



## Predicting the stock price companies using artificial neural networks (ANN) method (Case Study: National Iranian Copper Industries Company)

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### ABSTRACT

The purpose of this research is the model fitness of predicting the companies' stock price using artificial neural networks (ANN) method of multilayer Perceptron with back propagation algorithm. The research population is Tehran Stock Exchange and National Iranian Copper Industries Company is considered as research sample.

In order to model fitness, predicting of two cases is considered, in the first case, predicting occurred based on independent variables including the Tehran Stock Exchange price index, the price index of operating companies in the field of basic metals, the dollar exchange rate to Rial and monthly inflation rate and in the second case, predicting occurred based on the time series of past prices.

The model of predicting stock price of National Iranian Copper Industries Company in the next day was studied and analyzed for each case individually on the fitted training data collection and then performance of fitted models in two cases, on the total testing data based on measuring criteria of error including mean absolute percentage error (MAPE), mean squared error (MSE) and root mean square error (RMSE). Evidence indicates the superiority of the predictive power of artificial neural network based on time series of the past prices. And to provide the predictive model the powerful software of MATLAB2014 is used.

**Keywords:** predicting price, stock price, artificial neural networks (ANN), back propagation algorithm

### INTRODUCTION

There are different models in the field of financial for optimal investment that gives the investor the power of assessment and decision-making. Models of technical, fundamental, Capital Asset pricing Model (CAPM) and arbitrage are, including predictive models and justify the stock price.

Multi-factor models are designed to simplify the necessary data creation for portfolio analysis and deficiencies of single index models. A group of scholars have started the multi-index models with single-index models and then have entered the effects of industry and inflation rate, etc into the model. Including the research can be noted to research of Elton and Gruber.

The result of research shows that despite more elaboration of model and addition of various indicators, unfortunately in the future prediction, due to increasing deviations from entering multiple indicators, compared to the obtained benefit have not had them.

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To cite this article: Hashemi, M., Ravanpak Noodezh, H., Valinia, S.N. (2016). Predicting the stock price companies using artificial neural networks (ANN) method (Case Study: National Iranian Copper Industries Company). *Academic Journal of Accounting and Economic Researches*, 5 (2), 55-61.

The idea of using neural networks in the economic predictions was raised first by Halbert White in 1988. The research tried to discover the hidden system in the historical prices of capital assets. So, daily stock returns of IBM company is used as a special case and the role of statistical inference methods and learning methods is raised in neural networks as two elements of complement. In another study, Takuha, Yoda, Asakava and Kimoto in 1990 launched the system of predicting stock market in which the neural network was used. In this study, while comparing expert systems and neural network systems, nonlinear learning of neural networks was mentioned as the high ability of the network<sup>1</sup>.

After it many researchers proved the successes of neural networks in various forms such as<sup>2,3,4,5</sup>.

A reflection on literature and conducted research show that by ability of neural networks in learning the nonlinear systems and chaos, it is likely that compared with traditional analysis and other methods that have basic of math, perform better<sup>6</sup>. By expansion of neural networks, researchers and investors seek to open the unknown nodes of market. This study attempts to find a solution for the analysis of mentioned nodes and on this basis it can be said that the main problem of this research is to understand how to predict the stock price of operating companies in Tehran Stock Exchange. Turning to the mentioned issue can state the original research question as:

\*Can predict the stock price of operating companies in Tehran Stock Exchange for the coming days?

## METHODS

### In the present study the following factors:

- \* price index of Tehran Stock Exchange
- \* price index of active companies in the field of basic metals
- \* inflation rate
- \* currency rate (Dollar exchange)

As independent variables and stock price of National Iranian Copper Industries Company in the coming days will be considered as the dependent variable.

This research is applied objectively and in terms of data collection is descriptive, so the used data in the study are extracted of the central bank's Internet database, website [www.tsetmc.com](http://www.tsetmc.com) of Tehran Exchange Technology Management Co., the website [www.tse.ir](http://www.tse.ir) related to the Tehran Stock Exchange, OPEC's official website <http://www.opec.org> and other library materials.

### Society and statistical sample

The population of the research is Tehran Stock Exchange and National Iranian Copper Industries Company has been selected as the sample company. Data related to dependent and independent variables over five years (beginning of 2010 to the end of 2014) are collected and divide into two categories: training and testing data. Data from 2010 to the end of 2013 are used to teach and model fitness and the data related to 2014 are used to investigate the efficiency of fitted model.

As mentioned, in the research including predictive models, to measure the fitted models and compare their results, collected data are divided into two parts of training and testing data.

Because neural networks to train need a large number of data, equivalent to approximately 80% of the survey data, related to 965 workdays as in total training (workdays of stock from the date of 01.01.2010 to 29.12.2013) and 20% of data remaining related to 241 working days (working days of stock from the date of 01.01.2014 to 29.12.2014) are selected as the total of the testing.

In order to answer the questions and hypotheses, two cases will be investigated below:

1. Predicting stock price of National Iranian Copper Industries Company in the future working day based on the affecting independent variables
2. Predicting stock price of National Iranian Copper Industries Company in the next working day based

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on the time series of past prices

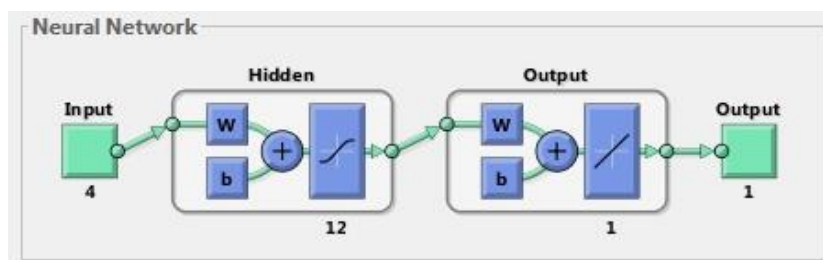
### MODELING

The following pattern to categorize of total data of training, is given to the software:

1. Collection of training or learning data, including 80% of all records
2. Collection of evaluation, including 10% of all records
3. Collection of test, the network includes 10% of all records

Then, for each of the cases, first the results and outputs of the software are estimated in the form of table and related graphs and then analyzed it.

In this case, the model fitness of predicting the stock price of National Iranian Copper Industries Company in the next day is done based on total data related to 4 independent variable of current day. Thus, according to Figure 1, the network with architecture 1-1-12-4 (numbers from left are: the number of input variables, the number of hidden layer neurons, and the number of output layer neurons and output variable) is created and taught.

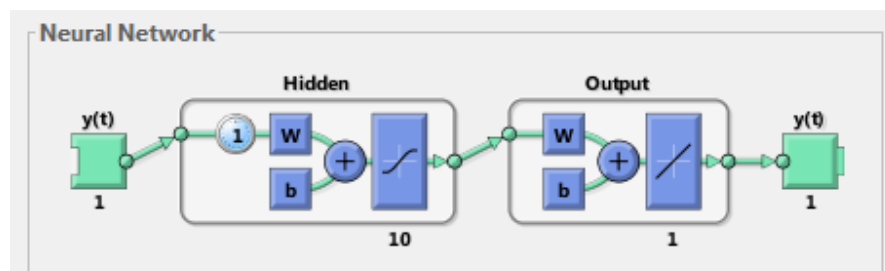


**Figure 1.** The architecture of the trained neural network to predict future stock price based on independent variables

In this case, the model of predicting stock price of National Iranian Copper Industries Company in the next day is fitted based on the past prices.

In this part, model of predicting based on the stock price of National Iranian Copper Industries Company is fitted in 6 past days.

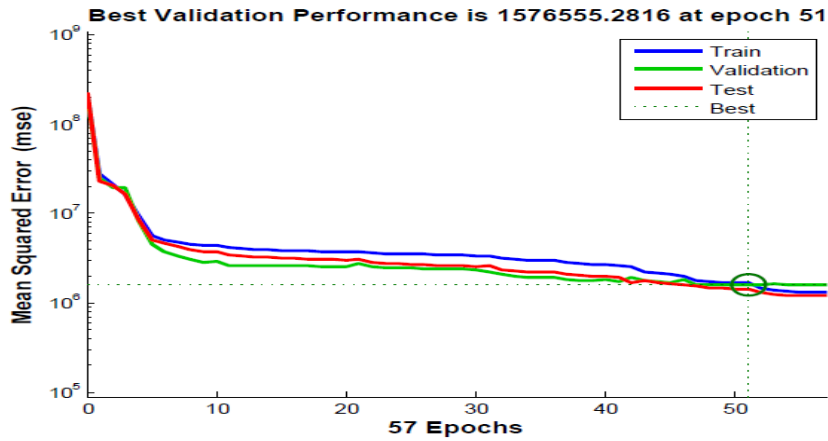
Thus, according to Figure 2, a network with architecture 1-1-10-1 is created and thought.



**Figure2.** Architecture of trained neural network to predict the future stock price based on the time series of past prices.

Network after 57 repetitions in the repetition of 51 reaches to the optimal solution, and the training stops. Network performance in the training course is evaluated on total training data.

RESULT



Graph1. Network performance in the learning course based on the structure 1-1-12-4

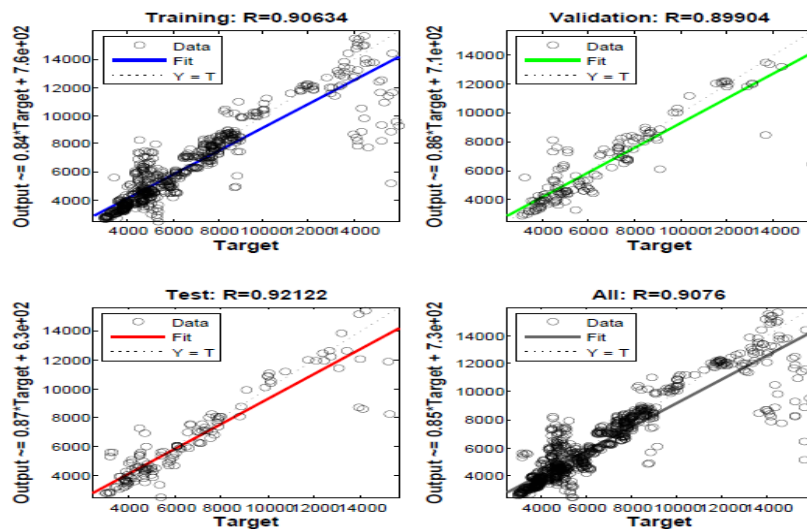
The MSE and RMSE amount and also correlation coefficients and determining the trained network are shown in Table 2.

Table 2. Error, correlation coefficient and determination

Input data	The number of data	MSE	RMSE	R2	R
Training	675	1666693.27	1291.005	0.82138	0.9063
Evaluation	145	1576555.28	1255.61	0.808201	0.8990
Test	145	1440540.33	1200.225	0.848609	0.9212
Total	965			0.823738	0.9079

Trained network to predict the stock price of National Iranian Copper Industries Company in next day.

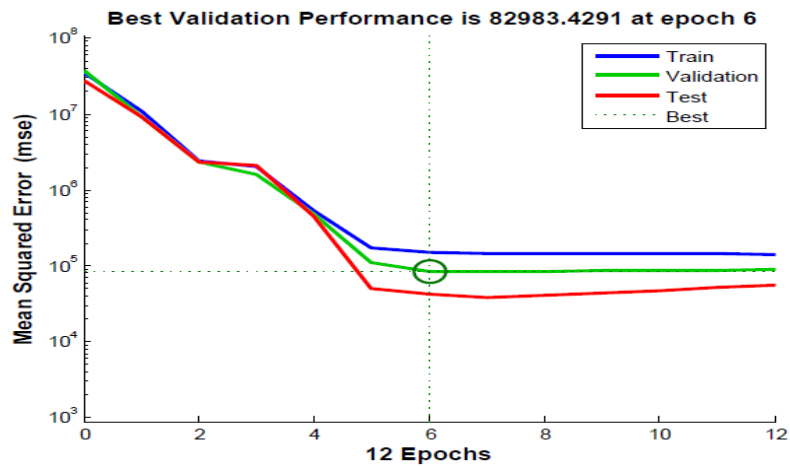
The R amount of trained network is shown in graph<sup>2</sup>.



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**Graph 2.** Regression analysis of output and goal in predicting the stock price of National Iranian Copper Industries Company in the next day

Network after 12 repetitions, in the repetition 6 reaches to the optimal solution, and the training stops. Network performance in the training course is evaluated on total data of training and test is shown in graph 3.



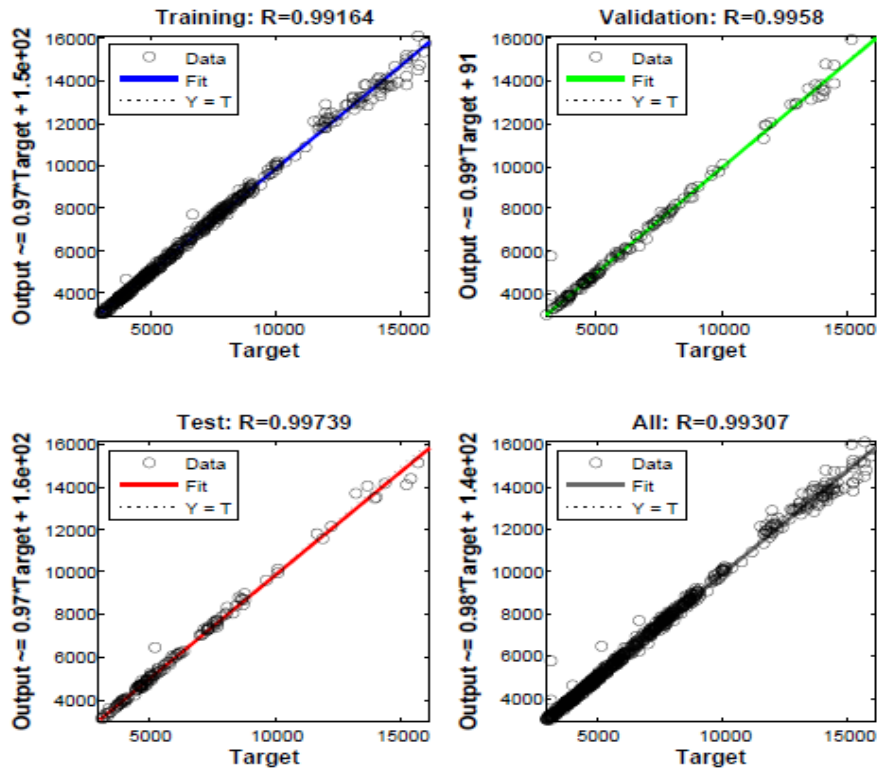
**Graph3.** Network performance in the learning course based on the structure 1-1-10-1

The MSE and RMSE amount and also correlation coefficients and determining the trained network are shown in Table 3.

**Table 3.** Error, correlation coefficient and determination in Trained network to predict the stock price of National Iranian Copper Industries Company in next day.

Input data	The number of data	MSE	RMSE	R2	R
Training	675	148701.31	385.6181	0.983271	0.9916
Evaluation	145	82983.43	288.0684	0.991618	0.9958
Test	145	43152.36	207.7315	0.994807	0.9974
Total	965			0.986248	0.9931

The R amount of trained network is shown in graphs 4.



**Graph 4.** Regression analysis of output and goal in predicting the stock price of National Iranian Copper Industries Company in the next day

## CONCLUSION

Analyzing the data, the following conclusions can be obtained:

1. Investigating the performance of the two models on the collection of test data indicates the success of artificial neural network method in predicting the stock price of National Iranian Copper Industries Company in the case of predicting based on time series of past prices (Mean absolute percent error 1.82%).

2. Failure to predict the price (the mean absolute percent error greater than 4%) based on independent variables of transition can be due to two major reasons:

- A. Affecting independent variables aren't selected correctly.
- B. Price volatility of Tehran Stock Exchange has a constant trend (Chartist view)

3. Student's t-test results show there is a significant difference between the obtained results of predicting the stock price of National Iranian Copper Industries Company in the next day.

4. Basically, one of the most important economic theories in the field of financial markets is the theory of unpredictability of the stock market price (random walk). Models of predicting price, in fact are considered as a challenge against this theory and trying to show that despite the more complexities in price trends, their future trends are predicted with an acceptable error level.

In this study and similar studies, large amount of R2 for fitted models indicates the capability of extracting the process structure of generating price in the market of Tehran Stock Exchange and this is in fact in the opposite direction of the efficient market hypothesis based on the randomness of prices in the market.

## FUTURE AREAS OF RESEARCH

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According to the presented material in the context of this research, the following suggestions for future research are proposed as:

Due to the failure of predicting the stock price based on the considered independent variables in this study proposed that in future research other independent variables can be investigated.

\* It is proposed in future research, predicting the stock price is predicted for a longer period (weekly or monthly).

\* In this study also the artificial neural network with back propagation algorithm and sigmoid function is used that proposed that use the other artificial neural networks and the results can be compared with each other.

\*Also proposed using artificial neural network models predict the price or price index of other industries or the price index of Tehran Stock Exchange and the results compare with the obtained results of mathematical methods.

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