

# A COMPARATIVE STUDY OF MACHINE LEARNING TECHNIQUES TO EVALUATE THE IMPACT OF COVID-19 ON THE MSME SECTOR

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## **ABSTRACT**

The coronavirus, also known as Covid-19, severely affected the world economy. This research aims to compare the expected and real stock prices of BSE SMEs before and after the covid using 2 machine learning techniques. To utilize a methodical estimation of the data manipulation and model assessment, this research evaluates and investigates the literature on the implementation of machine learning models in the major financial domains. The most efficient deep learning model, the LSTM network of RNN is compared with the oldest and most used technique; linear regression to predict the stock prices in this paper. It shows the loss in the MSME sector by conducting a comparative study using secondary data collection between the predicted closed stock prices and actual stock prices of the BSE SME IPO index for the period of 1st January 2018 to 30 April 2021. The study offers insight and guidance, showing that COVID-19 significantly impacts the stock prices of BSE SME IPOs as differences in the prediction accuracy can be seen in both techniques. The LSTM model outperformed the linear regression model in the comparative analysis as the LSTM model predicted better in both scenarios, whether before COVID or after COVID-19. Little research is being done, especially in India, despite the LSTM model being the most recent model utilized for prediction. Compared to other countries, India uses machine learning and deep learning in the finance sector much less frequently.

**Keywords** *Machine learning, MSME sector, Linear Regression, LSTM, BSE SME IPO, RNN*

## **1. INTRODUCTION**

Since the last few decades, the world economy has changed dramatically. However, as was already stated, various breakouts are seen when the economy is doing well. The world economy was seriously harmed initially by the great depression in the early 1930s. In 1929, it began in the US and quickly expanded around the globe. There were company losses, rising levels of poverty and unemployment, global trade, etc. The stock market suffered the most because it collapsed severely during the Great Depression.

It was said that if the situation had not normalized and the appropriate steps had not been taken at that time, it was anticipated that there would be another financial crisis in 2020 due to COVID-19 after 11 years, The last happened in 2008 as the worst financial crisis. A contagious illness known as COVID-19, or coronavirus, originated in Wuhan, China, beginning in December 2019, it quickly spread over the world by March 2020.

216 countries were affected. Big countries include the US, Chile, India, Mexico, the UK, Brazil, the Russian Federation, and others. By April 2021, COVID-19 was estimated to have caused more than 31,00,000 deaths and 15 crore confirmed cases (WHO, 2022).

To control the increase in several cases and deaths, a lockdown of the countries was adopted at the time. Because of the lockdown, there was a decline in the labour force and productivity, which affected the business's profits. A worrying situation was evident in the financial market around the world because if more action were not taken, corporations could experience insufficient liquidity, which could result in bankruptcy (Liu et al., 2020).

The stock market has experienced a significant fall. Customers' inability to purchase shares owing to a lack of funds results in losses for many enterprises, particularly for those who own small businesses and make a living daily. If business losses persist, various bankruptcies will be seen in the future. India's growth projection by Moody's Investor Service was revised downward from 0.2% in April to -3.1% for 2020 (Economic Times, 2020).

At the time of the global financial crisis, both advanced economies and emerging nations that had not yet suffered a crisis showed significant changes in SMEs due to a fall in debt maturity and company leverage (Demirgüç-Kunt et al., 2020).

Micro, small, and medium-sized firms are referred to as MSMEs. The MSME sector supports 11 crore jobs nationwide, contributes 48% of India's exports, and accounts for 29% of its GDP (Wire, 2020). According to SEBI standards, BSE Ltd. established

the BSE SME Platform in 2012 for the SME sector that preferred listing on BSE to support the MSME sector in India (BSE, 2022).

For investors, businesses, and the government, predictions of the impact of the coronavirus on different sectors are crucial because they allow for the development of future policies and measures. In the realm of finance, machine learning is regarded as the most applicable AI technique. It is used to make statistical learning data predictions (Aziz et al., 2022). ANN is a branch of machine learning in which neural networks acquire knowledge through experience. It draws inspiration from the human body's nervous system's neurons.

Deep learning is the most recent method developed from earlier ANNs (Aziz et al., 2022). Deep learning is helpful when data is extremely complex—whether varied, interconnected, or unstructured. Deep learning's efficiency increases as it acquires more knowledge (Bernard, 2018).

Since it is difficult to train an RNN model, LSTM (Long Short-Term Memory) is utilized as an improved form of RNN. Back-propagation is used to train the model, and it ensures that past data is easily remembered in memory (Mittal, 2019). Due to RNN's inability to hold long-time memory, Long Short-Term Memory (LSTM), which is based on "memory line," has been proven to be extremely helpful in forecasting scenarios with long-time data. A group of cells associated with storing passed data streams must constitute every LSTM node (Moghar & Hamiche, 2020).

## **2. LITERATURE REVIEW**

The COVID-19 outbreak caused a sharp decline in the stock market in the impacted regions and nations (Liu et al., 2020). Due to COVID-19, the emerging stock market began to have negative effects in March 2020 (Topcu & Gulal, 2020). Due to COVID-19, there was a short-term impact on stock market volatility and returns in the top 32 affected countries' stock markets (Okorie & Lin, 2021).

The stock markets of 64 countries experienced a drop as the number of Covid-19 cases increased. The impact of the number of cases was greater than the deaths caused by COVID-19. The outcome varies periodically depending on the Covid-19 stage (Ashraf, 2020).

Midway through February 2020, NIFTY and SENSEX both had significant declines; following March 3, 2020, those declines escalated (Singh & Neog, 2020).

The non-linear stock market performance in Japan, the US, China, Germany, and Italy during the GFC and Covid-19 periods were compared using the APGARCh model, which revealed that Covid-19 had a greater impact than the GFC (Global Financial Crises) period. Market returns in the US and Japan were more adversely affected by COVID-19 (Shehzad et al., 2020).

A sensitivity analysis of Covid-19 data was done in India (Sarkar et al., 2020).

For the death cases and the confirmed cases, genetic programming (GP) based prediction models were used for the data of the three most impacted Indian states, Maharashtra, Delhi, and Gujarat (Salgotra et al., 2020). Since SMEs are directly impacted by financial crises, a crisis management model was created for them to deal with the effects (Hong et al., 2012).

Before the introduction and implication of advanced neural networks, linear regression was a popular technique to predict time series data. Various papers have currently compared Linear regression with advanced neural networks whether it is ANN, CNN, or RNN. In the paper by (R. Shah et al., 2022), predictions were made using both linear regression and LSTM on times series data of the Indian stock market Index Nifty 50. The comparative analysis was done based on RMSE in this paper. In another paper, two techniques were used: Regression and LSTM. Improvement in the prediction accuracy was seen in both techniques with positive results. It was concluded that stock market predictions are possible with high accuracy with the implementation of machine learning techniques (Parmar et al., 2018). The study examines machine learning algorithms and determines the top algorithms for predicting stock prices. Additionally, the outputs of the four methods of linear regression, LSTM, k-nearest neighbours, and fb-prophet were compared. It was found that the LSTM algorithm is one of the best algorithms for forecasting the market cost of a supply by comparing the RMSE of the various algorithms (Sravani et al., 2021).

Due to its capacity for pattern discovery in chaotic and non-linear circumstances, ANN was employed for a variety of complex issues (Lawrence, 1997). Supervised learning is the most used machine learning model for stock market forecasting (Kumbure et al., 2022).

Hawley claims that expert systems rely on a preprogrammed knowledge foundation while artificial neural systems (ANS) rely on experience gained. The usage of ANS in the financial sector will be beneficial for valuing bankruptcy risk, fundamental research, technical analysis, and spotting arbitrage opportunities (Hawley et al., 1990).

LSTM is the best forecasting algorithm for the data set's structure in terms of worldwide and adaptive technology, yet both ANN and LSTM will reach better accuracy. It produced the outcome based on the trained values and predicted values that were input (Sai Sravani & Raja Rajeswari, 2020). Both the logit model and MLP neural networks are defeated by RNN-LSTM. These days, there is a growing amount of research on using machine learning to predict financial crises. RNN-LSTM is a novel idea in crisis prediction (Tölö, 2020).

A recurrent neural network (RNN) was used in a study to forecast the prices of the three stocks. It was found that when historical data and economic indicators were input, the anticipated price fit the actual price more closely (da Silva et al., 2016).

The LSTM is used in deep learning for natural language processing and other serial data because of its unique memory function, however, there aren't many predictions for stock time-series data (Pang et al., 2020).

- To compare the predicted and actual stock prices of BSE SME IPO pre Covid-19 using linear regression and LSTM model.
- To compare the predicted and actual stock prices of BSE SME IPO post Covid-19 using linear regression and LSTM model.
- To do a comparative analysis of linear regression and LSTM model for the prediction of stock prices of BSE SME IPO.

### 3. RESEARCH METHODOLOGY

#### 3.1 DATA COLLECTION

Secondary data collection is done. From 1 January 2018 to 30 April 2021, closing stock prices for the BSE SME IPO Index were extracted from the BSE dataset. (BSE, 2022a).



*Source: BSE SME IPO index*

Figure 1 shows the closing stock prices for BSE SMEs from January 1, 2018, to April 30, 2021, as collected from the BSE SME IPO Index.

#### 3.2 METHODOLOGY

Stock prediction is done using the LSTM model and linear regression using supervised learning in Python. Data is divided into training and testing periods for both the models and then preprocessing is done using MinMaxScaler. 70% data is training set and 30% data is tested for prediction.

#### 4. DATA ANALYSIS

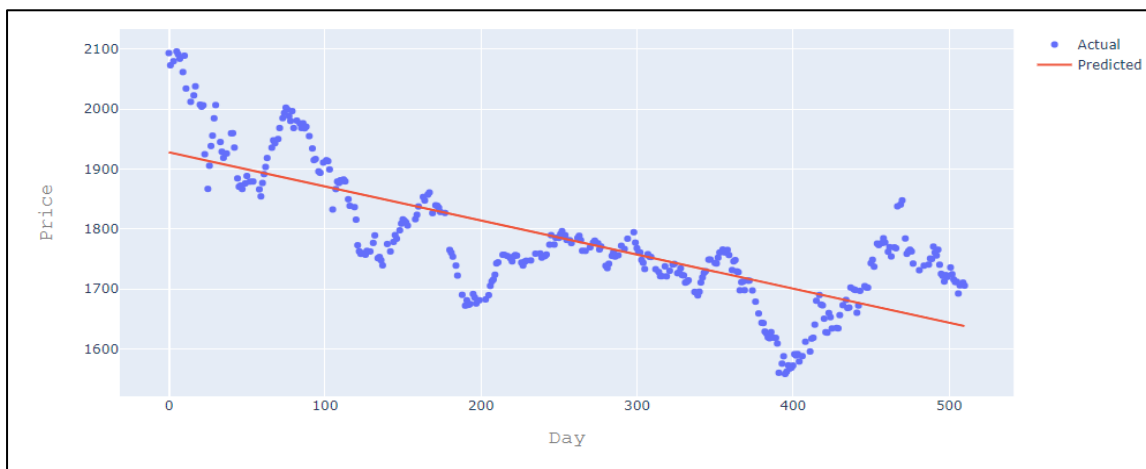
Predictions were done as mentioned below:

- Prediction of stock prices using linear regression before Covid-19.
- Prediction of stock prices using LSTM before Covid-19.
- Prediction of stock prices using linear regression after Covid-19.
- Prediction of stock prices using LSTM after Covid-19.

#### Prediction of stock prices using linear regression before Covid-19

The data selected is from the period 1<sup>st</sup> January 2018 to 29<sup>th</sup> January 2020. Data was divided into training and testing period.

Figure II: Prediction of stock prices before COVID-19 using Linear Regression



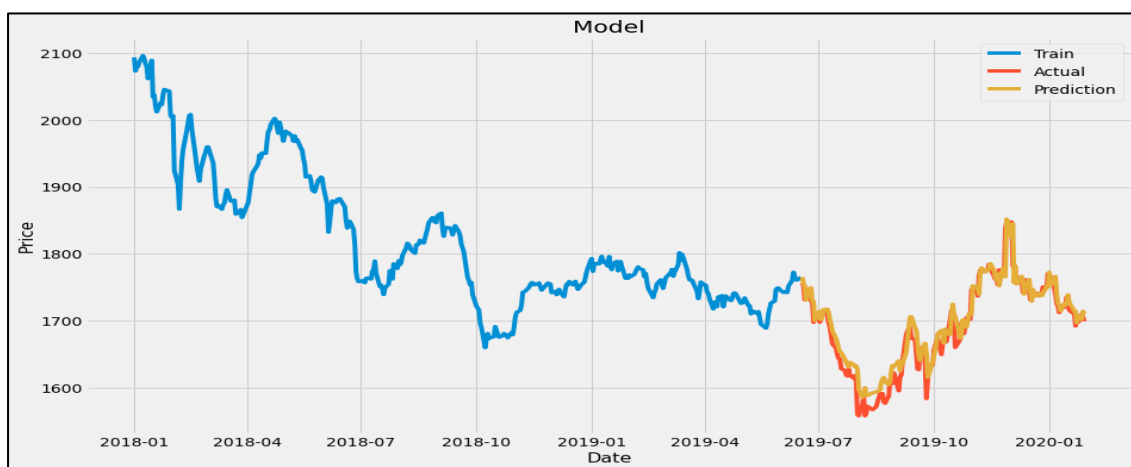
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**In Error! Reference source not found.** training time period is from 1<sup>st</sup> January 2018 to 17<sup>th</sup> June 2019 whereas the testing time period is from 18<sup>th</sup> June 2019 to 29<sup>th</sup> January 2020. The RMSE of linear regression is 67.30. The average value of BSE SME IPO over the testing data interval of 153 was 0.4 which is hardly between the 0.1 and 0.5 threshold (D. Shah et al., 2018) and this model can be used to further predict stock prices after Covid-19. [Root mean square error is the difference between predicted values by model and observed values. It shows how closely the values of the observed data variables fit those predicted by the model.]

### Prediction of stock prices using LSTM before Covid-19

The data selected is from the period 1<sup>st</sup> January 2018 to 29<sup>th</sup> January 2020. Data was divided into training and testing period.

Figure III: Prediction of stock prices before Covid-19 using LSTM



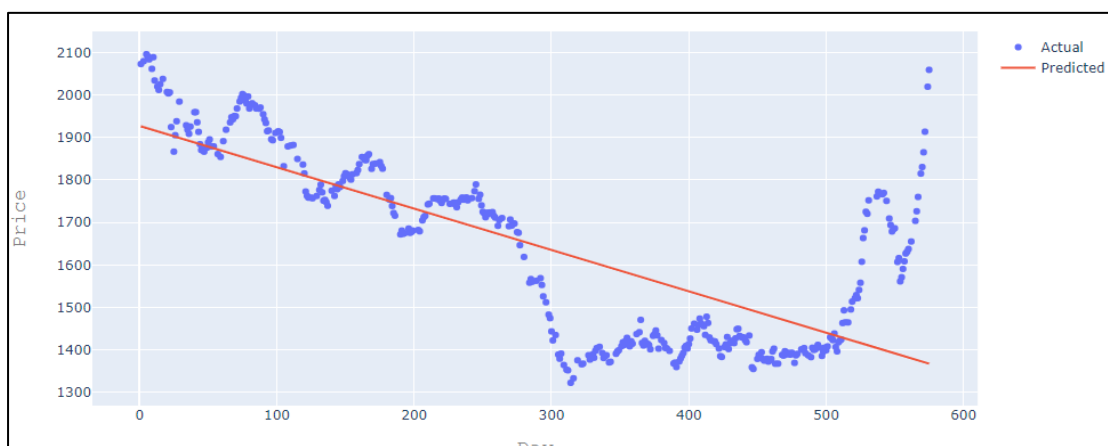
Source: Compiled by the author

In Figure, the training time period is from 1<sup>st</sup> January 2018 to 17<sup>th</sup> June 2019 whereas the testing time period is from 18<sup>th</sup> June 2019 to 29<sup>th</sup> January 2020. RMSE of LSTM is 20.37. The average value of BSE SME IPO over the testing data interval of 153 was 0.13 which is between the 0.1 and 0.5 threshold and this model can be used to further predict stock prices after Covid-19.

### Prediction of stock prices using linear regression after Covid-19

The data selected is from the period 1<sup>st</sup> January 2019 to 30<sup>th</sup> April 2021. Data was divided into training and testing period.

Figure IV: Prediction of stock prices after Covid-19 using Linear Regression



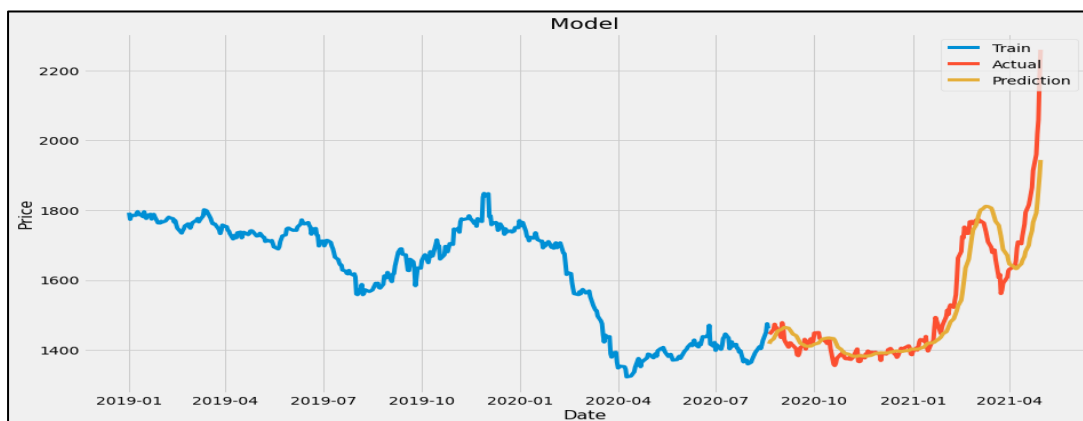
Source: Compiled by the author

In Figure, the training time period is from 1<sup>st</sup> January 2019 to 19<sup>th</sup> August 2020 whereas the testing time period is from 20<sup>th</sup> August 2020 to 30<sup>th</sup> April 2021. The RMSE of linear regression is 120.59. The average value of BSE SME IPO over the testing data interval of 173 was 0.69 which is not between the 0.1 and 0.5 threshold and there is a high difference in the predicted and actual stock values after Covid-19.

### Prediction of stock prices using LSTM after Covid-19

The data selected is from the period 1<sup>st</sup> January 2019 to 30<sup>th</sup> April 2021. Data was divided into training and testing period.

Figure V: Prediction of stock prices after Covid-19 using LSTM



Source: Compiled by the author

In Figure, the training time period is from 1<sup>st</sup> January 2019 to 19<sup>th</sup> August 2020 whereas the testing time period is from 20<sup>th</sup> August 2020 to 30<sup>th</sup> April 2021. In this prediction, data is taken from 1<sup>st</sup> Jan 2019 and not from 2018 because the COVID-19 period was needed in the training period. RMSE of LSTM is 67.41. The average value of BSE SME IPO over the testing data interval of 173 was 0.39 which is still between the 0.1 and 0.5 threshold It shows that the prediction model values and actual values still have a huge difference but are better than the linear regression model in which Covid-19 showed huge impact on stock prices of BSE SME IPO.

## 5. RESULTS



A comparative analysis is done based on RMSE value. It is seen in **Error! Reference source not found.** and Figur that both the models were able to accurately predict the stock prices, it showed the accuracy of the LSTM model in predicting stock prices before covid is better than linear regression. When COVID-19 happened in India, stock prices showed the impact of COVID-19 in Figure and Figure and there was a huge difference in the actual and predicted prices but still LSTM was able to predict better than linear regression. The average value of BSE SME IPO over the testing data interval in the case of predictions done after covid of LSTM was in the threshold average value of 0.1 to 0.5 whereas, in the case of linear regression, the value was not in the threshold average value of 0.1 to 0.5.

## 6. CONCLUSION

In this paper, it is concluded that the LSTM model is a better predictive model than linear regression in terms of time series data as it showed high accuracy levels as compared to linear regression. The impact of covid 19 was visible in both models but still, LSTM was able to predict better than linear regression.

One of the largest contributors to India's GDP is the MSME sector. MSME sector losses have a severe negative impact on the Indian economy. The government has taken several initiatives, particularly during the COVID-19 period, to support the MSME sector, demonstrating a genuine interest in this direction. Several programs are also launched by BSE and NSE to support the MSME sector.

To save the MSME sector, BSE and NSE offered a 25% listing fee rebate to SME companies who list on both NSE's EMERGE platform and BSE's SME platform each year (Times, 2020).

In April, the RBI published a second set of measures that included TLTRO 2.0 and AIFIs refinancing facilities for the MSME sector at the time of COVID-19. The RBI also released instructions for a reduction in CRR, payment rescheduling, and an extension of the period for realizing export proceeds (Ministry of Micro, 2020).

## 7. DISCUSSION

Despite the LSTM model being the most recent model used for prediction, relatively little research is being done, particularly in India. Implementation of deep learning and machine learning techniques in the financial sector in India is significantly less frequent than in other countries.

One of the main limitations of the paper is that in this study, the MSME sector is the only one that is considered. Stock market predictions can also be done in other sectors by researchers.

Another limitation is that only BSE SME stock prices are considered, although Covid-19 may also have an impact on unlisted MSME enterprises.

Finally, in future studies, the researcher can compare other predictive models for stock market predictions for the highest accuracy.

## **LIST OF ABBREVIATIONS**

**AI** - Artificial Intelligence

**AIFI** - All India Financial Institutions

**APGARCH** - Asymmetric Power Generalized Auto-Regressive Conditional Heteroskedasticity

**ANN** - Artificial Neural Network

**ANS** - Artificial Neural Systems

**BSE** - Bombay Stock Exchange of India

**CNN** - Convolutional Neural Network

**CRR** - Cash Reserve Ratio

**GDP** - Gross Domestic Product

**GFC** - Global Financial Crisis

**GP** - Genetic Programming

**IPO** - Initial Public Offering

**LSTM** - Long Short-Term Memory

**MLP** - Multi-Layer Perceptron

**MSME** - Micro, Small and Medium Enterprises

**NIFTY** - National Stock Exchange FIFTY

**NSE** - National Stock Exchange of India

**RBI** - Reserve Bank of India

**RMSE** - Root Mean Square Error

**RNN** - Recurrent Neural Network

**SEBI** - Securities and Exchange Board of India

**SENSEX** - Stock Exchange Sensitive Index

**SME** - Small and Medium-sized Enterprises

**TLTRO** - Targeted Longer-Term Refinancing Operations

**US** - United States

**UK** - United Kingdom

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