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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESIS (ES)

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

LIMITATIONS

SCOPE FOR FURTHER RESEARCH

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MONTE CARLO SIMULATION METHOD Vs. BACK PROPAGATION METHOD ANN: A COMPARATIVE STUDY USING VOLATILITY INDEX OF INDIA

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ABSTRACT
Stock forecasting is one of the complex process involved in investments. There are many past studies and working papers are based on effective forecasting methods and techniques. The more the accurate prediction would help the investors and the financial advisors to take appropriate investment decision in the field of investment. This paper is an endeavour to find out whether the Artificial Neural Network method can accurately predict the option price comparing to conventional method (Monte Carlo simulation). Daily data from Volatility Index were considered for the study from January 2019 to December 2019. Both the models are compared and the accuracy of these two models are measured using Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE).

KEYWORDS
stock forecasting, forecasting methods, investment decisions.

JEL CODE
G11

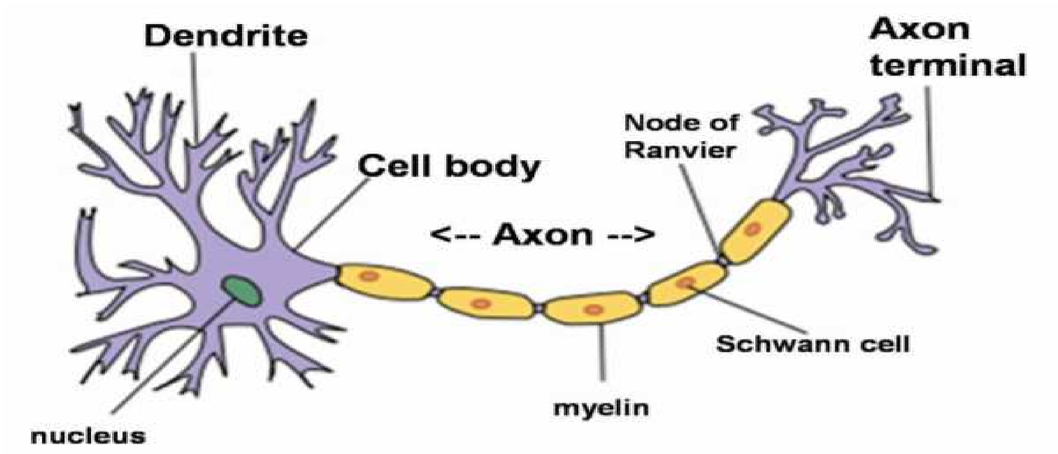
1.0 INTRODUCTION
The primary aim of the financial analyst in the recent past in the financial analysis and stock market analysis, tried to analyse the stock movements. Further there are lot of studies made an attempt to find out the best suitable models in the field of time series analysis. However, accurate prediction of stock prices gave us the most challenging task for both investors and for the financial analyst. Many studies pertaining to stock price movements and identifying the patterns are also carried in the recent past. Stock Market forecasting has long frequently sparked the interests of academics. Despite Multiple scientific attempts, no mechanism for reliably predicting stock price movement has been discovered. The complexities of modelling market dynamics add to the complexity of forecasting. There have been some minor successes despite the lack of reliable prediction methods. The phrase "stock market analysis" refers to the study of the stock market. Fundamental and technical approaches to stock market analysis are two fundamental trading philosophies. Stock market price fluctuations are thought to be derived from a security's relative data in fundamental analysis. Fundamentalists predict the future using numerical data such as profits, ratios and management effectiveness. The majority of current financial text mining literature relies on a predefined collection of keywords and machine learning techniques. Keywords are usually assigned weights in proportion to the movement of a stock price in these systems. These types of analyses have demonstrated a definite, but limited, ability to predict share price direction.

For this analysis, the research uses the back propagation tangent sigmoid function to compare to the Monte Carlo Simulation model to see which one outperforms the other in terms of predicting the time series data.

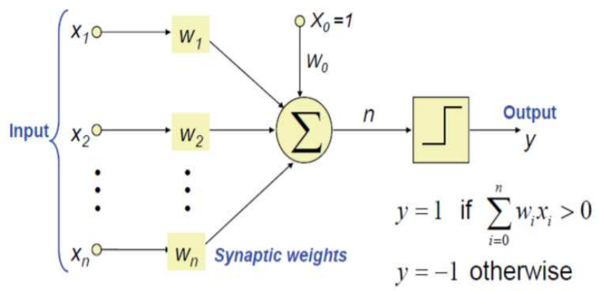
1.1 MONTE CARLO SIMULATION METHOD
In general, a Monte Carlo Technique can be described as any technique that solves a problem using random numbers. It can be used to solve both probabilistic and mathematical problems (James,1980). Halton (1970) has defined Monte Carlo Technique for representing a problem as a parameter of a hypothetical population and generating a sample of the population from which statistical estimates of the parameter can be derived using a sequence of numbers. As a result, simulation in general is often referred to as a computational method for performing computer based experiments involving random sampling from probability distributions. The law of Large Numbers and the Central limit theorem are at the heart of the MC Definition. The Law of Large Numbers state that as the sample size becomes bigger, the sample mean is pushed to get similar to the population mean (BelginSert,2011). The Central Limit theorem states that as the sample size grows, we can assume a normal distribution of data. Monte Carlo approaches are computational approaches that are capable of addressing a complicated mathematical or statistical problem. The rationale behind MCs is to create random number sequences in order to conduct mathematical simulation of creating new configurations of a system of interest over long periods of time (Rollett and Manohar, 2004). Furthermore, even though Convergence is sluggish, the primary feature of MCs is to reduce variance by integrating the outcomes of a large number of samples (Lafortune, Simulation facilitates solving many problems in financial engineering, which focus on estimating a certain value such as: pricing derivative securities, computing price sensitivities, and evaluating portfolio risks. Consequently, MCs is a stochastic method that is often applied to approximate expectations. In fact, MCs is applied by three essential steps: generating sample paths randomly, evaluating the payoff along each path, and calculating an average to attain estimation (Chen & Hong, 2007).

1.2 ARTIFICIAL NEURAL NETWORK
Basic element of the human neural network is a neuron. Neuron stores and processes the information. Typical structure of a neuron is shown in Fig.3.1. Neuron has Dendrites, Soma (Cell Body), Axon, Axon Terminal, Myelin, Schwann Cell, Nodes of Ranvier and Synapses as the basic elements.

PICTURE 1



An Artificial Neural Network (ANN), often just called a neural network, is a set of interconnected links that have weights associated with them. The concept of ANN was derived from biological neural networks. Neural networks open up a new foray into the field of making efficient and usable predictions in order to optimize profits. Artificial Neural Networks are being used in numerous areas, as it is an irrefutably effective tool that aids the scientific community in forecasting about probable outcomes. Any ANN can be thought of as a set of interconnected units broadly categorized into three layers. These three layers are the input layer, the hidden layer and the output layer. Inputs are fed into the input layer, and its weighted outputs are passed onto the hidden layer. The neurons in the hidden layer (hidden neurons) are essentially concealed from view. Using additional levels of hidden neurons provides increased flexibility and more accurate processing. However, the flexibility comes at the cost of extra complexity in the training algorithm. Having more hidden neurons than necessary is wasteful, as a smaller number of neurons would serve our purpose just fine. On the other hand, having less hidden neurons than required would cause reduced robustness of the system, and defeat its very purpose.



1.3 BACK PROPAGATION MODEL ANN

To overcome the limitation of perceptron, in 1986, Rumelhart et al. had describe a new supervised learning procedure known as Back Propagation Neural Network (BPNN) which is used for linear as well as non-linear classification. BPNN is a supervised algorithm in which error difference between the desired output and calculated output is back propagated. The procedure is repeated during learning to minimize the error by adjusting the weights thought the back propagation of error. As a result of weight adjustments, hidden units set their weights to represent important features of the task domain. BPNN consists of three layers: 1) Input Layer 2) Hidden Layer and 3) Output Layer. Number of the hidden layers, and number of hidden units in each hidden layer depend upon the complexity of the problem. Learning in BPNN is a twostep process.

Step 1 (Forward Propagation): In this step, depending upon the inputs and current weights, outputs are calculated. For such calculation, each hidden unit and output unit calculates net excitation which depends on:

- Values of previous layer units that are connected to the unit in consideration.
- Weights between the previous layer unit and unit in consideration.
- Threshold value on the unit in consideration.

This net excitation is used by activation function which returns calculated output value for that unit. This activation function must be continuous and differentiable. There are various activation functions which can be used in BPNN. Sigmoid is widely used activation function. It is defined as following.

$$s_c(x) = \frac{1}{1 + e^{-cx}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Step 2 (Backward Propagation of Error): During this step, error is calculated by difference between the targeted output and actual output of each output unit. This error is back propagated to the previous layer that is hidden layer. For each unit in the hidden layer N, error at that node is calculated. In the similar way, error at each node of previous hidden layer that is N-1 is calculated. These calculated errors are used to correct the weighs so that the error at each output unit is minimized. Forward and backward steps are repeated until the error is minimized up to the expected level.

1.4 REVIEW OF LITERATURE

Dima Waleed Hanna Alrabadi and Nada Ibrahim Abu Aljarayesh, in the year 2015, tested the use of Monte Carlo Simulation in Forecasting Stock Market Returns in Amman Stock Exchange. The accuracy of the results was measured by Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Theil Inequality Coefficient (U). The test revealed that Monte Carlo Simulation is the most accurate forecasting technique and also stated that Amman Stock Exchange seems to be inefficient at the weak level, given that the technical analysis approaches enable investors to predict stock market returns.

Masimba E. Sonono and Hopolang P. Mashele, in the year 2015, have examined the accuracy of Time Models in the Prediction of Stock Prices. The Research consists of a Comparative Analysis of continuous time models like, General Brownian Motion (GBM) and Variance Gamma (VG) in predicting the accurate price levels and it's direction using Monte Carlo methods like, Quasi Monte Carlo (QMC) and Least Squares Monte Carlo (LSMC). The models were evaluated using, Hit

Ratio and Mean Absolute Percentage Error (MAPE). The findings state that, both GBM Model or VG model in any Monte Carlo Method can be used to determine the direction of Stock Price Movement. In terms of predicting the stock price values, the findings reflect that, GMB Model functions efficiently in QMC Method and the VG Model performs well in the LSMC Method.

Rene D. Estember, Michael John R. Marana, in the year 2016, attempted to Forecast the Stock Prices using Brownian Motion in the Philippine Stock Exchange. The research examined the potential of Brownian Motion method as an effective forecasting method compared to Artificial Neural Network (ANN). The number of days the volatility and drift are moved were also determined and this was used to perform the forecasting of stock prices of holding companies registered with the Philippine Stock Exchange and also compared to the ANN method. The findings state that the average percentage error of the GBM method was 6.21% or an accuracy of 93.79% while the ANN method generated an accuracy of 91.71%, showing that GBM method is a much more reliable method in terms of forecasting compared to the ANN method.

1.5 RESEARCH METHODOLOGY AND DESIGN

1.5.1 Research Gap

From the above-mentioned literatures, we see that many past studies have focused on conventional methods. Studies have witnessed that Monte Carlo has the ability to predict compared to other models. Very few studies were carried out in this area to find whether models have the capability to predict. Back Propagation Method has not been used by most of the researchers. This led to the comparison of the results of both methods in the study in terms of their accuracy. ANN is the hybrid models which is not used extensively in the area of stock forecasting. Hence this study is an attempt to find out whether ANN can predict the Options prices effectively and efficiently, Monte Carlo Simulation Method.

1.5.2 Statement of the Problem

Despite many tools and techniques to study the Stock Price Movements being pre-existential in order to find out the Trade Signals and Patterns, the best investment decision with lower risk that is to be determined is becoming a complex task. The study mainly attempts to resolve the problems of determining secure investment signals in order avoid risky investments in Index Options that are complex in nature.

1.5.3 Research Objective

- To analyse whether Monte Carlo Simulation model could outperform ANN (Back Propagation)
- To analyse the option prices using simple moving average and exponential moving average.

1.5.4 Research Hypothesis

H0 – Monte Carlo does not outperform compared to Artificial Neural Network (Back propagation)

H_A - Monte Carlo outperform compared to Artificial Neural Network (Back propagation)

1.5.5 Scope of the study

As the world of Stock Market is perceived to be a Risky stream by many potential investors to manoeuvre their economic activities, this study attempts to find out the most reliable method of Technical Analysis that can be used by Investors to make their Investment Decisions. The study mainly concentrates on the Methods of Forecasting in terms of their Accuracy as a result of which, the accurate Forecasting Model can be used by investors to make lucrative investment decisions that includes safety for their investments

1.5.6 Data Collection

For the present study the closing price of Volatility Index of India (VIX) were considered from January 2019 to December 2019. Since there are huge volume traded, this index was considered for the study.

1.5.7 Tools and Techniques

The forecasting techniques that we use in this study are: Monte Carlo simulation (MCs) through excel. ANN: Multi- Layer Perceptron through MATLAB was used to forecast the option prices. The tools and techniques for both Monte Carlo and ANN is discussed in the below paragraphs along with the formulas:

1.6 RESEARCH DESIGN

1.6.1 Monte Carlo Simulation Model

1.6.2 Simple Moving Average Method

Moving average method is one of the most popular methods of technical analysis. A moving average is calculated as an average of observations from a number of subsequent time periods. It soothes out the irregularities in the data series. A SMA is the average of price series over a selected time period which gives an equal weight to each period price. The mechanism of SMA includes the market movement forward in time; the oldest price is removed from the average calculation and replaced by the most recent price (Mendelsohn, 2000). Hence, we calculated the simple moving average for the present data set using the below equation:

$$f = 1/n \sum_{i=0}^{n-1} \mathrm{A}\,(n-i)$$

1.6.3 Exponential Moving Average

The exponential moving average (EMA) solves the equal-weight problem of the simple moving average (SMA). In specific, the SMA gives the same weight for every data point. On the other hand, the EMA gives greater weights to more recent data; thus, the weight of the past data declines exponentially (Brooks, 2006).

$$Ft + i = (1 - \alpha)\, A\, t + \alpha\, ft$$

Where f: is the forecasted value, is the smoothing constant (0< α <1), the larger the α, the more weight is given to recent observation (damping factor), and A is the actual value. We apply the EMA with two values of damping factor (α), 20% and 30%Limitations.

1.6.4 Monte Carlo Simulation

To predict the stock prices using MCs, the steps to be incorporated are:

1. Calculate the Average Daily returns, Standard Deviation of the returns according to your selection of the time period of the data.
2. Estimate Random Numbers over the study period on a daily basis
3. Follow a Stochastic Process, with the help of which we sum the average return with a random return shock which can be calculated by multiplying the Standard Deviation that involved random value estimation in the second step.
4. The concluding step is to calculate the forecasted price of Day (t+1). This can be completed by multiplying the actual price of the trading day by the exponential value of the sum that is calculated in the third step. The Forecasted returns are further calculated following (Choong, 2012) using excel.

$\ln (p_t/p_{t-1}) = \mu + z\,\sigma$

Where

μ: being the constant (deterministic component) calculation of daily mean on a monthly basis.

Z: being the “pseudorandom number" (stochastic component).

σ: being the monthly volatility, expresses the random shock stochasticity.

1.6.5 Comparison Techniques of Forecasting Accuracy

The Root Mean Squared Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) are the forecasting accuracy metrics used in the analysis. The RMSE is a measure of the average squared difference between the predicted and actual values.

It is denoted by the equation:

$$RMSE = \sqrt{\sum \frac{e_t^{\,2}}{n}}$$

The MAE is an error statistic that averages the forecasted values' absolute deviation from the original values. It can be calculated using the formula:

$$MAE = \frac{\sum |e_t|}{n}$$

MAPE accounts for the average absolute error figure, which tends to perpetuate the impression of unreliable predictions. MAPE has properties that are similar to MAE properties. It can be determined using the formula:

$$MAPE = \frac{1}{n} \cdot \sum \frac{|e_t|}{A_t}$$

$$U = \frac{\sqrt{\frac{1}{n} \cdot \sum (A_t - f_t)^2}}{\sqrt{\frac{1}{n} \cdot \sum f_t^2} + \sqrt{\frac{1}{n} \cdot \sum A_t^2}}$$

The close the four errors measures to zero the better is the forecast.

1.6.6 Monte Carlo Simulation on Excel

Based on the extracted data, the Monte Carlo simulation was performed using MS-excel functions. The following are the clear steps how the simulation was carried out. Option data was extracted on daily basis. For the present study only, the call option closing prices was used for the analysis. There are six steps involved in this formula: Following are the steps in detail.

Step 1: Calculation of Daily Changes- The First Step involved the calculation of daily changes. The formula mentioned below was used.

$$= \textbf{Today's Price} \div \textbf{Yesterday'sPrice}$$

Step 2: Random Number Generation – the second step involved is to find out the random number generation to see the possible outcomes in the given trading days eg. 364 days. The formula mentioned below was used.

$$= \textbf{Randbetween}(\textbf{First day}, \textbf{Last day})$$

Step 3: Random Change Determination- The third step in the simulation involved the determination of Random Change using a Random Number in the prices of the Options to find out the changes that have taken place over the history and the formula mentioned below was used.

$$= \textbf{Small}(\$\textbf{First Change}\$: \$\textbf{Last Change}\$, \textbf{Random Number})$$

Step 4: Price Simulation- The Fourth Step involved the simulation of future prices using the present-day price. Future Price was calculated by multiplying the exponential of the Random Change with Present Day Price and the formula mentioned below was used.

$$= \textbf{Today's Price} * \textbf{exp}(\textbf{Random Change})$$

Step 5: Combined Price Simulation- The Fifth Step is to make a combined price simulation. The Random Change as well as the Random Number was combined with the future price to obtain the Combined Price Simulation. Hence, the formula mentioned below was used.

$$= \textbf{Today's Price} * \textbf{exp}(\textbf{Small}(\$\textbf{First Change}\$: \$\textbf{Last Change}\$, \textbf{Randbetween}(\textbf{First Day}, \textbf{Last Day})))$$

Step 6: Creating Multiple Simulations- The Sixth step involved the creation of Multiple Simulations by Copying the Combined Price Simulation and pasting it in the adjacent column. '$' symbol was added to both row and column in the formula.

The following table A depicts the simulation.

TABLE A

1	Date	Close	Daily Changes	Price	Price	Price
2	28-Dec-18	10859.90	0.007403	10859.90	10859.90	10859.90

1.7 DATA ANALYSIS AND INTERPRETATION

1.7.1 Descriptive Statistics

TABLE 1: SUMMARY OF DESCRIPTIVE STATISTICS

Variable	Mean	Median	Max	Min	SD
Index	16.55318	15.92375	28.6575	10.525	3.37543
Actual	-0.0002	-0.00425	0.121963	-0.29775	0.047251
2 Days SMA	0.32799	0.26325	3.08870	0.01661	0.33418
3 Days SMA	0.03280	0.02898	0.16547	0.00534	0.02177
5 Days SMA	0.03828	0.03447	0.14546	0.00777	0.02049
10 Days SMA	0.04100	0.03714	0.11703	0.01636	0.01844
20% EMA	0.05015	0.04440	0.23950	0.00256	0.03239
30% EMA	0.04861	0.04346	0.22796	0.00645	0.03126
MCS	0.1239	0.1225	1.5879	0.2665	0.01587

Source: Calculated from the primary analysis

Interpretation

Table 1 shows the summary of the Descriptive Statistics of the Daily Data from the Volatility Index. Daily Market Volatility Index Value, Actual Market Returns and Forecasted Stock Market returns that are calculated using three forecasting techniques namely, Simple Moving Average (SMA), Exponential Moving Average (EMA) and Monte Carlo Simulation (MCs) are depicted in the above table.

1.7.2 The Descriptive Statistics Results: The Descriptive Statistics cover the period of 1 year (January 2019 to December 2019) and the observed values of Mean, Median, Maximum, Minimum and Standard Deviation of the Daily Market Volatility Index value are, 16.55318, 15.92375, 28.6575, 10.525, 3.37543. The Observed values for the Actual Market Returns under the Descriptive Statistical techniques are, -0.0002, -0.00425, 0.121963, 0.29775, 0.04725.

1.7.3 Simple Moving Average was calculated for 2, 3, 5 and 10 days to find out the equal weightage of the Daily Market Volatility Index prices for the selected number of days and the descriptive statistical values for 2, 3, 5 and 10 Days SMA are, 0.32799, 0.26325, 3.08870, 0.01661 and 0.33418; 0.03280, 0.02898, 0.16547, 0.00534 and 0.02177; 0.03828, 0.03444, 0.14546, 0.00777 and 0.02049; 0.04100, 0.03714, 0.11703, 0.1636 and 0.01844.

1.7.4 Exponential Moving Average with damping factors of 20% and 30% were used to smoothen the irregularities of the data and also to determine the presence of greater weightage in the selected data. The Descriptive Statistical values of 20% and 30% EMA are, 0.05015, 0.04440, 0.23950, 0.00256 and 0.03239; 0.04861, 0.04346, 0.22796, 0.00645 and 0.03126.

1.7.5 Monte Carlo Simulation: It is simulation used to determine the outcomes using the idea of generating random variables to measure the uncertainties related to a particular study. Monte Carlo Simulation was performed for the Actual Returns of the Daily Market Volatility Index prices. Descriptive Statistics of the Monte Carlo Simulation are, 0.1236, 0.1125, 1.5879, 0.2665

1.7.6 Simple Moving Average: It is a Technical Analysis that aids in determining the average value of a given price over a given time span. It is a methods of analysing data points by calculating a series of averages for the subsets of the entire data. Simple Moving Average was calculated for the Actual Returns of the Daily Market Volatility Index prices for 2, 3, 5 and 10 days.

TABLE 2: SUMMARY OF DESCRIPTIVE STATISTICS FOR 2 DAYS SMA

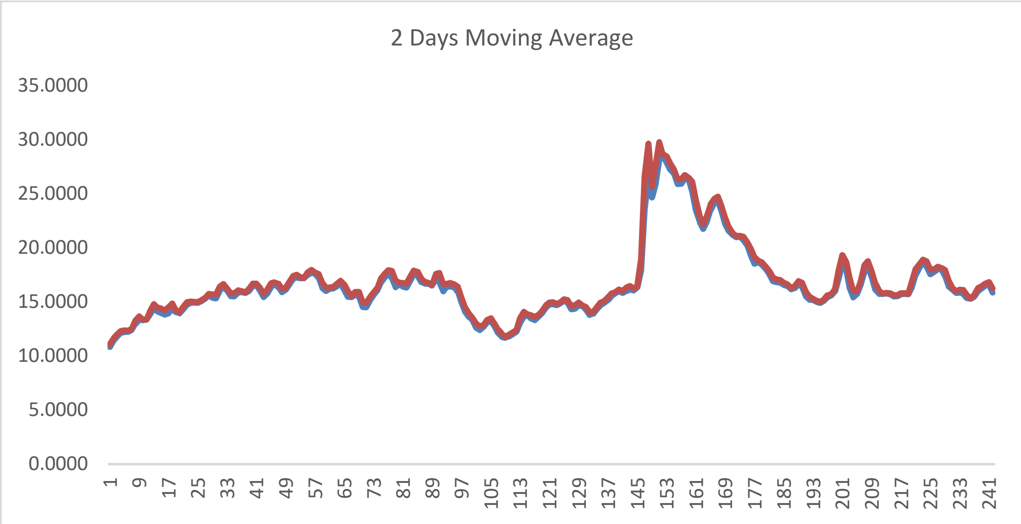
SMA for 2 Days	
0.271526357	
Mean	0.32799
Median	0.26325
Standard Deviation	0.33418
Minimum	0.01660
Maximum	3.08870

Source: Calculated from the primary analysis

Interpretation

Table 2, summarises the Descriptive Statistics calculated from the Simple Moving Average for 2 Days. The values of the Descriptive Statistics are, 0.32799, 0.26325, 0.33418, 0.01660 and 3.08870. The SMA of Actual Returns for 2 days given in Table 2 is, 0.271526.

FIGURE 1: GRAPH DEPICTING THE FLOW OF SMA FOR 2 DAYS



Interpretation

Figure 1, depicts the Simple Moving Average for 2 days which was calculated from the Actual Returns from the Daily Market Volatility Index.

TABLE 3: SUMMARY OF DESCRIPTIVE STATISTICS FOR 3 DAYS SMA

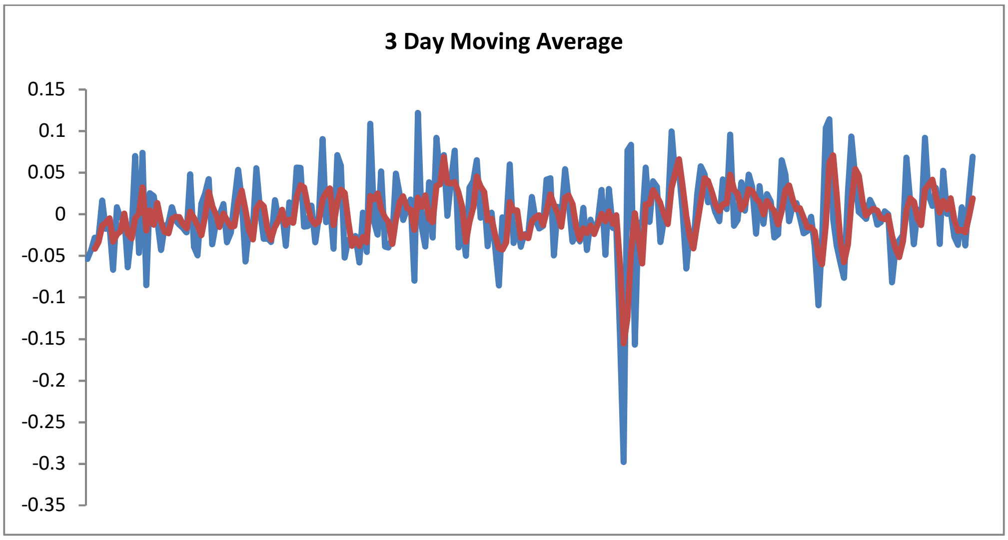
SMA for 3 Days	
0.019365201	
Mean	0.032800
Median	0.028984
Standard Deviation	0.021772
Minimum	0.005335
Maximum	0.165471

Source: Calculated from the primary analysis

Interpretation

Table 3 summarises the Descriptive Statistics calculated from the Simple Moving Average for 3 Days. The value of the Descriptive Statistics is, 0.0328, 0.028984, 0.021772, 0.005335 and 0.165471. The SMA of Actual Returns for 3 days in Table 3 is, 0.019365.

FIGURE 2: GRAPH DEPICTING THE FLOW OF SMA FOR 3 DAYS



Interpretation

Figure 2, depicts the depicts the Simple Moving Average for 3 days which was calculated from the Actual Returns from the Daily Market Volatility Index.

TABLE 4: SUMMARY OF DESCRIPTIVE STATISTICS FOR 5 DAYS SMA

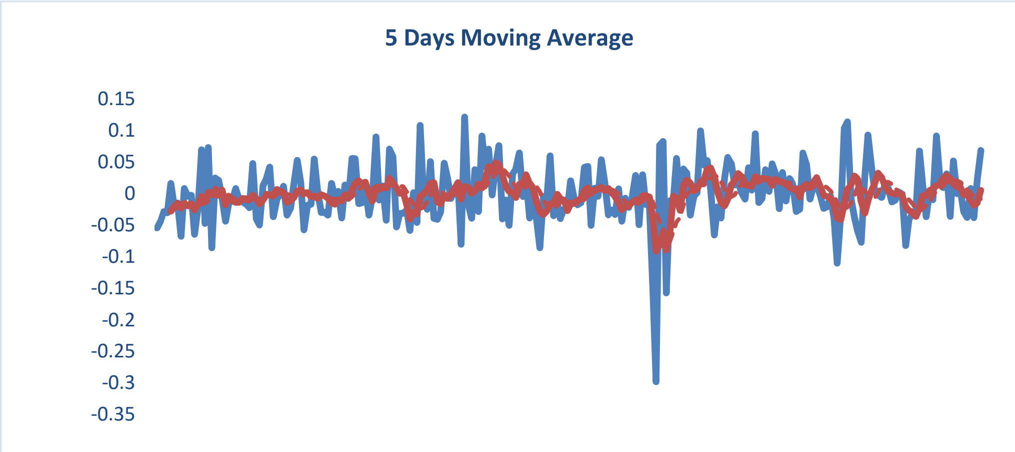
SMA for 5 Days	
0.029981568	
Mean	0.038278528
Median	0.034468481
Standard Deviation	0.02048571
Minimum	0.007767263
Maximum	0.145461029

Source: Calculated from the primary analysis

Interpretation

Table 4, summarises the Descriptive Statistics calculated from the Simple Moving Average for 5 Days. The values of the Descriptive Statistics are, 0.38278, 0.034468, 0.02048, 0.00776 and 0.14546. The SMA of Actual Returns for 5 days from the above table is, 0.029987

FIGURE 3: GRAPH DEPICTING THE FLOW OF SMA FOR 5 DAYS



Interpretation

Figure 3, depicts the depicts the Simple Moving Average for 5 days which was calculated from the Actual Returns from the Daily Market Volatility Index.

TABLE 5: SUMMARY OF DESCRIPTIVE STATISTICS FOR 10 DAYS SMA

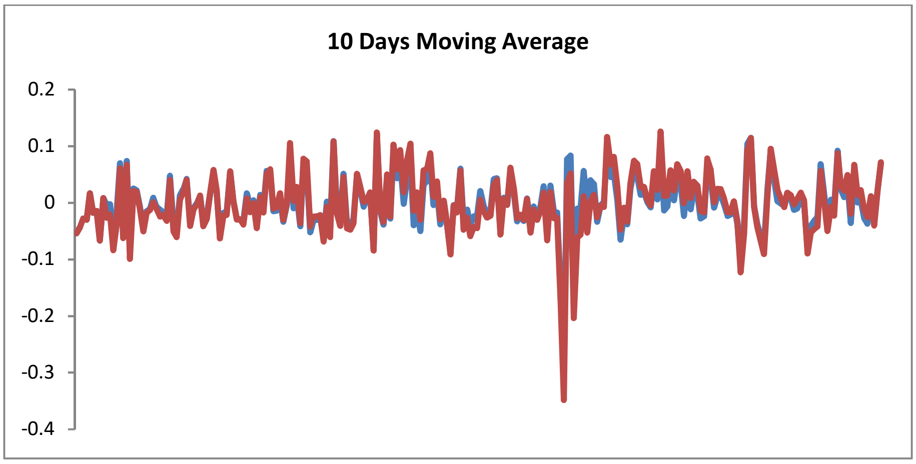
SMA for 10 Days	
0.047867825	
Mean	0.040998957
Median	0.037144719
Standard Deviation	0.018439687
Minimum	0.016362303
Maximum	0.117034464

Source: Calculated from the primary analysis

Interpretation

Table 5, summarises the Descriptive Statistics calculated from the Simple Moving Average for 10 Days. The values of the Descriptive Statistics are,0.04099, 0.37144, 0.01843, 0.01636 and 0.117034. The SMA of Actual Returns for 10 days from the above table is, 0.04786.

FIGURE 4: GRAPH DEPICTING THE FLOW OF SMA FOR 10 DAYS



Interpretation

Figure 4, depicts the depicts the Simple Moving Average for 10 days which was calculated from the Actual Returns from the Daily Market Volatility Index.

1.7.7 Exponential Moving Average

Greater weight and significance on the most data points that are recent can be placed with the help of Exponential Moving Average. The price of an investment can be through the technical chart indicator. Exponential Moving Average with 20% and 30% Damping Factors were used to smoothen the irregularities of the data set.

TABLE 6: SUMMARY OF EXPONENTIAL SMOOTHING AT 20% DAMPING FACTOR

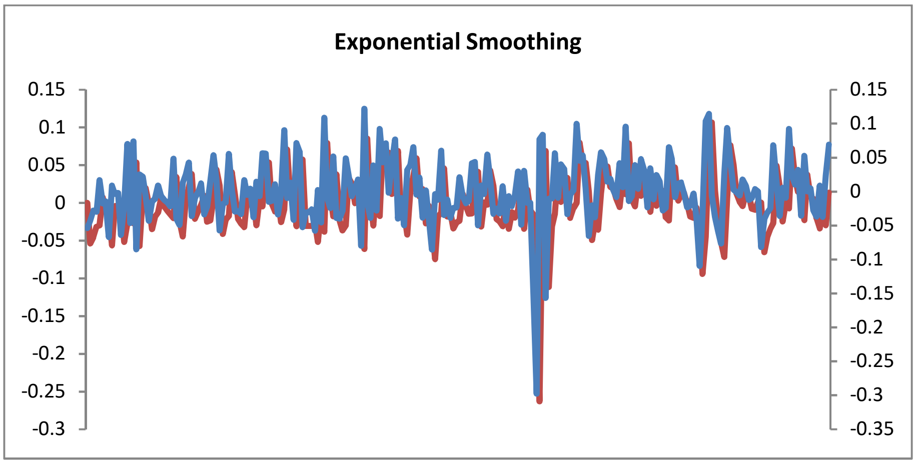
Damping Factor at 20%	
0.011821302	
Mean	0.050150006
Median	0.044399362
Standard Deviation	0.032392911
Minimum	0.002555924
Maximum	0.239496957

Source: Calculated from the primary analysis

Interpretation

Table 6, summarises the value of Exponential Smoothing at 20% Damping Factor of the Returns from the Volatility Index as, 0.011821. The descriptive Statistics as shown in the above table are. 0.05015, 0.04439, 0.032392 and 0.00255, 0.23949.

FIGURE 5: DEPICTS THE EMA AT 20% DAMPING FACTOR



Interpretation

The above Figure, shows the Exponential Smoothing calculated from the Actual Returns of the Daily Market Volatility Index at 20% Damping Factor.

TABLE 7: SUMMARY OF EXPONENTIAL SMOOTHING AT 30% DAMPING FACTOR

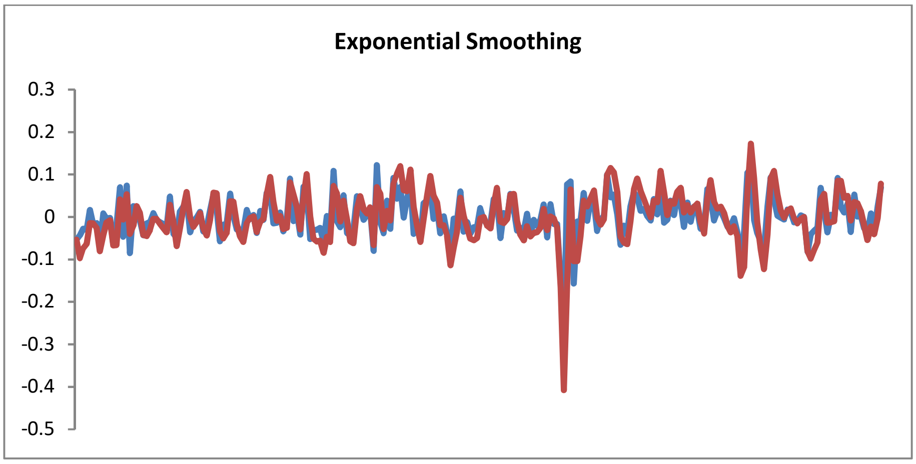
Damping Factor at 30%	
0.012483845	
Mean	0.048606
Median	0.043457
Standard Deviation	0.031255
Minimum	0.006454
Maximum	0.227964

Source: Calculated from the primary analysis

Interpretation

Table 7, summarises the value of Exponential Smoothing at 30% Damping Factor of the Returns from the Volatility Index as, 0.012483. The descriptive Statistics as shown in the above table are, 0.04860, 0.43457, 0.031255, 0.00645, 0.22796.

FIGURE 6: DEPICTS THE EMA AT 30% DAMPING FACTOR



Interpretation

The above Figure, shows the Exponential Smoothing calculated from the Actual Returns of the Daily Market Volatility Index at 30% Damping Factor.

TABLE 8: SUMMARY RESULTS OF THE ACCURACY MEASURES

Variables	RMSE	MAE	MAPE
2 SMA	0.0165	0.0248	0.0148
3 SMA	0.0152	0.0289	0.0123
5 SMA	0.0087	0.2782	0.0215
10 DSMA	0.0074	0.2647	0.0266
20% EMA	0.0127	0.0146	0.0271
30% EMA	0.0177	0.2164	0.0211
MCS	**0.0048**	**0.2011**	**0.6124**
ANN	**0.0084**	**0.3124**	**0.9421**

Interpretation

The above table represents the Accuracy Measures of all forecasting Techniques namely, Mean Absolute Percentage Error, Root Mean Squared Error, Mean Absolute Error. The table represents the values of (SMA for 2,3 and 5 Days, EMA with 20% and 30% Damping Factor). The RMSE, MAE and MAPE for Monte Carlo is, 0.0048, 0.2011, 0.6124. The RMSE, MAE and MAPE for Artificial Neural Network is 0.0084, 0.3124, 0.9421.

1.8 FINDINGS AND CONCLUSION

This study investigates the accuracy of the forecasting abilities of the Monte Carlo Simulation and Artificial Neural Networks, considering the Daily Data of the Volatility Index of India from the period of January to December of 2019. According to the Analysis and Interpretation, comparing the numbers of both the models, the study indicates that the traditional methodology of Monte Carlo Simulation outperforms the Artificial Neural Networks and is more reliable than Artificial Neural Networks in terms of the accuracy in predicting the stock prices as the error terms from RMSE, MAPE and MAE of Monte Carlo Simulation is lesser compared to error terms of Artificial Neural Networks. Further studies can also be conducted in similar ways. However, the study includes the comparison of two models, advance techniques can be incorporated using econometric models using a larger data set as this study includes only the daily data of Volatility Index of India for 1 year. Henceforth, there could be a possibility where the Artificial Neural Networks can be a better option and might as well outperform the traditional methodology of the Monte Carlo Simulation when the study is conducted with the inclusion of a larger data set.

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