COVID-19 and Market Volatility: An Empirical Study of Bombay Stock Exchange Indices

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Abstract

This study investigates the impact of the COVID-19 pandemic on sectoral indices of the Bombay Stock Exchange (BSE) in India. Analyzing daily closing prices from January 14 to August 9, 2020 (207 trading days), the research examines seven indices: Energy, Finance, Healthcare, Infrastructure, Manufacturing, Information Technology, and Oil & Gas. The period is segmented into three distinct 69-day phases: pre-lockdown (Phase I), during lockdown (Phase II), and post-lockdown (Phase III). Employing the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model, the analysis reveals a significant pandemic impact on the Manufacturing and Information Technology sectors in Phase I. In Phase II, all sectors except Healthcare and Information Technology were significantly affected. During Phase III, significant effects persisted in the Finance, Infrastructure, and Information Technology sectors. The study concludes with a discussion of both theoretical and practical implications.

Keywords: lockdown, stock indices; COVID-19, EGARCH (1,1)

1. Introduction

The COVID-19 pandemic, emerging in late 2019, represents a defining 'black swan' event of the century. It brought global socio-economic activity to a near standstill. Governments worldwide imposed lockdowns, making social distancing and virtual communication the new norm. This crisis forced a paradigmatic shift across all sectors, from retail and finance to education and healthcare. Periodic lockdowns and distancing requirements fundamentally altered how economic and business transactions are conducted, reshaping daily life and institutional operations globally as nations mobilized resources to counter the threat.

The global pandemic has resulted in a significant decrease in economic activities worldwide and has adversely affected income generation and consumption. The COVID-19 has resulted in colossal losses to almost all the countries, where some countries suffered the most while some were affected mildly (Tobias et al., 2020). The global pandemic has harmed people's physical and financial health in various countries. In addition, the pandemic has adversely affected the financial markets (Goodell, 2020). The researchers began analyzing the impact of COVID-19 on stock markets, identifying the reasons for setbacks, and finding out the ways of the reconstruction as a way to recover (Zhang, and Hamori,2021). The global financial market has suffered a prolonged period of stagnation because of the worldwide pandemic, and this stigma has significantly slowed down many countries in the world (Garg, 2021; Yoo, 2020). While some countries-imposed lockdowns for more extended periods (examples: China, Italy, Spain, and the UK); whereas, in some countries, the governments-imposed lockdowns only for a short period (Camera and Gioffre,2021; Pachetti.2020).

In India, the government announced a mandatory lockdown on March 25, 2020, until May 2020. This lockdown adversely impacted the Indian (Singh, 2020). Because of lockdown, the manufacturing sector of non-essential items in India is shut, resulting in the downsizing of the workforce, thus drastically reducing the gross domestic product and personal disposable income of many individuals and families. All these signaled a deflationary gap as there is a vast gulf between aggregate demand and output, and the chances that the economy may be under the grip

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of the recession were high (Joshi, 2020). Against this backdrop, the present study explores the impact of COVID on the Bombay Stock exchange to assess the extent of the damage created by the pandemic.

2. Literature review

Since the pandemic was hit roughly two and half years back, the literature was not rich in content. However, many researchers worldwide examined the impact of COVID-19 in different countries. For example, Baker et al. (2020) investigated the effects of COVID-19 on the US stock market. These results were confirmed by some other researchers who studied the US stock market using the Russell 3000 index (Ramelli and Wagner, 2020).

On the other hand, investors perceived US companies favorably compared to China, probably because the pandemic was born in China sometime at the end of 2019. Similar studies conducted in the US context produced almost identical results. For example, in their research on the Chinese stock market (Hang Seng index and Shanghai Stock Exchange), between 10th January 2020 and 16th March 2020, Al-Awadhi et al. (2020) found that a total number of deaths during the period had a significant negative impact on stock market returns of all the companies. On the parallel side, the reported deaths in the US did not have a substantial effect on the Dow Jones and Standard and Poor (S&P) indices of the US stock market, as reported by were Onali (2020), who applied a GARCH (1,1) model to calculate the volatility. However, it was reported that the number of deaths in Italy and France hurt US stock market returns but positively affected the VIX returns.

In a recent study conducted on three global markets (US, Japan, and Germany), it was found that the impact of the global pandemic has superseded the global financial crisis that occurred during 2008 (Zhang and Hamori, 2021). However, these researches reported that oil and stock markets are gradually returning to normal, and the oil prices and stock prices remained unstable as the pandemic continues. A similar pattern was observed by Yousaf et al. (2020), who examined the market's return to normality among Bitcoin, Ethereum, and Litecoin.

Some of the other notable studies included examining the impact of the global pandemic on the portfolio of investments, i.e., transfer of risk between the stock market and bond market (Chen et al., 2020). It was found that the pandemic had a significant negative impact on the stock market, whereas it had a positive effect on the bond market. In a recent study conducted in the context of the Indian stock market, it was documented that firms were employing resilience strategies to revert to normalcy (Chakraborty, 2021). The main argument is that stock markets do not reflect the actual position because most of the companies that were not publicly traded were excluded from stock market analysis. In India, several tiny firms play a significant role in influencing the investors' behavior that the study of financial markets cannot capture.

Against the backdrop of existing studies on the impact of the global pandemic, the present study explores the effect, particularly concerning the Bombay Stock Exchange (BSE).

The rest of the paper is organized as follows. In the next section, outline the objectives of the study. Then, formulate hypotheses in the following section. Section 3 deals with methodology, and section 4 provides results. Finally, section 5 discusses the effects, contributions of the present study, limitations, and suggestions for future research.

2. Objectives of the study and statement of Hypotheses

2.1 Objectives

The study's primary objective is to examine the impact of covid-19 on stock Bombay Stock Exchange (BSE) indices in India. The sub-objectives are:

1. To empirically examine the impact of the global pandemic from 14th January 2020 to 9th August 2020 in India, divided into three phases: pre, during, and post-COVID-19.

2. To explore the reasons for the impact of the pandemic on indices and offer suggestions.
3. To provide directions for future research concerning the month-of-the-year effect

To achieve the above objectives, first need to examine whether the stock market indices are stationary during the lockdown period. Second, need to explore the descriptive statistics for BSE indicators during these three phases. Third, need to perform a statistical check to see whether the BSE sectoral devices follow a normal distribution.

2.2. Hypotheses

H_0 : BSE stock market indices are not impacted by pre, during, and post-COVID-19 period (Null Hypothesis)

H_1: BSE stock market indices are impacted by pre, during, and post-COVID-19 period. (Alternative Hypothesis)

3. Methodology

In this research, started with identifying the problem, followed by outlining the study's objectives and hypotheses. Then, selection of sample and collection of data followed by the explaining appropriate econometric tools to test the hypotheses are provided.

3.1 Sample

The researchers in the stock market analysis consider BSE as the most important in the Indian context because the entire country echoes the reverberations from BSE. The stock exchange indices consist of information from various sectors: energy, finance, healthcare, infrastructure, manufacturing, information technology, and oil and gas. The study sample includes 987 observations from January 14, 2020, to August 9, 2020, with daily closing prices of seven sectoral indices data BSE. As mentioned before, subdivided the period into three phases: (i) Phase I, pre-COVID-19 phase [Pre-lockdown period from January 14, 2020, to March 23, 2020, 69 days (43 working days)], (ii) Phase II, lockdown period [from March 24, 2020, to May 31, 2020, 69 days (42 working days)] and (iii) Phase III, post-COVID-19 period (69 days from June 1, 2020, to August 9, 2020, with 50 trading days). All phases equally divided 69 days include the lockdown period. Data collected for 207 days.

3.2 Data Collection

The data collected from the official websites of BSE (i.e., www.bseindia.com). The data collected for this study included daily closing prices of sectoral indices of the BSE. Formally, an EGARCH (p,q):

$$Ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha(\lfloor u_{t-1} \rfloor)$$

This model differs from the GARCH variance structure because of the log of the variance. The following specification also has been used in the financial literature (Dhamija and Bhalla, 2010).

There are two steps of the parameter estimation of EGARCH model: first, estimate the exponential GARCH model for each sectoral index to obtain the standardized residuals; and then the coefficients of the model are estimated with the standard residuals.

4. Results

The descriptive statistics: means, standard deviations, skewness, kurtosis, Jarque-Bera, ADF were presented in Table 1.

Table 1
Descriptive Statistics

Phase-I: Pre-lockdown period from January 14, 2020 to March 23. 2020 69 days (43 working days)							
	Sectoral Indices						
	Energy	Finance	Health Care	Infrastructure	Manufacturing	Information Technology	Oil and Gas
mean	4588.53	6434.81	13686.57	162.39	421.94	15324.38	13165.72
SD	607.90	788.56	858.99	22.90	43.16	1519.70	1654.18
Minimum	3030.50	3860.32	11007.36	105.80	296.09	11202.70	8944.96
Maximum	5286.34	7046.57	14535.10	185.75	459.32	16469.98	14776.05
Skewness	-1.21	-1.82	-1.76	-1.11	-1.42	-1.73	-1.18
Kurtosis	0.31	2.43	2.21	0.05	1.04	1.65	0.19
Observation	43	43	43	43	43	43	43
Jarque-Bera	10.69	34.39	30.92	8.81	16.42	26.37	9.97
p-value	0.00	0.00	0.00	0.01	0.00	0.00	0.01
ADF	2.385	2.201	1.999	1.907	1.739	1.477	1.272
observation	49	49	49	49	49	49	49
Phase-II, During lockdown period from March 24, 2020 to May 31.2020 69 days (42 working days)							
mean	4441.1	4390.55	15223.97	124.68	370.94	13470.04	11312.59
SD	380.346	204.364	1119.878	4.549	16.988	602.088	614.422
Minimum	3384.620	3956.510	11628.780	111.890	318.070	11780.880	9217.020
Maximum	4776.400	4892.570	15656.670	129.750	390.860	14235.040	12066.360
Skewness	-0.855	0.085	-1.924	-0.911	-1.365	-0.275	-1.496
Kurtosis	-0.430	0.293	2.455	0.517	1.626	-0.573	2.387
Observation	42	42	42	42	42	42	42
Jarque-Bera	5.443	0.200	36.455	6.283	17.673	1.104	25.638
p-value	0.066	0.905	0.000	0.043	0.000	0.576	0.000
ADF	0.551	0.932	0.457	1.221	0.487	-0.070	0.643
Observation	42	42	42	42	42	42	42
Phase-III, Post lockdown period from June 1, 2020 to August 9, 2020 69 days (50 working days)							
mean	5845.93	5108.868	17099.3	137.6597	432.9117	16821.35	13134.11
SD	426.696	164.416	795.599	3.015	15.713	1428.890	375.293
Minimum	5009.330	4598.530	16135.230	133.440	397.650	14346.500	12441.500
Maximum	6406.340	5320.690	18821.240	144.570	450.430	18373.810	13758.530
Skewness	0.201	-0.674	1.332	0.353	-0.109	0.127	0.437
Kurtosis	-1.220	0.719	0.702	-0.965	-1.039	-1.593	-0.634
Observation	50	50	50	50	50	50	50
Jarque-Bera	3.439	4.862	15.802	2.978	2.348	5.421	2.427
p-value	0.179	0.088	0.000	0.226	0.309	0.066	0.297
ADF	0.298	0.185	-0.418	0.011	0.021	-0.004	-0.518
Observation	50	50	50	50	50	50	50

As shown in Table 1, in Phase- I, the information technology index displayed the largest mean (15324.38) whereas infrastructure index displayed the smallest mean (162.39). During the phase-II period the health care index displayed the largest mean (15223.97), and infrastructure index displayed the smallest mean (124.68). One of the primary reasons for this drastic change is the impact of COVID-19 on healthcare sector. Further, the infrastructure sector has come too lagged among the all indices. When the country was locked down, decrease in floating population resulted in partial paralysis of industrial sector that was heavily dependent on migrating labor force. During the Phase-III, the health care index displayed the largest mean (17099.3) whereas infrastructure index displayed the smallest mean (137.65). These results signify some progress due to partial opening up of the economy after lockdown.

Across all sectors, the value of negative skewness distribution is shown in the phase-I. The descriptive statistics displayed varying levels of positive skewness during Phase-II, with the only exception of energy and information technology indices. The descriptive statistics during the

Phase-III, displayed the varying levels of positive skewness, with the only exception finance and manufacturing indices. Also, the Jarque-Bera test rejects the null hypothesis of normality at the1% level for all sector indices. Finally, the results of the ADF test show that no sectors contains a unit root, thus the following results are not distorted by the usage of non-stationary time series.

Table 2 captures the correlations, along with the significance levels of p-values for each pair of the variables, during the three phases during January 14, 2020 to August 9, 2020. The results reveal a high unconditional correlation for Phase I and low correlation for the phase-II and III.

Table 2
Correlation matrix

Phase-I							
	1	2	3	4	5	6	7
1.Energy	1						
2.Finance	.967**	1					
3.Health Care	.908**	.956**	1				
4.Infrastructure	.988**	.957**	.889**	1			
5.Manufacturing	.988**	.981**	.932**	.989**	1		
6.Information Technology	.954**	.979**	.972**	.940**	.966**	1	
7.Oil & Gas	.993**	.964**	.905**	.997**	.994**	.948**	1
Phase-II							
1.Energy	1						
2.Finance	-.078	1					
3.Health Care	.924**	-.097	1				
4.Infrastructure	.750**	.382**	.806**	1			
5.Manufacturing	.808**	.234	.910**	.910**	1		
6.Information Technology	.891**	-.007	.776**	.712**	.717**	1	
7.Oil & Gas	.910**	.159	.932**	.893**	.944**	.783**	1
Phase-III							
1.Energy	1						
2.Finance	.733**	1					
3.Health Care	.811**	.380**	1				
4.Infrastructure	-.159	.367**	-.307*	1			
5.Manufacturing	.972**	.752**	.824**	-.112	1		
6.Information Technology	.929**	.603**	.849**	-.360*	.943**	1	
7.Oil & Gas	.872**	.787**	.572**	.154	.892**	.758**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The EGARCH model is the exponential version of the GARCH model and was first suggested by Nelson (1991). There are various ways to express this exponential conditional variance; one possible way is given by Brooks (2008):

$$Ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + u_t$$

The results of EGARCH Model in impact of Covid-19 on BSE sectoral indices for effect were presented in Table-3.

Table 3 Coefficients of the EGARCH parameters

Phase-I	**Energy**	**Finance**	**Health Care**	**Infrastructure**	**Manufacturing**	**IT**	**Oil & Gas**

AR(1)	0.2726	0.1989	0.2149	1.3618***	0.5915***	0.3312	-0.0305
p	0.1283	0.8975	0.3462	0	0.0003	0.2072	0.8413
AR(2)	0.2692	0.1910	0.2631	0.1523	-0.0941	0.4443	0.9286***
p	0.1489	0.9176	0.2122	0.6124	0.5246	0.2527	0
AR(3)	0.3224	0.1901	0.4118***	-0.5345	0.1455	0.1785	0.4538***
p	0.196	0.9182	0.0466	0.2717	0.3534	0.4926	0.0011
AR(4)	0.1149	0.5686	0.1044	0.0195	0.3390***	0.0379	-0.3577***
p	0.486	0.6423	0.5828	0.936	0.0191	0.9098	0.0644
Ma(1)	0.4309***	0.5517	0.8575***	-0.2239	0.4688	0.4284	0.9767***
p	0	0.7361	0	0.2616	0	0.1175	0
Ma(2)	0.9216***	0.1989	0.8495***	-0.6718***	0.9043***	-0.3606***	0.9464***
p	0	0.8975	0	0.0039	0	0.0542	0
Variation equation parameters- EGARCH (1,1)							
ω	17.6342***	17.3753***	1.4538	0.5227	4.6196***	15.6202***	21.4622***
p	0	0	0.1926	0.2528	0.0362	0	0
α	-0.3467	-1.7525	-0.4964	-0.4866	1.0089***	-1.9091***	0.4896
p	0.2516	0.6271	0.3587	0.3971	0.0262	0.0002	0.4761
ϒ	0.05161	-0.7138	-0.4118	-0.5542	0.4232***	-1.1098***	-0.5526***
p	0.761	0.8358	0.1254	0.2165	0.0685	0.0061	0.0734
β	-0.8685***	-0.1293***	0.9044***	0.9393***	-0.2903	-0.2052	-0.9805***
p	0	0	0	0	0.5435	0.5078	0
Phase-II							
AR(1)	0.4608***	0.2455***	1.4396***	0.3182***	0.6783	-0.1760	0.2663***
p	0	0.0038	0	0	0.176	0.7882	0.0001
AR(2)	0.5269***	0.0984	-0.9010***	0.1784***	0.3706	0.4668***	0.0790***
p	0	0.2008	0.0019	0	0.2347	0.0119	0.08
AR(3)	0.1065***	0.7216***	0.6341***	0.2359***	0.099	0.5046	0.7928***
p	0	0	0	0	0.8178	0.2014	0
AR(4)	-0.0834***	-0.0737	-0.1652***	0.2612***	-0.1435	0.2134	-0.1258***
p	0	0.4387	0.0638	0	0.1362	0.6001	0.0344
Ma(1)	0.3787***	0.8476***	0.1893***	0.5458***	0.3431	0.7845	0.7491***
p	0	0	0.0366	0	0.4954	0.216	0
Ma(2)	-0.2009***	0.6011***	0.8916***	0.4469***	-0.1215	-0.0244	0.9365***
p	0	0	0	0	0.8045	0.9597	0
Variation equation parameters- EGARCH (1,1)							
ω	11.9524***	13.7374***	7.4437***	2.8006***	1.4317***	17.1621	9.8354***
p	0	0	0	0	0	0.2887	0.0001
α	-2.7729***	-1.8312***	0.2681	-2.6627***	-0.7194***	0.1693	-1.7719***
p	0	0.0284	0.6942	0	0	0.7882	0.0033
ϒ	0.3931	1.2874***	0.1048	1.5395***	0.3023	0.0912	0.7102***
p	0.1071	0.0025	0.8422	0	0.1069	0.8571	0.0713
β	-0.0628	-0.2836	0.3160***	0.1835	0.7580***	-0.5160	0.1831
p	0.811	0.2498	0.0116	0.3613	0	0.7112	0.407
Phase-III							
AR(1)	0.8670***	0.8342***	0.2288***	0.3283	0.6811	0.3178	0.3103
p	0.0003	0.0028	0.0014	0.9188	0.4513	0.7255	0.7247
AR(2)	0.2681	-0.0006	0.1408***	0.7874	-0.0717	0.6616***	0.2486
p	0.2554	0.9988	0.0413	0.5693	0.9478	0.0008	0.8053
AR(3)	-0.1992	0.1392	0.8432***	-0.1186	0.2697	0.0160	0.3853
p	0.469	0.6544	0	0.9627	0.5881	0.9817	0.4245
AR(4)	0.0700	0.0300	-0.2045***	0.0014	0.1256	0.0100	0.0559
p	0.769	0.87	0.0054	0.9984	0.4844	0.9787	0.7066
Ma(1)	0.1379	0.0641	1.1878***	1.0073	0.3559	0.5176	0.7308
p	0.4998	0.8169	0	0.7554	0.6886	0.5479	0.4008
Ma(2)	-0.7891***	0.4871	0.9645***	0.0898	0.4419	-0.3232	0.4461
p	0	0.1019	0	0.976	0.3466	0.681	0.2941
Variation equation parameters- EGARCH (1,1)							
ω	0.4884	4.5834***	1.3789	1.0399***	2.9203	5.9915	20.1906***
p	0.7311	0.0172	0.5973	0.0574	0.1844	0.1608	0
α	-0.3063	-0.9627***	0.3119	-1.0967***	0.0631	1.3984***	-0.3179
p	0.5196	0.0145	0.5459	0.0841	0.9066	0.0203	0.4533
ϒ	0.1530	-0.0721	0.5737	0.1977	0.3759	-0.2861	0.3300
	0.5343	0.7951	0.1447	0.5013	0.3228	0.4195	0.2311
β	0.9742***	0.5640***	0.8308***	0.7051***	-0.1030	0.3438	-0.9263***
	0	0.0028	0.0019	0	0.9017	0.3692	0

Note: *, **, *** Statistically significant at the 10%, 5% and 1% significant level.

To analyze the return and volatility spillovers among energy, finance, healthcare, infrastructure, manufacturing, information technology, and oil& gas sector use EGARCH model.

Regarding the mean equation, the results show that all the coefficients are significant at 1%, 5% and 10% level. We can therefore employ a multivariate EGARCH model in our analysis. As shown in Table 3, during the pre COVID-19, there are significant autocorrelation and ARCH effects for the returns of all indices except infrastructure and manufacturing sector indices. During the covid-19 period, healthcare and manufacturing sector indices are significant. In contrast, ARCH effects for the entire sector has significant except manufacturing and information technology for the post covid-19 period. During the COVID-19 period, volatility transmission is positive and significant healthcare and manufacturing sector indices. The investor disinclined to all sector apart from health care sector. The highly negatively affected sectors are energy, finance, infrastructure, information technology and oil and gas sectors indices. These sectors witnessed the highest negative impact of COVID-19 with an evident of EGARCH model.

5.3 Conclusion

This study examines the pandemic's impact on seven BSE indices, analyzing stock market volatility. Although vaccines and the pandemic's recession suggest its effects will fade, it has fundamentally divided financial market research into distinct pre- and post-COVID eras. As a defining event of the century, investigating its precise effects on markets and investor behavior remains a vital scholarly agenda in finance.

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