

Predicting Blue-Chip Stock Returns Using Machine Learning Algorithms

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Abstract. The aim of the paper is to identify the relationship between blue chip stock returns and market indices using advanced machine learning models. The key objective of the study is to determine an efficient machine learning (ML) model that produces minimum error which gauging the relationship between market volatility indices, i.e., VIX, ISEE, and NASDAQ-100 and stock returns of blue-chip companies like Apple, Amazon, and IBM. In recent studies, machine learning models are generally used for the prediction of stock price movements of the company's stocks. However, very few studies attempt to explore the relationship between market volatility indices and stock returns of blue chip or large capitalization companies using ML models. Therefore, the current research fills this research gap by analyzing the relationship between market volatility indices and the returns of blue-chip stocks like Amazon, Apple, and IBM. The study employs support vector machine (SVR), regression tree, and random forest model to assess the desired relationships. The findings suggest that the regression tree model predicts the stock returns of Amazon better, while SVR model is comparatively better in predicting the stock returns of Apple and IBM. However, the main limitation of the research is lack of consideration for additional stocks and machine learning which could have improved the generalizability of the research findings. Thus, future research studies should consider different types of stocks from different sectors and estimate the predictive capacity of various machine learning models.

Keywords: Amazon, Apple, IBM, VIX, NASDAQ-100, ISEE index.

1. Introduction

The accurate prediction of stock price returns is a challenging task, requiring consistent use of advanced analytical approaches to trace non-linear relationships and volatility in the stock price movements [1,2]. Conventional statistical and forecasting models like Autoregressive Integrated Moving Average (ARIMA) and Moving Averages (MA) are used to predict stock prices. However, the predictive capacity of these models tends to underperform when the market volatility increases. Due to the limited applicability of conventional models, researchers explored various machine learning (ML) algorithms to map stock price movements effectively. A wide range of literature in this domain [3-5] claims that machine learning algorithms like Linear regression, Support Vector Machine (SVM), Random Forest model and Long Short-Term Memory (LSTM) models perform relatively better.

Besides extensive research on the relevance of ML models in predicting stock prices, a significant gap is observed in similar analyses using blue chip stocks. By definition, blue-chip stocks are less volatile, stable, highly valued, and a superior form of investment that ensures long-term profit for investors [6]. Due to the possibility of low volatility, many investors prefer blue chip stocks in their portfolio to hedge against the risk of market uncertainty. Some of the common blue-chip stocks are Amazon, IBM, and Apple. Although blue chip stocks are valuable assets, it is critical to understand the factors influencing returns on these stocks and machine learning algorithms that can effectively capture the underlying volatility to effectively predict the stock returns [6].

In the Covid-19 pandemic, the stock market stumbled following a sharp decline in the overall valuation of the companies. Although blue chip companies like Apple, Amazon and IBM are known for their financial stability, the valuation of these companies also declined following the closure of many unsupervised and non-profitable production plants. Besides these internal factors, it is also critical to understand and reflect upon the external and market factors which led to the same [7, 8].

For instance, Volatility Index (VIX) indicator measures the level of fear in the stock market or declining consumer and business confidence in the market which is suggested by their reluctance to invest [9]. Another factor is the ISE sentiment index (ISEEE) which helps measure the level of bearish sentiments or negative sentiments in the market, reflecting the low level of prosperous future expectations of investors [9]. Finally, the technology index or National Association of Securities Dealers Automated Quotations Index (NASDAQ-100) is crucial in understanding the level of technology diffusion in the market and its impact on the level of investments [9].

By using these three quantitative variables, this study aims to understand the impact of market volatility indices on the stock returns of blue-chip companies. The findings of the study will contribute to the existing pool of literature concerning the stock return predictions of blue-chip companies.

In contemporary literature, many studies conduct fundamental analysis of blue-chip stock returns using price to book ratio, organizational values, structure, stakeholder values, equity ratio, and dividend pay-outs to evaluate their performance. Although, convincing and statistically significant results are not observed in these studies [2, 10, 11]. However, this implies that there is a need to include other factors that could explain the movement in blue-chip stock returns. Additionally, many studies consider time series modelling approaches and advance statistical models like Autoregressive distributed lag model (ARDL), Vector Autoregressive models/Vector Error correction model (VAR/VECM), and Logit models to understand the interplay of these factors [2].

Celina and Kavitha analyzed the movement of blue-chip stock returns in the context of Indian markets [12]. The rationale of the paper was to conduct technical and fundamental analysis and estimate general time series models for the prediction of stock prices during the period of turmoil in the market. The study considered the Support vector machine (SVM) models, random forest model, and moving averages to linearly predict the stock prices in order to estimate the best model with high prediction accuracy. However, the study lacks discussion of the external market factors like the presence of sentiments, technology, and fear in the market which undermined the relevance of the literature. The inclusion or the discussion of technology is relevant in this context because of continuous development of Covid-19 vaccine during the time of health crisis. Thus, many pharmaceutical companies experienced a growth in their valuation following a sudden increase in investment levels.

Another study by Widiyarti et al. assessed the stability of blue-chip stocks by claiming that random walk nature of stock prices increases the risk of investments even if the companies are financially sound [13]. Indonesian investors are increasingly becoming more and more interested in investing stocks of small and large capitalization firm. The Indonesia Stock Exchange (IDX) is the focal point of stock trading in Indonesia. The Value at danger and Geometric Brownian Motion (GBM) methodologies were used to determine price changes and anticipate the danger of potential losses. The study forecasted the price of blue-chip stocks listed on IDX or Indonesian Stock Exchange and assessed the risk of loss associated with each stock. The empirical analysis on five blue chip stocks from 30th July 2020 to 14th March 2021 revealed that the GBM model was quite accurate in predicting stock values. Blue Chip's possible losses ranged from 4.66% to 5.96% at the 99% confidence level.

Handayani et al. investigated the impact of size of the businesses and associated market risks on the stock return of high-reliability firms or simple blue-chip companies of Indonesia [14]. The 45 companies in the samples were listed on the LQ45 between 2015 and 2017. The information was gathered from the financial reports of the companies and examined using the regression for panel data method such as the model of common effects and the Chow test to validate the hypotheses. The findings suggested that business size has an effect on stock return, however market risk has no effect on the stock return of blue-chip companies. The findings of this study were designed to assist investors in making sound investments in blue-chip Indonesian enterprises. However, the study's main limitation was its excessive focus on the fundamental analysis, which is difficult to estimate using machine learning algorithms.

A study by Henrique et al. conducted a short frequency analysis of stock price movements to determine if Efficient market hypothesis (EMH) holds [15]. This study employs SVR machine learning model to predict the stock prices for small and large capitalization firms in three different markets, using high frequency data of daily and minute-based prices. The comparison of prediction error estimates of random walk model and the new model are used to validate efficient market hypothesis in the study. The results indicate SVR sustains high prediction accuracy when new information is regularly included in the model. There are also indications of high forecast precision during low volatility. Based on the general idea of this study, the current research aims to apply advanced machine learning algorithms for the prediction of blue-chip stock prices.

Chousa et al. conducted a comprehensive study to analyze the associated between stock returns of pharmaceutical companies in the US and market volatility indexes [9]. The research considered proxy indexes like VIX as a proxy of the market fear index, ISEE as the market sentiments index, and NASDAQ-100 as a proxy of the technology index. The research employed advanced time series forecasting models like DCC-GARCH and M-GARCH models to validate if there were any significant effects between market volatility indices and the stock returns of the selected companies. The study observed significant impact of the technology index on the stock returns of the selected pharmaceutical companies (Pfizer and Moderna). The study further observed that the market fear index and sentiments index also affected the stock returns of these companies significantly. The primary implications of the study suggested that the increase in the research and development and the associated investments in the development of Covid-19 vaccines by these two companies support the idea of the paradoxical spiral. This idea implies that due to anthropogenic changes in the economy, the persistent adverse effects are likely to become more pronounced, spreading across different sectors of the economy. The study also observed the contagion effect of the same as growth in the stock returns implied a significant growth in the technology index, which later subsided the ongoing fear and bearish sentiments in the market.

Thus, the current research aims to fill these research gaps by initially considering factors like sentiment index or ISEEE, fear index or VIX index, and technology index or NASDAQ-100, in determining the blue-chip stock returns movements. The selected blue-chip stocks in this research comprise Amazon, Apple, and IBM where the initial stock is related to e-commerce while the latter two stocks are associated with technology market. During the pandemic, these two markets specifically experienced shocks (both positive and negative). Additionally, the research will consider advanced machine learning models like Support Vector Machine (SVM), regression tree, and random forest to understand the impact of selected indicators on stock returns movement. The research will consider the root mean squared error (RMSE) term to determine the feasibility of models in predicting the outcome variables or the selected blue-chip stock returns during the era of pandemic.

2. Methodology

2.1. Data Sources

This research selects the three blue-chip stocks (Apple, IBM, and Amazon), and each stock's daily adjusted closing price was collected from Yahoo Finance from 2020 to 2022 [16]. The returns for each stock were calculated, as mentioned in Equation 1, to achieve the desired outcomes.

$$\ln(R_{t_i}) = \ln(R_{t-1}) - \ln(R_{t_c}) \quad (1)$$

Whereby $\ln(R_{t_i})$ indicates the natural log returns, $\ln(R_{t-1})$ indicates the natural log returns in the previous period, and $\ln(R_{t_c})$ indicates the natural log returns in the current period.

The rationale for selecting this period was to account for the pandemic strain in the companies and market volatility following the health crisis to determine the role of selected independent variables effectively: Sentiment Index (ISEE), fear index (VIX), and technology index (NASDAQ-100), on the returns of these stocks. The data for ISEE and NASDAQ-100 was collected from the official website of NASDAQ [17]. In contrast, the data for the VIX index was collected from Chicago Board Options

Exchange (CBOE) for the study period [18]. R software was used to execute the selected models, whereby relevant codes were generated to obtain relevant outputs from the analysis.

2.2. Indicator Selection

The rationale for selecting Apple, IBM, and Amazon as the leading blue-chip stocks was based on the idea that technology and online shopping increased during the pandemic [19]. Therefore, these three blue-chip stocks are considered for the analysis to fulfil the research objectives, i.e., to identify the impact of market volatility on the log returns of blue-chip stocks. Additionally, the market was reactive to the information about the pandemic and the increasing number of Covid cases [11, 20]. Thus, to capture the effect of market volatility and evaluate its impact on the selected blue-chip stocks, the sentiments index, fear index, and technology index were considered as the leading determinants of selected blue-chip stocks' returns predictions.

2.3. Models Introduction

2.3.1 Support vector machine model

Support Vector Machine is an advanced supervised machine learning algorithm which helps resolve regression and classification-related problems. It is an effective tool for multivariate analysis as it uses kernel functions to predict the linear and non-linear relationship between the variables [21].

2.3.2 Random forest

Similar to the SVM model, random forest is an ensemble machine learning algorithm to solve regression and classification problems. This method or algorithm is known for its high accuracy and versatility because it initially fits multiple models in which the best model is selected based on the lowest prediction error or noise [21].

2.3.3 Regression tree

The regression tree models are derived from decision tree modelling approach in which the target variable is continuous. The model selects a variable to split, and the subsequent independent variables (followed through leaves) explain or predict the quantitative outcome variable [21].

In this research, random forest, regression model, and SVR model are considered to analyze the impact of market volatility indexes like VIX, NASDAQ-100, and ISEE index on the respective stock returns of the selected blue-chip stocks. In order to analyze the prediction accuracy of the selected ML models, root mean square error (RMSE) will be considered i.e., a model producing the lowest RMSE will be termed as a better performing model in relation with other models [2].

3. Results and Discussion

3.1. Descriptive Statistics

As shown in Table 1, descriptive statistics of the key variables of interest are outlined whereby Ln (VIX), Ln (Nasdaq), and Ln (ISEE) suggest the natural log-transformed variables of VIX, NASDAQ-100 and ISEE index. In Table 2, Ln(apr), Ln(ibmr), and Ln(amr) indicate the log returns of Apple, IBM, and Amazon, respectively. Table 1 suggests that the average skewness and kurtosis of VIX, NASDAQ-100 and ISEE is relatively small which suggests no significant outliers in the market volatility indices. However, Table 2 suggests that the log-returns of the blue-chip stocks are extremely volatile because the kurtosis value is high, although it is relatively within the desired limits of +10. This statistic suggests that extreme outliers are not present in the log returns of the blue-chip stock returns of the companies. The median value of each of the indicators is less than the mean value of the series, which further confirms that the value of each blue-chip stock is normal and do not exhibit any significant outlier.

Table 1. Descriptive Statistics of Market Volatility Indices

Statistics	Ln(vix)	Ln(Nasdaq)	Ln(isee)
Mean	3.183	9.437	4.640
Standard Error	0.010	0.007	0.008
Median	3.151	9.456	4.644
Standard Deviation	0.276	0.173	0.200
Sample Variance	0.076	0.030	0.040
Kurtosis	2.410	0.737	6.012
Skewness	1.064	-0.825	-0.108
Range	1.706	0.863	2.494
Minimum	2.709	8.853	3.638
Maximum	4.415	9.716	6.131
Sum	2256.458	6691.151	3290.068
Count	709	709	709

Table 2. Descriptive statistics of Stock Returns

Statistics	Ln(apr)	Ln(ibmr)	Ln(amr)
Mean	0.001	0.000	0.000
Standard Error	0.001	0.001	0.001
Median	0.001	0.001	0.001
Standard Deviation	0.023	0.019	0.025
Sample Variance	0.001	0.000	0.001
Kurtosis	4.389	10.061	4.086
Skewness	-0.137	-0.883	-0.133
Range	0.251	0.245	0.278
Minimum	-0.138	-0.138	-0.151
Maximum	0.113	0.107	0.127
Sum	0.618	0.305	-0.119
Count	709	709	709

3.2. Trend Analysis

3.2.1 Blue-Chip stock prices

Figure 1 indicates the trends in the adjusted close price of blue-chip stocks from 2020 to 2022. The plot indicates that the adjusted price of IBM has been increasing throughout as compared to the other two stocks. IBM stocks also overtake the growth in adjusted close price of Amazon and Apple during late December 2022. Contrarily, a constant increase in the stock price of Apple is evident from the plot, with a subsequent decline in late 2022. The stock price of Microsoft indicates a constant increase followed by a continuous decline after late 2022. The plot also indicates that during the pandemic, blue-chip stock prices were increasing, followed by an increase in demand for technology and e-commerce-related products due to social distancing measures.

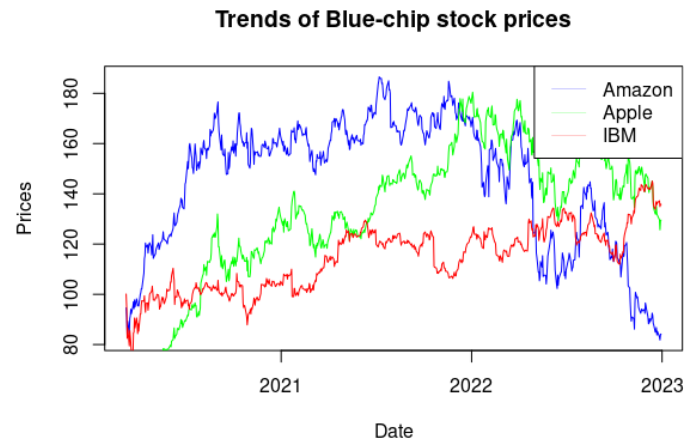


Fig. 1 Trends in the stock price of Blue-chip stocks

3.2.2 Market volatility indices

Figure 2 indicates that the volatility index, which reveals the average level of fear in the market, increased during the third quarter of 2020. The index gradually declined afterwards, which indicates that market fear subsided with the adoption of new normal such as social distancing, work from home, and allocation of resources to online businesses.

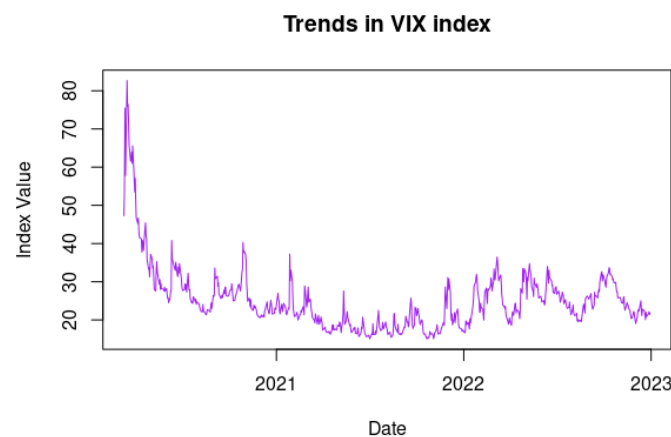


Fig. 2 Trends in VIX index

Figure 3 indicates that the adjusted close price of NASDAQ-100 or the technology index gradually increased until the initial quarters of 2022, which suggests an increased use and demand for technology-related products following social distancing measures. Although a sharp decline in the trend is observed from 2022 onwards that can be attributed to the gradual opening of the economies and lifting of social distancing measures.

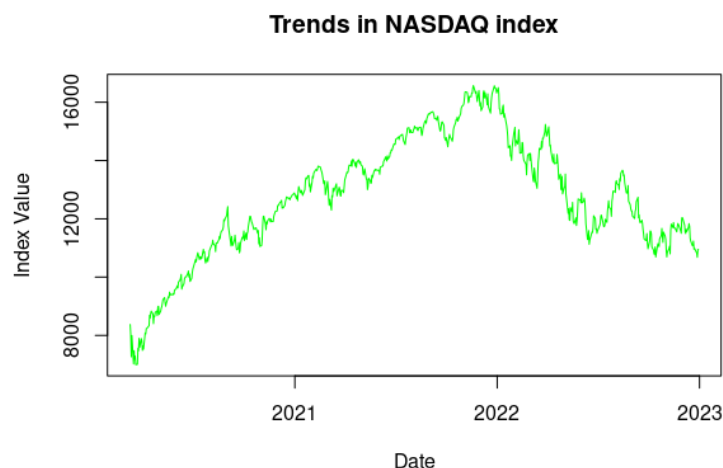


Fig. 3 Trends in NASDAQ-100 Index

Figure 4 suggests extreme volatility in the ISEE index and a slight increase in the trend during the initial quarters of 2020. A consistent decline in the trend observed throughout can be attributed to the strains of a new variant of Covid-19, i.e., Omicron. However, an increased spike in the late 2022 suggests a surge of bullish sentiments in the market which can be associated with the increasing demand for online products and services in the backdrop of pandemic. A comparison of ISEE index trends with the trends of other market volatility index suggests that the NASDAQ-100 index declined during 2022 after a major increase in the ISEE index (or bullish sentiments), while frequent spikes are observed in the VIX Index.

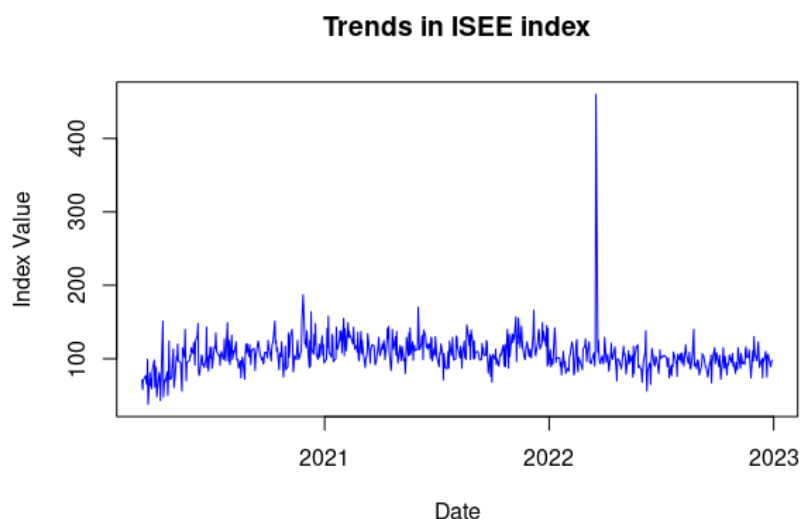


Fig. 4 Trends in ISEE Index

3.3. Prediction Accuracy of Machine Learning Models

As observed from Table 3, it is observed that the root mean squared (RMSE) of the regression tree model is the lowest. In other words, the regression tree model performs relatively better than SVR and random forest model in terms of explaining the impact of market indices on the log returns of Amazon. However, the RMSE of SVR model is the lowest for Apple and IBM which implies that the model performs relatively better than the random forest and regression tree model in terms of predicting the stock returns of the companies.

Table 3. Model Performance

Algorithms	RMSE		
	Amazon	Apple	IBM
Support Vector Machine	0.023	0.021	0.016
Random Forest Model	0.024	0.022	0.017
Regression Tree	0.023	0.022	0.017

3.4. Discussion

3.4.1 Market volatility and Blue-chip stocks

The contemporary literatures [12] and [13] extensively study pandemic effects on the stock return trends of blue-chip stocks, particularly Amazon, Apple, and IBM. The findings suggested a significant level of uncertainty and instability in the stock prices of these companies in the pandemic era. Extensive analysis of the stock market trends indicates that Amazon's stock price increased in the initial period of the pandemic compared to its technology company counterparts like Apple and IBM. However, IBM and Apple experienced a sudden increase in their respective prices during the late period of the pandemic. This growth spurt may have been due to increased investments in the research and development of Covid-19 vaccines [9]. The studies suggest that both internal and external shocks have a significant impact on stock price movements, leading to disruptions in average and annual

returns. Despite these significant findings, the studies overlooked the role of volatility indices in providing valuable insights into the current market sentiment [14, 15].

3.4.2 Emergence of volatility indices

An essential contribution of this research lies in identifying significant volatility spikes in crucial market indices, namely NASDAQ-100, ISEE, and the VIX index, at the beginning of the Covid-19 pandemic. The VIX index, also called as the fear index, exhibited a gradual decline since 2020 due to optimistic market sentiments fuelled by increased investments in Covid-19 vaccine research and development. Another factor contributing to this decline was the thriving online business ecosystem during the pandemic which generated favourable returns for e-commerce giants like Amazon.

Furthermore, the Nasdaq-100 index defied conventional trends, experiencing a persistent ascent amid the pandemic's challenges [9]. This remarkable volatility pattern can be attributed to intensified investments in technology, research, and development, following the accelerated shift towards remote work and amplified demand for electronic devices, especially in online education.

The ISEE index's trend analysis highlights a surge in bullish investors sentiment in mid-2022, a phenomenon congruent with economies regaining stability after a period of disruption. This resurgence signifies a pivotal turning point in the market outlook and suggests a potential return to pre-pandemic levels of economic equilibrium [9].

3.4.3 Machine learning models and stock return predictions

A pivotal facet of this research entails the evaluation of three distinct ML models—Regression Tree, SVM, and Random Forest—in predicting average market returns for Amazon, Apple, and IBM. As observed in the contemporary literature, advance machine learning models are usually considered to predict the stock price movements of the companies and businesses. However, a significant research gap in this domain is associated with the lack of assessment of the predictive capacity of these models when volatility predictors are included. The current study considers this possibility as a major foundation of evaluating the adequacy and accuracy of advance statistical and machine learning models in terms of predicting the stock returns of companies while considering volatility parameters [3, 4, 5].

Surprisingly, the Regression Tree model emerged as the most efficient model in forecasting the average market returns for Amazon. These findings challenge conventional expectations, as Regression Tree models are generally perceived to exhibit inferior performance when contrasted with sophisticated machine learning techniques like SVM and Random Forest. The divergence in model performance is likely attributed to the unique internal dynamics of Amazon, characterized by a gradual improvement in stock returns throughout the pandemic, propelled by the exponential growth of the e-commerce sector during the pandemic era.

Conversely, the Support Vector Machine model exhibited superior predictive capabilities concerning Apple and IBM stock returns compared to the Regression Tree and Random Forest models. The rationale underlying this discrepancy lies in the inherent nature of these technology-driven stocks. The stock returns for Apple and IBM remained volatile and steadily escalated during the later period of 2020, reflecting the immense impact of technological shifts and advancements within the sector [7, 8].

3.4.4 Practical implications

The Regression Tree approach proves adept at estimating stock returns for companies with lower volatility and heightened stability during times of turmoil. In contrast, advanced ML algorithms such as SVR are imperative for stocks exhibiting pronounced volatility and uncertainty. The latter models can effectively accommodate subsequent prediction errors arising from extreme variable volatility, facilitating more accurate stock return predictions. This study's comprehensive exploration of market volatility indices, their impact on blue-chip stocks, and the performance of diverse machine-learning models underpins the complicated relationship between market dynamics and stock returns during the pandemic era. The research is a robust foundation for guiding investment strategies and decision-

making processes, enabling stakeholders to navigate the complex and unpredictable financial landscapes that characterize such unprecedented times.

4. Conclusion

The current study analyzed the relationship between market volatility indices and the stock returns of blue-chip companies like Apple, Amazon, and IBM. These companies are usually preferred by the investors to hedge against extreme market risks because of the consistent financial stability. However, many financially stable and large capitalization companies experienced significant decline in their stock prices during the pandemic era. The study identified that stock returns of the selected blue-chip stocks experienced a significant decline during the pandemic. The trend analysis further highlighted a surge in the stock prices of technology stocks followed by an improvement in the technological index. This growth can be associated with the development of Covid-19 vaccines which positively affected the related sectors in the economy. Another reason for the increase can be associated with the increase in demand for technology products like laptops and higher internet connectivity to ensure smooth process of work from home and online education.

Furthermore, uncertainty across market volatility indices like VIX, ISEE, and NASDAQ-100 was observed during this period. The insights from the comprehensive evaluation of the market volatility indices suggested that market sentiments, fear, and declining inflow in technology were persistent during the pandemic era. As a result, the investors gradually exited from the market, leading to extreme volatility in the stock markets. The findings from the machine learning models suggested that regression tree model outperformed SVR and random forest model while predicting the stock returns of Amazon. Contrarily, the SVR model performed relatively better in terms of predicting Apple and IBM stock returns. The practical implication of the research suggests that investors should consider relatively less complex model while predicting the stock returns of a company which experience less volatility during uncertain times. On the other hand, the complex model which accounts for the underlying non-linear relationship between variables and potential uncertainty, should be considered while predicting the stock returns of volatile stocks.

One of the main limitations of the research methodology of this study is that only three stocks are considered which reduced the scope and generalizability of the research findings. Additionally, limitation of the number of selected models in the study following time constraints, reduced the possibility of garnering insights from exhaustive comparison of all three models. The study fails to identify any significant findings associated with random forest models which undermine the objectives of the current research. Thus, future research or studies can modify the methodology of this paper by including different stocks such as pharmaceutical stocks and commercial stocks to compare the model accuracy in the case of different types and nature of the stocks. Additionally, more models like neural network and LSTM can be included to enhance the findings obtained from model comparisons. Future studies can also consider including robust modelling approaches based on ordinary least square like ridge and lasso to estimate if the underlying assumptions of the models hold when volatility is controlled.

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