-

ogy sector during the crisis compared to the previous period.

Furthermore, the Indian stock market's volatility was compared with the United States, Japan, and the United Kingdom stock markets. The influence of the coronavirus on index volatility was analyzed using a GLS regression by taking into account BSE 500 (the Indian stock market), S&P 500 (the United States stock market), Nikkei 225 (the Japanese stock market), and FTSE 100 (the United

**Table 7.** Regression analysis – comparing BSE 500 with global market indices (Model 1 – Model 3)

| Model | Particulars | BSE 500 | S&P 500 | NIKKEI 225 | FTSE 100 |
|---|---|---|---|---|---|
| Model 1 | Constant | 0.0084* | 0.0073* | 0.0085* | 0.0071* |
| | | −14.1065 | −10.4616 | −23.5422 | −15.1797 |
| | COVID | 0.0134* | 0.0174* | 0.0107* | 0.0133* |
| | | −12.6316 | −13.9514 | −16.6199 | −15.9987 |
| | Adj. $R^2$ | 0.3348 | 0.3741 | 0.4727 | 0.4396 |
| | $F$-test | 159.56 | 194.64 | 276.22 | 255.95 |
| | $p$-value ($F$) | 0 | 0 | 0 | 0 |
| Model 2 | Constant | 0.3896* | −0.4923* | −0.0607 | −0.5441* |
| | | −8.1417 | (−13.3935) | (−1.5356) | −10.3343 |
| | COVID | −1.1058* | 0.1790** | 0.2474* | 0.0816 |
| | | (−13.0653) | −2.7412 | −3.5126 | −0.8715 |
| | Adj. $R^2$ | 0.3501 | 0.0197 | 0.0356 | 0.0007 |
| | $F$-test | 170.7 | 7.51 | 12.34 | 0.7595 |
| | $p$-value ($F$) | 0 | 0.01 | 0 | 0.38 |
| Model 3 | Constant | 1.0506* | 1.2328* | 1.2272* | 1.6602* |
| | | −8.1925 | −13.721 | −16.8192 | −10.9583 |
| | COVID | 0.8755* | −0.6655* | −0.5913* | −0.1865 |
| | | −3.8595 | (−4.1695) | (−4.5478) | (−0.6919) |
| | Adj. $R^2$ | 0.0423 | 0.04814 | 0.0602 | 0.0016 |
| | $F$-test | 14.9 | 17.39 | 20.68 | 0.48 |
| | $p$-value ($F$) | 0 | 0 | 0 | 0.49 |

*Note:* Figures in ( ) indicate the value of *t*-statistics, * significant at 1% level; ** significant at 5% level.

Kingdom stock market). Table 7 shows a significant positive correlation between the coronavirus and the standard deviations of the index returns. This implies that COVID-19 has led to an increase in global market volatility. The largest coefficient was for the S&P 500 Index, suggesting that the virus's impact on this index was greater than its impact on the BSE 500, Nikkei 225, and FTSE 100. However, the relationship of coronavirus and skewness of index returns showed a significantly larger negative coefficient for BSE 500 as compared to significant positive coefficients of S&P 500 and Nikkei 225. In the case of FTSE 100, there is an insignificant relation between coronavirus and skewness of index returns, thus suggesting no changes in skewness due to coronavirus. Due to coronavirus, the skewness of BSE 500 has shifted into a larger negative value making the Indian stock market more volatile. At last, the relationship of coronavirus and kurtosis of index returns were observed. A significant positive coefficient was found for BSE 500 compared to the significant negative coefficient for S&P 500 and Nikkei 225. Again, in the case of FTSE 100, there is an insignificant relation between coronavirus and kurtosis of index returns, thus suggesting no changes in kurtosis due to coronavirus. However, all indices, in general, show leptokurtic distribution.

## CONCLUSION

In this study, the impact of COVID-19 is analyzed on the performance of the Indian stock market on the multiple measures of volatility, namely standard deviation, skewness, and kurtosis of index returns, concerning two composite indices and eight sectoral indices on the daily data from January 2019 to May 2020 using the GLS regression. This paper's key findings state that sub-sample analysis for the composite and sectoral indices before and during COVID-19 period, with equivalent window length, discloses that all indices show lower mean daily return, rather be specific, negative returns in the crisis period as compared to pre-crisis five-month period. Health care was only one of the sectors that could sustain its positive return during COVID-19 period. In total, the Indian stock market turned out to be more volatile during COVID-19 period, and the returns exhibit non-normality at all times. However, during the crisis, it is observed that skewness becomes negative with index returns or has shifted into more negative values for a few of the index returns. In general, the kurtosis values are exceptionally large, indicating that the returns follow a leptokurtic distribution both during the crisis and before the crisis. The crisis period has seen an increase and a decrease in kurtosis of returns for the indices. The negative skewness and higher kurtosis value is an indicator of future risk. It is also found that the relationship between indices has increased during the crisis period. Therefore, a close watch on the return correlation behavior is required. Another important finding of the paper is that the Indian stock market depicts roughly the same standard deviation compared to the developed economies of the United States, Japan, and the United Kingdom but has higher negative skewness and higher positive kurtosis of returns, which make the market seem more volatile.

With the number of increasing COVID-19 cases, the present market looking divorced with the economic reality and the returns displaying the non-normal distribution with increasing negative skewness and higher positive kurtosis. In this context, it is suggested that risk-averse investors should remain away from investing in the stock market during COVID-19 period, and those short-term investors who are holding the stocks should close their positions as early as possible to evade losses. Besides, short-term investors could buy low when there is a significant fall in the market and close the position in near 5 to 10 trading days whenever there is a technical recovery for generous profits. In this highly volatile market, traders can gain money by using hedging strategies such as protective put, limiting the potential losses that may result from an unexpected price drop of the underlying asset. For the long term, passive investors whose investment horizon is long enough (i.e., 5 to 10 years), buying the composite indices can be a good option. An active, long-term investor can also look for large-capitalization stocks as the large-capitalization stock has lower negative skewness and positive kurtosis than mid and small-capitalization stocks.

# AUTHOR CONTRIBUTIONS

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