



A Literature Review on Machine Learning Applications in Financial Forecasting

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ARTICLE INFORMATION

Received: June 26, 2020
 Revised: July 09, 2020
 Accepted: July 11, 2020
 Published online: July 31, 2020

Keywords:

Financial forecasting, Machine learning, Time-series analysis

ABSTRACT

Analyzing the past trend and predicting the future movement is an important aspect for every business. Knowing the future value makes an organization more efficient in planning specially if it is related to financial factors. This can be achieved by analyzing the historical data of the company. This is called time series analysis. The increased application of computer and information technologies has made this more effective and accurate which is called machine learning. Methods of Machine Learning (ML) have been proposed as alternative approach to statistical methods by many researchers in their academic literature. This paper presents a review of the works where the authors have used machine learning techniques in financial forecasting.



DOI: [10.15415/jtmge.2020.111004](https://doi.org/10.15415/jtmge.2020.111004)

1. Introduction

Time series analysis and financial forecasting is not a new concept. This has been in practice for a long period. A large number of research works are found on time series analysis. The authors themselves have published a number of works on time series analysis (Singh *et al.*, 2009; Gupta *et al.*, 2012; Singh and Chauhan, 2009; Bano *et al.*, 2014; Singh *et al.*, 2014; Sarangi *et al.*, 2010; Sarangi *et al.*, 2010; Singla *et al.*, 2019; Sinha *et al.*, 2019; Sinha *et al.*, 2019). Three prominent categories of forecasting tools are straight-line method, moving average method and regression method. The following Table 1 gives an insight to the factors related to these tools.

With the increasing application of information technologies, these statistical methods now a days have been replaced with techniques based on machine learning such as Artificial Neural Network (ANN). The following section describes various works on financial forecasting using ANN.

2. Review of Works

Singh *et al.* (2009) evaluated the use of Artificial Neural Networks (ANN) and Genetic Algorithm (GA) as a predictive method for forecasting load demand for three days and comparing outcomes. In this analysis, the capacity of Neural Network (NN) models and Genetic Algorithm-based neural Networks (GA-NN) models to predict future demand for electricity is tested using two separate techniques such as back propagation algorithm and genetic algorithm based back propagation algorithm (GA-BPN). The study found that the method of genetic algorithm-based back propagation is a good predictive tool for electrical load forecasting in the case of SLDC short-term load forecasting.

Gupta *et al.* (2012) focused on ANN technology applications to power systems in the forecast areas and overcoming the limitations of other approaches used for electrical load prediction. The findings obtained

Table 1: Factors related to the tools

Sr. No	Statistical Techniques	Use of Approach	Math involved	Requirement of Data
1	Straight line method	Constant growth rate	Minimum level	Historical data
2	Moving average method	Repeated forecasts	Minimum level	Historical data
3	Regression method	One independent with one dependent variable or more than one independent	Statistical knowledge required	A sample of relevant observations

that ANN and GA 's definition of hybridisation performed really well. The tests of GA-BPN have the least predictive bias and are considered to be the most effective method for forecasting .

Singh *et al.* (2009) investigated the use of Genetic Algorithm (GA) techniques to assess weights for short-term load forecasting in a back propagation network (BPN). Through this work, the author concluded that selection of other parameters and network structure usually affects the result.

Bano *et al.* (2014) has made an attempt to assess the development of the Indian car industry over the three years (up to 2015-16) using a statistical method. For different categories in the car market, an average growth rate of 6 to 11 percent has been recorded. The findings reflect despite the numerous ups and downs in recent years, their studies show positive growth across all segments.

Singh *et al.* (2014), made an attempt to analyze Indian spice industry's past export trends. Review of past pattern suggests erratic development for the spices industry. The results showed positive growth in area and development of spices.

Sarangi *et al.* (2010) analyzed the use of ANN as a tool for prediction, along with various existing techniques for prediction such as regression. Results suggested that the ability of Back Propagation (BP) algorithm-trained ANN models to forecast future electricity load performed best.

Sarangi *et al.* (2010) explored the use of Artificial Neural Network (ANN) as a predictive method for predicting future demand for electric loads and the effect of different numbers of neurons in the hidden layer in a three-layered ANN architecture.

Singla *et al.* (2019) made an attempt to develop a forecasting model for India's Consumer Price Index for the period of May to December 2018. The outcomes revealed that ANN produces better results in terms of prediction.

Sinha *et al.* (2019) analyzed the impact of different neural architecture and parameter combinations by applying ANN as a forecasting tool using Zaitun Statistical Package. The results showed that the architecture with 12 hidden layer neurons and a learning rate of 0.03 produced the minimum error.

Sinha *et al.* (2019) analyzed the effectiveness of Neural Network models in forecasting the Consumer Price Index. The author used 144 out of 159 data points for network training in this research work and 15 data sets were used for validation. Neural network works very well and gave the best results in terms of forecasting.

Shaikh *et al.* (2012) presents a review paper on Financial Forecasting using Neural Network and Data Mining Techniques. The authors have discussed various data mining techniques and finally concludes that Back Propagation (BP) neural network is one of the most

suitable tool to be used for financial forecasting.

Özgür *et al.* (2017) presents a review paper on Stock Market Prediction Performance of Neural Networks. In their paper the authors have presented a detailed review of works done in stock market prediction using ANN. According to the authors, ANN also produces more better result when it is used in combination with other statistical or machine learning techniques.

Tripathi *et al.* (2014) presents a paper on using of Artificial Neural Network in Stock Exchange Market. According to authors Neural Network is a better performer than the traditional methods. The improved and effective algorithms of the Neural Network is able to increase the efficiency and to classify the unknown pattern. This is why Neural network tools are getting popularity in area of Financial forecasting.

Authors like Guresen *et al.* (2011) have implemented three different approaches for stock market index prediction. The methods are: (i) Dynamic artificial neural network. (ii) Multi-layer perceptron. (iii) The hybrid neural networks. According to the authors, the ANN model performs better than dynamic artificial neural network with a little difference.

Guan *et al.* (2018) have introduced a hybrid market price forecasting method called the High-Order Fuzzy-Fluctuation-Trends-Based Back Propagation (HTBP) neural network model. There are some novel aspects to the proposed model: (i) Neural network algorithm and fuzzy set theory are combined to avoid over-fitting problems in traditional models. (ii) Back propagation algorithm can sensibly analyze external policies for the real existence of sequential records, without taking into account the major factors of particular laws and the course of action. (iii) If the proper treatment will be given then hybrid model will fairly eliminate noise from the internal rules.

Kara *et al.* (2011) introduced a paper on predicting stock price index variations using ANN and SVM for the exchange of Istanbul stock. The research sought to emerge two efficient models and contrasted the performance for the prediction of the variations of Istanbul Stock Exchange 's National 100 Index (ISE) daily. The models built on ANN and SVM classification techniques. Experimental findings showed that the average efficiency of the ANN model recorded 75.74 percent was found to be slightly higher than that of the SVM model i.e., 71.52%.

Moghaddama *et al.* (2016) uses artificial neural network to portray a paper on stock market index prediction. In this research, it investigated the capability of ANN to forecast the regular NASDAQ stock exchange rate. Several FFNN were conditioned by the back-propagation algorithm were evaluated. The method employed in this analysis took into consideration inputs from both the short-term historical stock prices and the weekday. The daily exchange rates for NASDAQ stocks

from 28 January to 18 June 2015 are used for model development. The initial 70 days are chosen as the training dataset (January 28 to March 7), and the last 29 days are used to test the predictive potential of the proposed system. NASDAQ index prediction networks were developed and validated for two input data set forms (four days before and nine days before).

Maditinos *et al.* (2016) introduces a review paper on the use of neural networks in forecasting. In their paper, the authors presented a summary of the literature on NNs applied to financing issues, focusing mainly on modeling. The study concluded that ANN offers the traditional linear methods with a promising alternative approach. Yet while ANNs deliver a lot of promises, they also embody a great deal of uncertainty.

Pawha *et al.* (2017) conducted a review work using Machine Learning on stock prediction. This paper addresses the suitable machine learning algorithms for such an application; as well as discussing what current tools and techniques are best suited for its implementation. The study recommends using linear regression and logistic regression for stock prediction and stock analysis, and this study recommends SVM to get precise results. A limitation to this hypothesis is the need to be considered friendly by the dataset used in prediction. The paper summarizes the tools that can be used for implementing algorithms in machine learning. All tools support algorithms of regression and classification, so users can pick any method based on their familiarity and convenience. The paper suggests a system for extracting knowledge from data and making a prediction to advise the consumer on investments.

Qui *et al.* (2016) introduces a paper on Artificial Neural Network Application to predict returns on the stock market. The dataset used was of Japanese stock market scenario. Due to the non-linear behavior of the time-series, exact stock-market return forecasting is a very challenging task. In the study, authors use ANN that can map any non-linear function without predicting the return of the Nikkei 225 index. (i) The authors suggested a new set of input variables to increase the efficiency of the prediction algorithms for the ANN models, (ii) Classical back-propagation (BP) learning algorithm was used to predict the returns of Nikkei 225 index to validate the predictive capacity of the selected input variables. (iii) Global search methods, i.e. a Genetic Algorithm (GA) and Simulated Annealing (SA) are used to increase the accuracy of ANN predictions and solve the BP algorithm's local convergence problem. Evidential tests analyze the selected input variables were beneficial for forecasting the returns on the stock market. A hybrid approach based on GA and SA improves predictive accuracy and surpasses the conventional BP training algorithm.

Aiken (1999) suggested another model to forecast

CPI by ANN using the Producer Price Index (PPI) and preceding data on economic indicators in the USA. The study revealed that the CPI level was predicted by the neural network with a greater precision than any other statistical technique.

Choudhary and Haider (2003) checked the strength of ANN models to forecast monthly inflation levels for 28 countries. The research was presented using two ANN techniques and two quasi-ANN techniques. The models were run for data set comprising of three months. It was found that on an average for approximately 45% countries (13 countries) the ANN model gave superior prediction while AR1 model proved to be a better performer for approx 21% countries i.e. 6 countries. For the remaining 9 countries the results were not very distinct.

Neural Network model performance was compared to conventional econometric models for forecasting inflation level (Moshiri *et al.*, 2000). In this analysis, they used the ARIMA model, an auto-regressive vector model, and a Bayesian vector self-regression model. These models were compared using the same set of variables to hybrid BPN model. Projections were made for one, three, and twelve months and comparisons were made based on RMSE and AME to measure the value of the forecast. Hybrid BPN models were found to be as successful as any other standard econometric model, and were found to be better in some cases.

In another neural network-based and linear comparative study, 'thick' models based on Philips-curve formulations were used to predict inflation in the US, Japan and Euro region. In 'Thick Model' are expressed the 'Trimmed-mean' forecasts from multiple models. These linear models has shown outstanding performance for "Real-time" and "Bootstrap" forecasts for service indices for the european region and were found to be better in a variety of countries for the more general business and commodity price indices (McAdam *et al.*, 2005).

Muskaan *et al.* (2020) in their paper have made the prediction of ICICI bank using Artificial Neural Network (ANN). The authors have concluded that ANN is a better choice for stock prediction however, selecting a suitable architecture is a challenging task.

3. Findings of the Review and Conclusion

The main objective of the paper is to study the research works where the authors have applied machine learning techniques in financial forecasting. In this work a selective number of research works (published between 2000 to 2020) have been studied. From this study, it is found that, though statistical methods are very popular and widely used methods for financial forecasting still there has been a big shift towards the use of artificial intelligence and machine learning techniques. Among various machine learning techniques, ANN, SVM are some very popular methods and widely used by researchers. At the same

time, researchers also have suggested the hybridization of these methods with GA and PSO for better accuracy.

Finally, it is concluded that in the field of financial forecasting, statistical methods have their own importance and value however, machine learning techniques are also getting popularity and also providing better accuracy in many cases in comparison to other widely used methods.

Acknowledgements

With deep sense of appreciation I acknowledged the guidance and encouragement received by Dr. Pradeepta Kumar Sarangi, Professor, Chitkara University. I also express my heartfelt gratitude to Mr. Sunny Singh who supported and inspired me during the research work.

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Journal of Technology Management for Growing Economies

Chitkara University, Saraswati Kendra, SCO 160-161, Sector 9-C,
Chandigarh, 160009, India

Volume -11, Issue-1

April 2020

ISSN 2456-3226

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