The Impact of COVID-19 Epidemic on Indian Economy Unleashed By Machine Learning

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Abstract. The outbreak of the Corona Virus (COVID-19) that has begun in December 2019 drastically affected the world. Endemic Coronavirus (COVID-19) is rapidly growing across the globe. SARS-CoV-2 is the virus name that causes a highly contagious and deadly disease COVID-19. It also entered India by the end of January 2020 and has significantly influenced India. More than two million people worldwide have been confirmed to have been contaminated with this virus as of the date (29 July 2020), and more than 7, 24,000 have died of this disease. The governments of most countries, including India, have already taken several measures to reduce the spread of COVID-19, such as lockdown, social distancing, closure of shopping malls, gyms, schools, universities, religious gatherings, etc. This lockdown has affected every Indian sector, such as the Economy, Retail Sector, Tourism Industry, etc. This paper aims to explore to what extent a 2020 epidemic like Covid-19 had impacted the Indian economy using a machine learning approach. The statistical data from esteemed and trustworthy information sources were gathered to realize the impact of the Corona Virus on the Indian economy. Based on this trusted data, analysis has been performed using the various regression models.

1. Introduction
The SARS-CoV-2 virus has profoundly impacted the economy, environment, health, and social structure of the globalized world[1][2]. The expenses associated with containment and treating this contagious disease are absurdly high, which is difficult to sustain even for the wealthiest and developed countries[3]. The COVID-19 pandemic has seriously affected the bitumen, share market, gold, and materials, and approximately all the sectors of the international market[4]. Top research
centres and large corporations are attempting to develop pharmaceutical drugs for the treatment and prevention of this devastating disease at significant speed. The COVID-19 has now become a global threat. The World Health Organisation declared COVID-19 a pandemic on 11 March 2020 [5]. It has been reported by this time (06-07-2020), more than 11.5 million cases and 5.4 lakhs death over the world due to COVID-19. There is no vaccination developed for the treatment of the virus, so the governments from most of the countries have already implemented several methods to prevent the disease from spreading [6]. The methods include social distancing, complete lockdown so that there is no gathering of the people. The educational institutes, gyms, shopping malls, airports, restaurants, airports, railways, bus transport, etc. were fully closed during the lockdown. The citizens are not allowed to leave their house except the police, healthcare workers, dairy worker, and other workers involved with the emergency services [7][8]. The COVID-19 had adverse effects on society like the healthcare system overburdened, economic downturn, starvation of the poor people, slow down of the stock market, losses in the retail sector, and downfall to the tourism sector [9]. Figure 1 shows the distribution of COVID-19 from China to the planet, and in India [10].

![Figure 1. The schematic of COVID-19 spreading throughout the world starting from China [10]](image)

In India, the lockdown was enforced in four phases to prevent the spread of COVID-19. Phase 1 of lockdown went from March 25, 2020, until April 14, 2020 (21 days) [11]. Phase 2 of lockdown was from April 15, 2020, until May 03, 2020 (19 days). Lockdown Phase 3 was from May 04, 2020, to May 17, 2020 (14 days). The last phase of lockdown was from May 18, 2020, to May 31, 2020 (14 days). During this lockdown, all places of worship were closed [12][13]. There was the prohibition of social, cultural, entertainment, and religious activities. The work from home is allowed for commercial and private firms. Only essential services like Bank, hospitals, pharmacies, grocery stores, and other essential services were permitted to operate [14][15]. From June 01, 2020, to June 30, 2020 (30 days), Unlock 1.0 was implemented in India. From July 01, 2020, to July 31, 2020, India has passed from the second phase of unlocking Unlock 2.0.

This COVID-19 and lockdown affect every aspect of Indian society. This research article investigates the various impacts on society due to COVID-19 pandemic. The data is taken from government documents and experts in different fields.
2. Impact of COVID-19 on Indian Economy
The countrywide shutdown has brought an immediate end to almost all economic activities. The instability of demand and supply powers is continuing even after the lifting of the lockdown. The Indian economy will need time to return to its normal state. India's growth fell to 3.1 percent in the fourth quarter of the fiscal year 2020, according to the Ministry of Statistics [16]. The unemployment rose to 26% in April, from 6.7% in March 2020. The 140 million people lost employment during this lockdown, and others got salaries cut. During the first phase of lockdown (25 March-14 April 2020), the Indian economy was expected to lose $4.5 billion every day. For the complete lockdown period, the economic loss predicted to near $2.8 trillion. It has significantly affected the small and large business in the country[17].

![Change Rate](image)

**Figure 2. Impact of COVID-19 on Export of India in April 2020[14]**

This coronavirus pandemic also impacts export and imports. The Ministry of Commerce & Industry, Government of India had released press information regarding the export and import of India in April 2020[18]. According to this document, Export and Import of India in April 2020 drop to 36.65% and 47.36% compared to the previous year. Figure 2 shows the reduction in export for the different sector in April 2020 as compared to April 2019; export of Gems &jewelry drops to 98.74% in April 2020, the export of Leather & leather product falls to 93.28%, the export of Handcraft excels, and Ceramic products drop to 91.84% and 91.67%.

3. Impact of COVID-19 on Stock Market
The International Monetary Fund (IMF) has already said the society is experiencing a terrible effect due to the pandemic of the Corona Virus and has entered a financial crisis. Not only in the global stock market but also in the Indian stock market, Covid-19 created a crisis[19]. This also causes concern about the global economic crisis and recession. Many big brands in India, such as BHEL, Tata Motors, UltraTech Cement, Grasim Industries, and L&T, etc., have shut down its operations or reduced the services significantly. The Sensex plunged a lot from Jan 2020 to March 2020 on the Bombay Stock exchange. The stock market posts the worst losses in history on March 23,2020, amid to lockdown.
Due to the fall of the funding during COVID-19, young start-ups have been impacted. The companies who supply the goods overall India has reduced its operations. In the next section, analysis of the COVID-19 on the stock market has been performed by using a machine learning approach.

4. Research Methodology and Data Analysis
The goal of this study is to determine the effect of the Covid-19 pandemic on the Indian stock market[20][21]. The proposed methodology consists of various phases: data collection, data pre-processing, feature extractions, data analysis using various regression models. The overall methodology is shown in Figure 3.

![Figure 3. Methodology for COVID-19 Data Analysis](image)

4.1. Data Collection
The Sensex rate for five months (March 01, 2020, to July 31, 2020) has been obtained from the stock exchange website. For the same period, the count of infected patients due to COVID-19 has been taken from the Ministry of Health and Family Welfare (MOHFW). The various attributes of each dataset are shown in Table 1 and Table 2.

4.2. Data Pre-processing
Pre-processing of data is an important step. The aim is to clean up the data for better analysis. Data must be pre-processed data so that quality data can be efficiently used by machine learning models. The Sensex dataset was cleaned by eliminating instances of missing values that existed because stock
market data for weekends and holidays were not available. Cleaning and noise reduction techniques have also been applied to data collection COVID-19. We converted the date attribute to a common format to both data set. After applying all pre-processing steps, our stock market dataset contains 103 observations with five attributes, and the COVID-19 dataset contains 103 observations with ten attributes.

| Attribute Name | Description |
|----------------|-------------|
| Date           | Date of the particular day |
| Open           | The opening rate of a given day for Sensex |
| High           | Sensex best price in a day |
| Low            | Sensex lowest price in one day |
| Close          | The closing rate of a given day for Sensex |

Table 1: Different Attributes of the SENSEX Data Set

4.3. Feature Extractions

From pre-processed datasets, important features were extracted. From the stock dataset, the opening price data of the Sensex for each day has been extracted. From the COVID-19 dataset, total_cases for each day have been extracted.

| Attribute Name | Description |
|----------------|-------------|
| iso_code       | Code for a particular country |
| Location       | Country name |
| Date           | Date of a particular day |
| total_cases    | Complete case count |
| total_deaths   | Total death rate |
| Population     | The population of a country as per the 2019 census |

Table 2: Different Attributes of the COVID-19 Data Set

4.4. Data Analysis

COVID-19 created a crisis for the global stock market as well as for the Indian stock market. This also causes concern about the global economic crisis and recession. Figure 4 shows the patients infected from COVID-19 from March 2020 to July 2020 in India. From Error! Reference source not found., it is clear that by the time the cases of COVID-19 are increasing exponentially. Figure 5 shows the opening rate of Sensex from March 2020 to July 2020 in India. It is clear from Figure 5 that Sensex falls sharply in March 2020.
4.5. Regression

Regression is one of the most commonly used methods for predictive modeling in machine learning[22]. Four methods have been used for prediction analysis: quadratic regression, cubic regression, decision tree regression, and random forest regression. Linear regression is used to find the relationship between one or more variables, and it is based on a supervised machine learning technique. The generalized equation for linear regression is shown in eq 1.

$$Y = a + b_1x + b_2x^2 + b_3x^3 + \cdots + b_nx^n$$  \hspace{1cm} (1)
In this equation, the Y is the dependent variable to be predicted, and x is the explanatory variable. Here, a is intercept and $b_1, \ldots, b_k$ are set of coefficients. This generalized equation for linear regression is converted into the quadratic and cubic regression, as shown in equation 2 and equation 3 by using the scikit-learn.

$$Y = a + b_1x + b_2x^2$$

(2)

$$Y = a + b_1x + b_2x^2 + b_3x^3$$

(3)

4.6. Decision Tree and Random Forest Regression

The decision tree uses the tree structure to build predictive models[23]. It is also a supervised machine learning algorithm and split the complex decision. Random forest combines the predictions from multiple machine learning algorithms to make more accurate predictions than any individual model.

5. Results

To perform analysis and predictions, Python 3 with various libraries such as numpy, pandas, sklearn, matplotlib are used. The dataset is divided into two sets, 75% data is used for the train set, and 25% data is used for the test set. All proposed models are evaluated by using the various parameters like MSE (Mean Square Error), RMSE (Root Mean Square Error), and $R^2$(R Square).

| Parameters for Evaluation | Quadratic Regression | Cubic Regression | Decision Tree Regression | Random Forest Regression |
|---------------------------|----------------------|------------------|--------------------------|-------------------------|
| MSE                       | 1356370.30           | 994719.83        | 588591.24                | 405587.55               |
| RMSE                      | 1164.63              | 997.35           | 767.19                   | 636.85                  |
| $R^2$                     | 0.801                | 0.854            | 0.913                    | 0.940                   |

Figure 6. Quadratic Regression for actual v/s predicted values
From Table 1, it is clear that from all four regression models, random forest regression performs better as it has lower MSE, RMSE, and higher $R^2$. Figure 6 and Figure 7 show the quadratic regression and cubic regression for actual and predicted values of the dataset. It is clear from Figure 6 and Figure 7 that both these regression techniques do not properly fit the model. Figure 8 and Figure 9 show the decision tree and random forest regression for actual and predicted values of the dataset. Both of these techniques fit the model better than the previous two techniques. The random forest regression better fitted the curve from all four models. Table 4 summarizes the economic impact of Covid-19.

Figure 7. Cubic Regression for actual v/s predicted values

Figure 8. Decision Tree Regression for actual v/s predicted values
Figure 9. Random Forest Regression for actual v/s predicted values

Table 4. Economic Impact of Covid-19

| Area       | Impact of COVID-19                                                                 |
|------------|----------------------------------------------------------------------------------|
| Economic   | • All production industries are impacted.                                        |
|            | • The entire supply chain is interrupted.                                        |
|            | • The export and import of India go to the downfall side.                        |
|            | • Oil prices dropped sharply due to COVID-19 in 2020.                             |
|            | • The entire tea industry will see a substantial decline in revenue.              |
|            | • Crash of the Stock Market in March 2020.                                       |
|            | • The tourism sector is on the downside in the entire world.                     |
|            | • The people most affected are those who can make their living at daily wages    |
|            | and lower-middle-income people.                                                  |
|            | • Starvation and depression.                                                     |

6. Conclusion

COVID-19 disease started from Wuhan, China, in December 2019 and has become a pandemic according to WHO. The disease has spread across the globe and emerged as a deadly risk to human health. The disease is spreading very quickly, and the number of people locked up is rising day by day. COVID-19 has badly impacted every aspect of life. This research concludes the economic impact of COVID-19 in India. We have performed data analysis on the Stock Market vs. COVID-19 patients in India from March 2020 to July 2020. We used machine learning to predict the opening SENSEX rate by using different regression models. The increasing number of COVID-19 cases directly impacted the stock market. From all four regression models, the random forest technique better fitted the curve of
the model. In the future, this work can be extended by including other features like the number of deaths, the number of recovered cases, etc. to analyze the impact on the stock market in India.

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