Stock price prediction based combined neural networks approach and comparison to artificial neural networks

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ABSTRACT

Stock price forecasting is a prominent phenomenon for investors and other financial information users. Indeed, stock price prediction has been regarded as an interesting yet challenging process in the advanced world of business. Various economical or non economical factors have effected on stock market behavior, hence stock price forecasting is recognized as one of the most complicated subjects in business. In past, statistic-based methods were suggested to solve this problem. In recent decade, nonlinear based fuzzy time series models methods, artificial neural networks, fuzzy neural networks and combined prediction models have been recommended. There have been permanent debates about different methods of forecasting precision among those authors who selected artificial intelligence in forecasting. Therefore comparative analyses are crucial. This study by applying neural networks and minimizing stock price forecasting error designs and provides stock price forecasting model, in comparison to combined artificial neural networks technique. Results show that the combined neural network model forecasts more appropriately and is faster with higher estimation capability in stock price forecasting in relation to single neural networks.

Introduction

Decision making that is defined as choosing the best solution out of existing various solutions requires recognition and assessing current solutions. Assessing needs a criterion to scale different alternatives so that select the most relevant options. Forecasting is the essential element of control and decision making process. In other way, it has a positive, direct relation to decision making risk, i,e. much precision may lead to less risk or loss due to decision making in non confidence conditions. Decision to buy new stock and/or sell current stock needs accessing to oncoming stock market price information; therefore if it is possible to predict upcoming stock market price procedure by some methods; economical decisions will be made based upon information, therefore the loss or risk of investment may reduce(5).

Stock price prediction and assessing financial behaviors are appealing since they have been always focused by investors and brokers. Numerous assumptions are presented to forecast stock price behaviors that always include mistakes and deficits. Of the most influential as well as the best model in forecasting procedure is Neural networks which were succeeded by technology and science progress particularly software, and are in great focus due to low level of error in calculation: as has effected on using classic methods. Neural networks have different algorithms with various applications in different models. Combined models are regarded as significant model with low error. Combined (integrated) models created through a combination of several models with broad application, by integrating some classical methods and artificial intelligent in previous studies including Morris(1977), Macris(1983),

Agno(1985), Milton(1987) and Dockeri(1996), got less error in forecasting(5).

As a result this study has been discussed to answer the questions whether stock price in exchange stock market in what level and with low error predictable? And can we predict upcoming stock price more preciously through applying integrated neural networks? Study hypothesis according to aforementioned questions are following: integrated neural networks model may reduce stock price forecasting error in Tehran stock market.

Literature review

Forecasting price in stock market of all different countries is done by substantial progresses in artificial intelligence and computer. Artificial intelligence techniques consisting of neural networks, genetic algorithms and fuzzy logic achieved successful results in forecasting financial events. In 1988, Hulbert White initially introduced the concept of applying neural networks in economic predictions, which tried to detect the latent system in capital properties historical prices. Since daily performance of IBM corporation stock was used as a specific element; the role of statistical deductive methods and learning approaches in neural networks are presented as two complement elements (4).

There were numerous studies in all countries around the world including Iran followed by white's investigation. Khaloo zade and Khaki in 2003 by defining three forecasting approaches, ultimately presented effective suggested structure of neural networks in short and long term processes. Comparative analysis of neural networks power with technical indexes

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analysis inputs in forecasting stock price in 2005 by Motavaseli and Kashefi are considered as those investigations comparing neural networks results to traditional methods results, which showed better performance in neural network. Fuzzy neural network critical role in forecasting stock price has been used in another study which with unique features was prominent over ARIMA model in all occasions (1). Chih-Feng Liue in 2012 by applying second type fuzzy neural model forecasted stock price that show the results, efficacy and efficiency of fuzzy neural modeling in predicting stock price. Referenced articles indicate great application of neural networks in forecasting stock price approaches which roughly show the prominence of artificial intelligence methods over classic; therefore author decided to use different neural networks through used approaches.

A new approach has been offered since the 70 decade that considers forecasting methods combinations. In other words, a set of forecasting methods are used instead of only one forecasting approach. There have been lots of efforts to get an optimum method to combine predictions approaches and most authors applied combination forecasting as a measure to minimize forecasting error. Biits and Granger (1996) were pioneered in developing the basis (foundation) of combinational forecasting approaches. Scholars predicted the precious stock price through providing different models with complicated structures and using various algorithms in a system, in recent years. The system predicted the price just by one index information (mostly stock price) or utilized several indexes as input to a multi input network. Pai &lin in 2005 predicted stock price in Taiwan through an ARIMA hybrid model and support vector machines model. The calculation results of this study are promising. Amano and et al, in 2005, presented a study titled the architecture neural network hybrid model and genetic algorithm to predict stock index (indicator). The genetic algorithm may control the neural network performance. Rafael Hassan and et al (2007) published a study *stock price forecasting through combinational Markov chain model, neural network and genetic algorithm* in university of Melbourne. Input data, through neural networks, are converted to Markov chain input data, and initial parameters of Markov chain are optimized by genetic algorithm. Chih – Ming Hsu (2011) investigated the integration of neural network and genetic programmer so that provide a comprehensive approach in solving current problems in stock price forecasting. The findings demonstrate that the suggested integration method is applied as the practical and efficient tools in forecasting stock prices. Mirzazade and Tavakoli Mohammadi (2011) forecasted stock price by using artificial neural networks. They have developed an innovative model based upon neural networks to predict stock price behavior. Utilizing stock market different data in order to achieve better results in forecasting are regarded as the study goals. Experimental results indicate the high precision of suggested model.

Explaining applied model

Neural networks are the best methods for stock price forecasting since are ideal tools which utilize statistics and learning based experiences as well as regarding intrinsic aspects. Neural networks learn patterns and procedures without any formulation or special method based upon historical data. This method through imitating brain function may simulate most of aforesaid brain abilities such as pattern recognition, establishing the communication and the expanding through observations. Neural networks are sampled in terms of biological neural networks with brain structure. An artificial neural network is composed of many nodes and directed lines linking the nodes. Information will enter network through input nodes, then linkages connect them to hidden layers, finally network output is achieved by output layer nodes.

Applied models and successful models in predicting financial events have been selected according to neural networks of referenced articles and previous investigations, respectively. Three successful neural networks in this area are as following:

Multilayer Preceptron network (MLP):

A structure of neural networks consisting input layer, output layer, median or hidden layer which are well known since great ability in prediction. Signals stream are transformed from input layer to median, then output layer and there would be no returned signal (3).

Generalized feed forward (GFF):

In fact, this network is a generalized form of preceptron neural network with higher efficacy and flexibility and similar algorithm and performance. Better performance of this model in comparison to MLP is the goal of investigating this model. This model has the ability to skip the signals from initial layers to others which demonstrate its ability in signals analysis (3).

Fuzzy neural networks (Adaptive Neuro-fuzzy inference systems) (ANFIS):

Combination of artificial neural networks and fuzzy logic may result in implementing a fuzzy system with the learning capability in which compute nodes output normally to the last layer in each instruction cycle in forward movement, then the result parameters will be calculated by least mean square errors method. The ratio of error over distributed limitation parameters and through error descending gradient is then corrected after error estimation in backward return (1).

Model implementation

There are two different scenarios to implement models which state the results:

1. Forecasting stock price by mentioned networks
2. Forecasting stock price by integration(combination) approach

The models were implemented by Tehran stock market information and data. In this way the information of Iran Khodro Company and Alborz Daroo were used as the input information to all three networks, including highest price, lowest price, price average, transactions volumes, price changes, daily transactions times, the ratio of daily transaction to company's total stock numbers, the numbers of people who transact stock in one day and stock yesterday price. The time period was investigated daily from 03/20/2006 to 03/19/2010. Due to high data content and using combined model approximately 80% of collected data were applied for instruction and the remaining 20% to test network performance. Algorithms performances were evaluated in terms of four error criteria of 'Mean Square Error (MSE)' , 'Normalized Mean Square Error(NMSE)', 'Mean Absolute percentage Error(MAPE)', 'Coefficient of Determination(R^2)'.

Forecasting by multilayer preceptron network:

Applying training data in preceotron neural networks need to determine first the numbers of inputs, numbers of hidden layers, and the numbers of neurons in each hidden layer and as a whole inner structure of preceptron neural network; which is selected by trial and error a Generalized feed forward neural network 1-5-10 post spread error. In this repeated training method has been tried to provide the best result by the least errors, through different numbers of hidden layers and repetitions numbers, which are as follow

Table 1

R2	MAPE	NMSE	MSE	Name of company
0.85951	0.0519	0.06485	0.1675	Iran Khodro
0.85514	0.0501	0.6348	0.1567	Alborz Daroo

Forecasting by Generalized feed forward:

Applying training data into feed forward neural networks first require determination of input numbers, the numbers of hidden layers, and the numbers of neurons in every hidden layer and altogether the inner structure of feed forward neural network. We have tried to consider feed forward networks' parameters identical to preceptron network, as the comparison of two preceptron and feed forward networks in forecasting stock rate in later stages.

Table 2

R2	MAPE	NMSE	MSE	Company's name
008782	0.0482	0.04617	0.1185	Iran Khodro
0.8605	0.0418	0.4479	0.1057	Alborz daroo

Forecasting by fuzzy neural network:

Specifying parameters are necessary to apply training data in fuzzy neural networks. Table 3 illustrates these parameters.

Table 3.Fuzzy neural input parameters

Type	Parameter
Sugeno	The type of fuzzy system
Hybrid	Optimization method
Grid Partition	Separation technique
1000	The numbers of periods
5	The numbers of independent variables' membership functions
Gaussian	The type of independent variables' membership function
Linner	The type of dependent variable membership function

Error values and real values comparison are shown

Table 4

R2	MAPE	NMSE	MSE	Name of company
0.7519	0.0805	0.8512	0.7418	Iran Khodro
0.7494	0.0798	0.8418	0.7355	Alborz Daroo

Forecasting by integrated (combination) approach:

In combined method, the best and the least error type of networks in three previous states are chosen to minimize forecasting error.

As you seen generalized feed forward neural network has the least error in forecasting hence is used as combined model. The integration is done in a way that in addition to input data, the output of approach with better response in terms of performance criterion may enter to the regarded network and are measured based upon evaluation criterion. Therefore all networks outputs will in order enter to networks as inputs then extract a unit output. The previous default of generalized feed forward in all layers has been used in designing combined neural network. The ultimate results are illustrated in table 5 and the following diagram:

Table 5

R2	MAPE	NMSE	MSE	Company's name
0.9625	0.0305	0.2741	0.0584	IranKhodro
0.9602	0.0298	0.2699	0.o573	Alborz Daroo

As it is shown, the combined method has less error and more performance in forecasting. The difference of this model to models in other studies is applying combined method in artificial intelligence and combination of different neural networks that avoid integration of classic and traditional methods to achieve the better conclusion, in other way it has been tried to use optimally all defaults of previous studies in forecasting financial events through neural networks.

Conclusion

This study has been done to minimize forecasting errors by neural networks applied in predicting financial events and presenting an ultimate combined method of them. The results of three neural networks comparisons by combined method demonstrate substantial reduction in forecasting error. This phenomenon indicates other investigations in the area of forecasting financial combined events which lead to better results due to using artificial networks instead of classic and traditional methods.

Reference:

1. Azar, Adel, Afsar, Amir (2006), sampling stock price forecast through fuzzy neural networks approach; commercial bulletin magazine, 40: 33-52.

2. Khaloozade, H., Khaki, A., (2003), stock price forecasting by linear and non linear methods in neural networks, accounting bulletin magazine, 64: 43-85.

3. Khamooshpoor, B., (2010), combined presentation of stock price forecasting to predict stock market index, the 4th Data searching Conference, Iran, Sanati Sharif, Uni.

4. Raei, R.,(2001)., Neural networks, A Novel Approach in management Decision making, Modares, fifth edition, 21: 133-154.

5. Forghani, H., Azizkhani, M., (2005). The efficacy of combined methods in stock price forecasting in Tehran stock market, Isfahan University economical magazine, 17th year, first num.

6. Mirzade, H. Tavakoli Mohammadi, (2011). Stock price forecasting by Combined neural networks, industrial management season magazine, Sanandaj Azad University, Humanity faculty, 15: 125-138.

7-Chang, P, C., Liu, C, H.,(2008), A TSK type fuzzy rule based system for stock price rediction, Expert Systems with Applications 34: 135–144.

8-Chen, T,L., Cheng, C,H., Teoh, H, Jong., (2007), Fuzzy time-series based on Fibonacci sequence for stock price forecasting, Physica A 380: 377–390.

9.Chih-Feng Liu, Chi-YuanYeh ,Shie-Jue Lee ,(2012), "Application of type-2 neuro-fuzzy modeling in stock price prediction", Applied soft computing12,1348-1358

10.Chih-Ming Hsu ,(2011)، "A hybrid procedure for stock price prediction by integrating self-organizing map and genetic programming"،Expert system with aplication،38،14026-14036

11.George S. Atsalakis ,Kimon P. Valavanis(2009) 'Forecasting stock market short-term trends using a neuro-fuzzy based methodology' Expert Systems with Applications 36 (2009) 10696–10707

12.Pai, P, F., Lin, C, S.,(2005). A hybrid ARIMA and support vector machines model in stock price forecasting, Omega 33:497 – 505.

13.Wang, Y.H.,(2007). Nonlinear neural network forecasting model for stock index option price: Hybrid GJR–GARCH approach, Expert Systems with Applications, Vol 36, Issue 1, 564-570

14.Yu, L., Chen, H., Wang, S., & Lai, K. K. (2009). Evolving least squares support vectormachines for stock market trend mining. IEEE Transactions on Evolutionary Computation, 13(1), 87–102.