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Predicting stock output of Banks listed in Tehran Stock Exchange using financial ratios with neural network approach

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A B S T R A C T

Timely prediction of stock output can help managers and investors to make better decisions. Nowadays, the use of innovative approaches to artificial intelligence in modeling and financial forecasting has become commonplace.

Banking industry, with 17 companies in Tehran Stock Exchange and OTC, is one of the groups paid attention by investors and especially risk averse people who except appropriate profit sharing and moderate rising slope of stock. This study aimed to investigate the prediction of stock output of Banks listed in the Tehran Stock Exchange using 7 financial ratios in the span of 2009 to 2015 with two approaches of Artificial Neural Networks (ANNS) and Support Victor Regression (SVR) as two techniques of artificial intelligence and data analysis and are used for prediction. Then, two methods were compared using the criteria for the function evaluation. The results of the study show that Support Victor Regression has better capability than the Artificial Neural Networks to predict stock output of Banks listed in Tehran Stock Exchange.

Keywords: predicting, stock output, artificial neural networks, support victor regression, financial ratios.

INTRODUCTION

One of the most important issues that researchers and scientists of decision making are confronted with is choosing effective variables on the on the decision output and prediction. Therefore, if stock output is predicted using appropriate variables and present models for that, a more certain condition is created in the stock market that will help the expansion of investment in the financial markets[1].

One of the main assets in the financial markets is the company's common stock, and the question for investors is whether future stock output can be predicted? Different models are created for modeling the relationship between the variables and their prediction such as analyses, regressions and time series. But according to recent studies, artificial intelligence methods are able to model non-linear relationships of variables with lower error percentage and due to the nature of the stock market variables, these models have been widely used recently to predict stock output in Stock Exchange[2, 3].

The aim of investors is maximizing the expected output. Although they want to decrease the risk, output evaluation is the only logical way (before risk evaluation) that investors can do to compare substituting and different investments[4].

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In each society, people are after enhancing their welfare and profit and output of an investment indicates the profit. As a result, the main factor that every investor pays attention to is output and the investor is after most profitable opportunities for his extra-resource investment in stock markets, if the decisions of stock market are made beneficial in the light of financial information, stock market will be efficient and resource allocation will tend to optimality and consequently the society economy will be more efficient and the realization of social objectives and creating welfare are made possible. So, studying stock markets is a necessary task in order for the efficient allocation of resources.

Artificial Neural Networks:

over the past decades, we have seen that Neural Networks have had a successful presence in managerial and financial issues and many articles are presented over the topic and the idea of education for solving the complex models' identification using intelligence data factor perspective is made challenging for the university researchers. Neural Networks are an intelligence device for a wide domain of management and cause the change in the point of view of the organization on the relationship between the data and company's strategy as a vital part of most data analysis systems[3].

However, the function of human brain and neurons can be as the most efficient and complete model for the identification of surrounding events due to million years of evolution. Over the years, neuroscientists and psychologists have tried to understand how the human brain works. This was an attempt to create artificial intelligence[5].

Research and interest in neurons was started when the brain was known as a dynamic system with parallel structure and a processor completely different with common processors. This modern attitude about the brain function was the result of thoughts created at the beginning of twentieth century about the brain structure as a colony of tiny parts named as neurons. The human brain is created of about 1011 (one hundred billion0 neurons among which 1014 to 1015 relationship is considered. It means that there is a very complex relationship network that cause human brain to act as a parallel processor[5].

There are several features in artificial neural networks that have made them attractive and at the same time valuable for prediction. Among which is the benefits that these networks have compared to conventional methods of anticipation (Zhang et al., 1998).

Of the main characteristics of neural networks compared to older models of prediction can be non-linearity and non-parametric features. Artificial neural networks are educable and have the ability to infer exactly a kind of functional relationships between the data the background of which for the usual methods of prediction is barely known or explainable[6,7].

These networks are considered data-centered structures compare to traditional methods and need less comparative assumptions for totalizing the results of prediction due to generalizability of the results.

METHOD

The aim of this study was objective, real, and ordered description of stock output characteristics and its relationship with financial ratios. Therefore, this study was descriptive and correlation-based in terms of nature because in this type of studies, the researcher seeks to evaluate the relationship between the variables. Financial statements and reports of banks published by Tehran Stock Exchange as weel as Rahavard Novin software were used to gather the required data.

Due to the limitation of the listed banks in Tehran Stock Exchange, the researcher has studied all the listed banks in Tehran Stock Exchange and there is no sampling done in this study. So, the population in this study included 17 banks as: Mellat, Tejarat, Saderat, Sina, Karafarin, Eqtesad Novin, Parsian, Pasargad, Sarmaye, Post Bnk, City Bank, Qavamin, Iran Zamin, Khavarmiyane and Hekmat Iranian Bank.

In this study, the dependent variable is the stock of listed banks in Tehran Stock Exchange.

Output in the process of investors is a driving force that motivates and is considered as a reward for investors. The total output is stock of the benefits that accrued during the year, the total of these benefits include:

1. The increase in stock prices at the end of the fiscal year compared to the beginning of the fiscal calculated year (first and last rate difference of fiscal year the of company's stock).
2. The gross dividend per share is paid in accordance with General Assembly resolution of equity after paying tax.
3. Advantages of primacy right to buy a stock that is ratable to value.
4. The benefits of dividend or bonus stock.

Calculating the Rate of Output

Earnings from the investment is divided by the initial investment amount to measure the rate of output on investment. Revenues from investment are composed of two parts:

1. The amount of received money for dividends or interest on bonds.
2. Capital gains or losses of investment arising from changes in stock prices over the course of Investment.

In fact, the result of subtracting the cash inflow from the outflow, will determine: "output rate on investment". That's mean:

$$\text{Rate of output} = \frac{\text{cash outflow-- cash inflow}}{\text{Cash outflow}}$$

Ouput on investment in common stock, at a given period, is obtained according to the first and last price and benefits of ownership. Revenues of property in the period that now, the Assembly is held, the shareholder will receive in periods in which the company has held assembly is allocated to the stockholder and in periods in which the company has not held

assembly, the ownership interests will be zero. Output of investment in the stock is calculated using 2-4 equation:

$$r_{it} = \frac{(P_t - P_{t-1}) + D_t}{P_{t-1}} \times 100$$

where in:

P t-1: The stock price at the beginning of t period or end of t-1 period.

Pt: stock price at the end of t period.

Dt: the benefits of stock ownership in t period is given to stockholders.

The benefits of ownership may be paid to stockholders in different forms the major ones of which are:

A – dividend

B - the capital increase of the reserves (bonus shares)

C - the capital increase of receivables and cash

D - stock split

E-the aggregate stock

For Case 1, equation 1-4 can be used to calculate the rate of output per share. For modes 2 and 3, the formula to calculate the rate of output will be as follows:

$$r_{it} = \frac{D_t + P_t(1+\alpha+\beta) - (P_{t-1} + C\alpha)}{P_{t-1} + C\alpha} \times 100$$

where in:

Dt: Cash dividend payment.

α: the percentage of capital increase from receivables and cash.

β: the percentage of capital increase from the reserves

C: Nominal value paid by the investor for raising capital from cash and receivables.

Of course, if the time of occurrence of each of these cases is before payment (convention), or in other words, if the extraordinary general assembly (in relation to the capital increase) is before the general assembly (in relation to the dividend), then the formula will be as follows:

$$r_{it} = \frac{[(D_t + P_t)(1+\alpha+\beta)] - (P_{t-1} + C\alpha)}{P_{t-1} + C\alpha} \times 100$$

For Mode 4, at the stock split, the company decides to reduce the nominal value of its shares, in which case the number of stock in the hands of the shareholders increases in proportion as the stock decomposition, and the price of shares decreases in the market in the same ratio.

In such circumstances, the stock output is obtained as follows:

$$r_{it} = \frac{SP_t - P_{t-1}}{P_{t-1}}$$

where in:

S: the number of new stock.

Nominal aggregation is a state in which the company decides to increase the nominal value due to the low nominal value. Consolidation or combination of shares, on the one hand reduces the number of stock and the increase in stock prices in the market on the other hand. Given that the stock price increase is not real in such circumstances and is caused by the accumulation of stocks, so the output adjustment factors appear with the "minus sign " in the equation:

$$r_{it} = \frac{[(1-1/Z)(P_t)] - P_{t-1}}{P_{t-1}}$$

where in:

Z: The number of stocks that are now converted into one share under the company Act[4].

INDEPENDENT VARIABLE

Independent variables is a variable that the researchers will measure its impact on other variables.

In this research, Banks' financial ratios, including 7 following ratios, have been used as independent variables in this study.

1.The capital adequacy.

2.The assets output .

3.The joint income ratio to total granted facilities.

4.Non-shared revenues to total revenues.

5. The total cost ratio to total income.

6. The ratio of non-performing and doubtful loans to total granted facilities.

7. The ratio of cash to total deposits.

RESULTS

In descriptive statistics, data analysis is done using measures of central tendency such as mean, median and dispersion indices like standard deviation, skewness and kurtosis.

Table1. Descriptive statistics for variables

Index	Mean	Median	Std. deviation	Skewness	Kurtosis	Min	max
The ratio of non-performing and doubtful loans to total granted facilities	0.10	0.09	0.08	0.54	-0.52	0	0.32
The joint income ratio to total granted facilities	0.21	0.19	0.11	2.99	11.44	0.09	0.76
Non-shared revenues to total revenues	0.20	0.12	0.15	1.72	5.82	0.01	0.96
The ratio of cash to total deposits	0.01	0	0.01	5.62	40.33	0	0.12
The total cost ratio to total income	0.32	0.24	0.22	1.10	0.47	0.09	0.94
The assets output	1.95	1.75	1.57	0.69	1.80	-2.84	7.30
The capital adequacy	16.10	10.05	1.91	4.05	18.06	2.29	122.70
Stock output	2.51	1.39	5.12	1.08	5.51	-12.55	26.52

The neural networks used in this study are multi-layer Perceptron neural network and learning algorithm used to train the network as propagation. This law is formed of two main lines; the first line is called go line in which the effects of input victor to MLP network work through middle layers to output layers. Output victor formed in the output layer forms the real answer of MLP network. In this line, network parameters are considered fixed and unchangeable.

The second line is called the return line. In this line, as the opposite of go line, the MLP network parameters are changed and set. This setting is done in accordance with the error correction rule. Error signal is established in the output layer of network. Error victor is equal to the difference between the desired response and the actual response of network. Error value, after calculation, on the return line is distributed through the output layer and layers of the network in the network. Because the recent distribution is done in the opposite direction of the weighted synapses connections, propagation is selected for describing behavior modification of the network.

Network parameters are adjusted so that the actual response tend closer to the desired response.

Since most optimal parameters used in neural networks (number of middle layers, number of neurons, the type of learning function, etc.) can be obtained through trial and error, the results of the parameters' change are studied and the results were compared. This change in function of the parameters in the form of learning algorithm function change, changes in the number of hidden neurons and conversion function were performed as follows: we have to meet the forbearance principle about the number of hidden node in the neural networks in which better generalize power is known in a network with less hidden node. Moreover, the probability of more-fitting (it means the exact learning of the educational data

and not the relationship between them which causes the network not to have generalize power. The network, in this case, acts as a memory that saves the educational data) decreases. In contrast, network with very little number of hidden Neurons may not have enough power for modeling and learning data.

In order to achieve the optimum combination of layers and hidden neurons and the evaluation of the effectiveness of their number, the number of middle layers increases from 1 to 2 and 3 and in each of these modes (one, two and or three middle layer) the number of neurons in each layer is tested increasingly. When the number of layers increases that the results of network performance do not improve with number of current layers. Network performance is measured using MSE criterion.

Due to the results of the neurons number change and hidden layers about educational data of the research, the best network structure is Tansig in the first layer and Logsig in the second layer and purelin in the last layer and Traingdm learning function due to the error value from the hidden layer dimension (2 hidden layers) and thenumber of hidden layer neurons (20 neurons0 with activation layer:

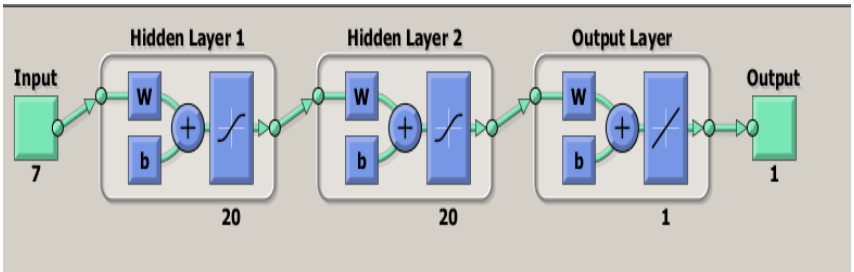

Figure1: optimal neural network

The error values are obtained as the following table:

Table2. Performance evaluation criteria for artificial neural networks

MSE	RMSE	NMSE	R2	MAE	MAPE
0.03	0.19	0.69	0.31	0.17	0.35

Thus, it is concluded that the neural networks have the ability to predict stock output of Banks listed in the Tehran Stock Exchange with mean square error of 0.03, Root Mean Square Error of 0.19, Normalized mean square error of 0.69, mean absolute error of 0.17 and mean absolute percentage error of 0.35. Determination coefficient of 0.31 shows that neural networks can predict 31% of stock output of Banks listed in the Tehran Stock Exchange using financial ratios in 2014.

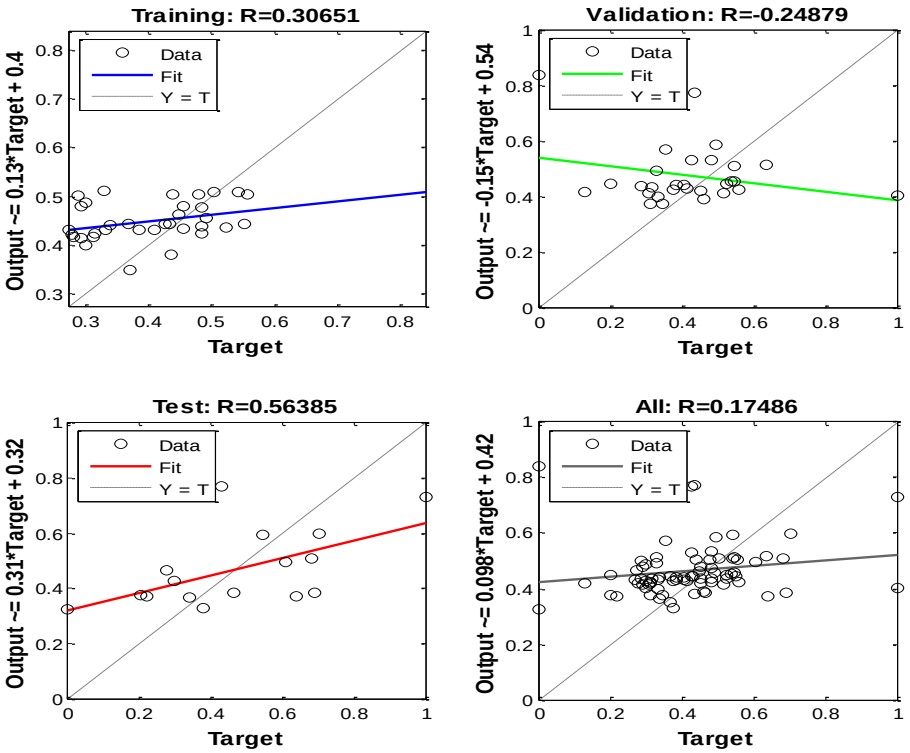

Figure2. Regression figures of trial and error level in neural network

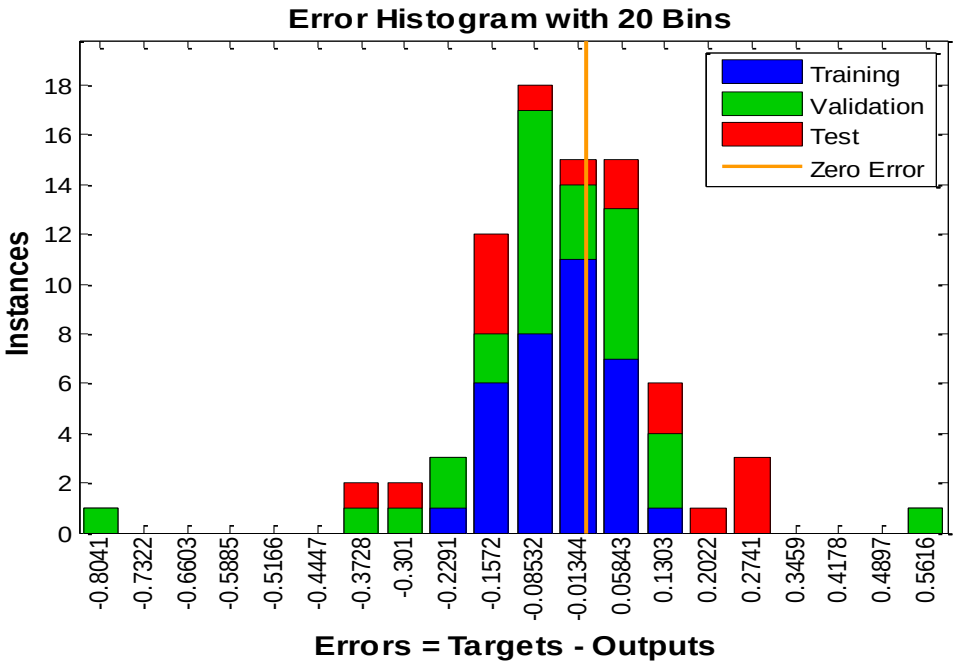

Figure3. The results of the implementation of neural network for the training data collection, validation and testing

CONCLUSION

according to the obtained R2 results, it is concluded that both support victor regression and neural networks have the ability to predict stock output of Banks listed in the Tehran Stock Exchange using financial ratios and the predicted error value by support victor regression (SVR) model is preferred in terms of six criteria to evaluate the performance of the MLP neural network method. Therefore, predicting stock output of banks listed in the Stock Exchange with financial ratios by support vector regression approach can reduce stock output predict error compared to neural networks.

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