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DEVELOPING AN OPTIMAL MODEL FOR DIVIDEND PREDICTION USING MULTI-LAYER PERCEPTRON NETWORK

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ABSTRACT

Dividend is one of the important financial factors which is of interest to managers, investors and financial analysts, and is often used for decision-makings on investment, profitability assessment and profit-related risk assessment, and to make judgments about the stock prices. Therefore, its prediction is important for both managers and stakeholders. The aim of the present study was to provide a model for predicting the dividend using the multilayer perceptron neural network (MLP). To do that, 43 companies from the metal industries of Tehran Stock Exchange were considered as the research population, and 301 years-companies for the period of 2009 to 2015 were selected as the research sample. The results of the research indicated that the perceptron neural network had a high potential for dividend prediction. The mean squared error of this network was about 0.4. Moreover, considering the architecture chosen to develop and train the network and the results of the testing data, the independent variables of the study were able to explain 80 percent of the changes in the dividend. As a result, the proposed model in the research hypothesis was accepted.

Keywords: *Dividend; Multi-layer perceptron network; Metal industries of Tehran Stock Exchange*

INTRODUCTION

Fixing the unawareness of the future has always been one of the main concerns of humanity throughout history. Human beings have always wanted to become aware of their future and to be able to organize it as they desire. At first, humans were not able to predict accurately and reliably; thus, they resorted to supernatural forces. When they gained a more rational ability, they made some attempts to use this ability. And, since science provided them with the opportunities for prediction, they utilized this achievement (Ghadiri et al., 2009). Today, with the growth and development of the global economy and its competitiveness, decision-making on the optimal allocation of resources have become increasingly important. Hence, the stock exchanges – as a mirror reflecting the entire economic situation of the countries and a place for investors to invest their resources and savings – have attracted most of the attention. As a result, knowledge of the future of companies will help investors to make the right decisions. Future decisions always face ambiguity and uncertainty.

Those who are able to predict the future or have at least some information about it will win this competition and will be able to make appropriate decisions. With the development of science, the possibility of a future prediction has become possible (Mahdavi et al., 2007). One way to help the investors is to provide them with the prediction models about the companies' financial

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situations. The closer the prediction is to the reality, the more accurate the decisions will be. The results of such classic methods as regression, although relatively successful in some areas, have not been able to satisfy the researchers in this field. The research shows that market behavior is non-linear and chaotic; therefore, linear and static models cannot explain the behavior of such systems. Thus, some nonlinear and intelligent models have been adopted in the financial sciences for making predictions (Khaloozadeh, 1998). Display quotations of over 40 words, or as needed. Investors do have the right to be concerned about and sensitive to the future of their investments. So, they seek to get some information about the future. Predictions helps investors and resource allocators make the right decisions and minimize the investment risks as much as possible. Beaver states: "predictions can be made without making a decision, but a smallest decision cannot be made without predictions" (Poorzamani, 2012). Dividend (cash) and the policies leading to decision-makings are of the major concerns for the managers – especially those in the companies admitted to the stock exchanges and the OTC – and are highly regarded by the shareholders in a way that discussing and decision-making on the dividend has always been one of the main issues of the annual general meetings of the companies. Alavi-Tabari et al. (2009) maintained that the dividend policy can reflect whether financial performance outcomes are true and fair or not. In fact, the managers show their tendency to pay the profits when they make sure that the profits are not manipulated and it is unlikely to have reduced dividends (unsustainable profit) in the future. Thus, dividend is not only a sign of future profits, but also a sign for earnings quality with a lesser degree of manipulation.

In addition, dividend is a management supervision approach in which the mangers less manipulate the profit in order to help themselves. On the other hand, with regular and increasing profits, the investors will realize the quality of reported earnings. Identifying the determinants of the dividend policy is one of the concerns of stakeholders and businesses. Potential and actual users of financial information are keen to become aware of the ability to create liquidity and, in some cases, to distribute it among the shareholders of the company. Awareness of the determinants of dividend policy provides a clear picture of the companies' liquidity distribution capability, making it possible to predict their future behavior. It is of great significance to the corporate executives because the information obtained can be used both in the process of managing the company and in market assessment of their performance. Therefore, part of the power and attention of corporate executives is focused on an issue that is referred to as the dividend policy. More important than dividend policy, however, is finding the roots of specific dividend policies adopted by the companies. This can pave the way for important economic decision-makings for various stakeholders, particularly the investors, because the reasons and determinant factors derived from the roots not only help explain the behavior of companies in the past, but also provide a tool for predicting their future movements and directions in this area.

Theoretical foundations and review of the literature

Dividend is one of the short-term and long-term strategies of the companies, the effects of which are evident in the company's general assemblies in each financial year and based on which the performance of the company is assessed. Dividend policy is a policy based on which the firm's performance is assessed. Dividend policy is a policy based on which the dividend, accumulated profit, remuneration of the board, financing, and other related issues are codified and submitted to the general assembly of the shareholders. Dividend policies are considered as important

policies and are among the most important financial decisions of companies which are developed according to the relevant theories and the factors influencing them. The issue of dividend policy has always been one of the controversial debates of the financial science in a way that it has attracted the interest of researchers of this century for the last five decades

International research

Cao and Pari (2009) studied the precision of earnings per share predictions using neural network models and concluded that the neural network model whose weight was estimated by the genetic algorithms was a more appropriate model. The results of this study also improved the research results of Zhang et al. (2004).

In 2009, Cao and Gan investigated 723 Chinese companies in the form of 22 industries over the course of 10 years to predict the earnings per share. They used both neural network and the genetic algorithms for prediction and found that the neural network model with an estimated weight of the genetic algorithm had a better performance in predicting the earnings per share than the neural network model with the estimated weight of the back-propagation algorithm.

Zhang et al. (2004) also conducted a research involving 283 companies in 41 industries and predicted the earnings per share using the four models of univariate linear, multivariate linear, univariate neural network, and multivariate neural network. They concluded that neural networks showed better performance in predicting earnings per share than the linear models used to date.

In 1994, Finger examined the ability of past profits to predict future cash flows and profits. The results highlighted that the future profits for 88% of sample companies can significantly be predicted, using the past profit information.

Research in Iran

Mahdavi and Rastgari (2007) concluded that current operating profits, operating cash flows and the economic value added could predict the future earnings, with the operating profits having a greater predicting ability than the other variables.

In 2004, Saqafi and Kordestani, however, examined the relationship between corporate profits and cash flows and the future profits, founding that the past profits could not predict the future profits.

On the other hand, Noravesh and Gholamzadeh (2003) studied the accounting earnings using Box-Jenkins time series. They concluded that the past earnings did not provide much information about predicting the future profits .

Jannat-Rostami (1999) also investigated the role and effectiveness of the profits in predicting the future earnings and the future cash flows of investments in the shares of companies admitted to the Tehran Stock Exchange and found that there was a meaningful relationship between the past profits and the future profits.

Research objectives

The main objective of this research was to provide a model for dividend prediction using multi-layer perceptron neural network (MLP) in Tehran Stock Exchange companies. In addition to the main objective of the study, there were some additional secondary objectives that fall in a lower level than the main objective. These objectives include:

- Helping the investors to make the right and desirable decisions
- Determining an optimal model to predict the dividend

Research question and hypothesis

After reviewing the objectives of the study and preliminary studies on possible responses, the research question is presented as follows:

- Is Multilayer Perceptron Neural Network (MLP) an appropriate model for predicting the corporate dividends?

According to the above question, the research hypothesis is expressed as follows:
Research hypothesis: Multi-layer Perceptron Neural Network (MLP) is an appropriate model for predicting the corporate dividends.

Population, sample and study period

The statistical population of the research included the metal industries admitted to the Tehran Stock Exchange from 2009 to 2015. The statistical sample in the research process is determined by considering the nature of the research and the characteristics of the members of the population in such a way that the extracted sample can test the research hypotheses, taking into account the cost and time of the research, and being able to maximize the generalizability of the results to the population. Therefore, systematic elimination has been used in this study to determine the statistical sample. To do that, those companies that met the following requirements were selected and the rest of the population was excluded from the study:

1. The companies' fiscal year had been by the end of March, and they had not changed their fiscal year from 2009 to 2015.
2. Companies should not be in the category of investment companies and intermediaries.
3. They should have had a continuous activity in the stock exchange during the period under investigation.
4. The companies should provide financial information required for conducting the research and their audited financial statements during the years in question.

According to the conditions applied, eventually 301 years-companies in the form of 43 companies were considered as the research population for the period under consideration, the required information of which was obtained from the Stock Exchange databases. After selecting the sample, in order to perform the training in nonlinear models, we divided them into two categories of educational samples and experimental samples. Training was first conducted on educational samples that consisted of 211 year-companies from 2009 to 2015. Then, in order to determine the accuracy of predictions, the experimental testing data, which was 90 year-companies, was tested and the dividend was predicted.

RESEARCH METHODOLOGY

The present study is functional in terms of the objective and quasi-experimental in terms of the research type. In this research, multilevel perceptron neural network (MLP) was used to predict the dividend. Since prediction in neural networks is done through training on input variables, input variables are among the important issues in the models using neural networks. To this end, having gathered the internal and external resources through the library method and studying the related literature, seven variables were considered as input variables of the model. Table 1 shows the input variables. In order to homogenize the variables, the total assets were divided in each period.

Table 1. Input variables (independent) used in the research

$EPSH_{i,t}$	Earnings per share of the company *i* at time *t*
$CFPSH_{i,t}$	Operating cash flow of each share of the company *i* at time *t*
$ASSETS_{i,t}$	Total assets of the company *i* at time *t*
$DEBT_{i,t}$	The debt ratio of the company *i* at time *t*
$M/B_{i,t}$	Market value to book value of each share in the company *i* at time *t*
$CR_{i,t}$	Current Ratio of the company *i* at time *t*
$QTRBETA_{i,t}$	Beta of the company *i* at time *t*

*Source: Research findings

The model has one output variable (dependent): the dividend. The next step was to prepare the data. Data preparation is one of the most complex steps in application of neural networks. Part of this complexity is due to the selection of data and the other part is due to the changes in the scales of input and output training data because the best condition for nerve networks is met when all the inputs and outputs are between zero and one (Kuldeep et al., 2006). In the next step, the normalized data was used for prediction via the MLP neural network. It should be noted that data analysis was performed using MATLAB software.

Artificial Neural Network Theory

An artificial neural network includes a set of connected neurons. Each set of neurons is called a layer. The role of neurons in neural networks is processing the information. In artificial neural networks, this is done by a mathematical processor, which is the same as an activation function. A transfer function (activation function) is selected by the designer depending on the specific needs of the problem to be solved by the neural network. The simplest form of a network has just two layers, the input layer and the output layer, which acts like an input / output system and uses the value of the input neurons to compute the value of the output neurons. Neural networks with hidden layers have more abilities than the double-layer neural networks (Manhaj, 2006).

Multi-layer perceptron neural network

The most widely used artificial neural network architecture are the feed-forward multi-layer networks. The multilayered perceptron neural networks are customarily called MLPs. These types of networks have the following characteristics:

1. Network processors are divided into several layers.
2. The minimum number of layers in these networks is 2.
3. Processors in each layer are allowed to receive the signals only from their previous layer processors and the output signal of each processor is applied only to the next processor.
4. In these networks, the first layer is called the input layer; the last layer is termed the output layer; and the middle layers are referred to as the hidden layers. Network inputs are effective parameters in determining the outputs. The number of input and output layer nodes, therefore, is actually known from the onset of the network usage. In fact, the proper number of nodes and hidden layers is obtained when the network provides the best answer (Manafi, 2006; Fadaei Nejad et al., 2011).

In this study, sigmoid non-linear activation function was used for training by the MLP network. The sigmoid activation function is as follows:

$$Sgm(x) = \frac{1}{1+\exp(-x)} \qquad (1)$$

The main reason for the success of this network can be found in the type of training algorithm of the network. The algorithm used in this network was an error propagation algorithm. This algorithm always seeks to minimize the squared errors. Therefore, each neural network follows an error function such as the following:
The error function in the MLP:

$$\varepsilon_{(t)}=\frac{1}{2}e^2 \qquad (2)$$

In this equation, e expresses the observed error.
When designing a network, the network structure parameters, the type of learning algorithm, the learning rate, the number of network layers, the number of neurons in each layer, and the epochs for each of the patterns during the training should be taken into account (Azami, 2009).

RESEARCH FINDINGS

In this study, the dividend prediction was calculated for the companies of the metal industry group admitted to the Tehran Stock Exchange using the multi-layer perceptron neural network (MLP). To achieve the optimal architecture, some criteria were used. As for the prediction problems, these criteria were mainly related to the difference between the expected output and the actual output. In the present study, three common criteria for performance evaluation were used: Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Ratio (R^2).

Making prediction with MLP

To achieve the best prediction error in the MLP network, we need to train the data with different parameters of the network in order to achieve the optimal error. To this end, in this study, we came across an acceptable error by training more than one hundred different patterns. The parameters of the final network structure resulting in an optimized error are shown in Table 2.

Table 2. Ultimate MLP Network Structure Parameters

Number of neurons per layer	Epochs	Number of hidden layers	Learning rate	Activation function
35	10000	2	1.5	Sigmoid Tangent

*Source: Research findings

To verify the accuracy of the prediction by the network, the above-mentioned performance evaluation methods were used, the results of which are presented in Table 3. In addition, the overall prediction error of the MLP network in relation to the changes in epochs for the testing, evaluation and training are shown in figures 1, 2, and 3.

Table 3. Results of the evaluation of the MLP network performance

R2	RMSE	MSE	
0.80736	0.49117	0.24125	Testing data
0.70895	0.4827	0.233	Training data

***Source:** Research findings

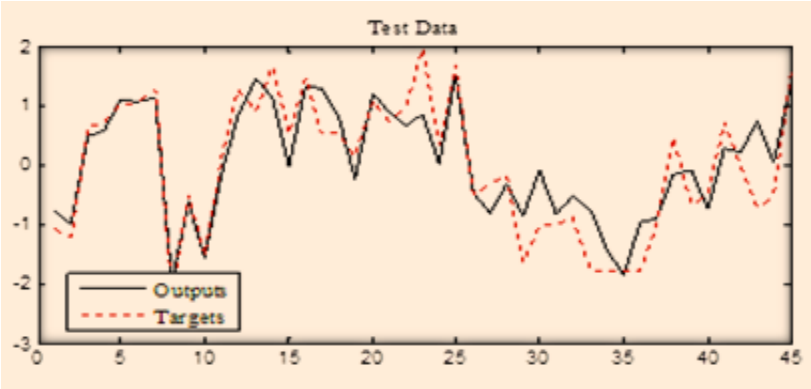

Figure 1. Overall network error in relation to the epochs for the testing data

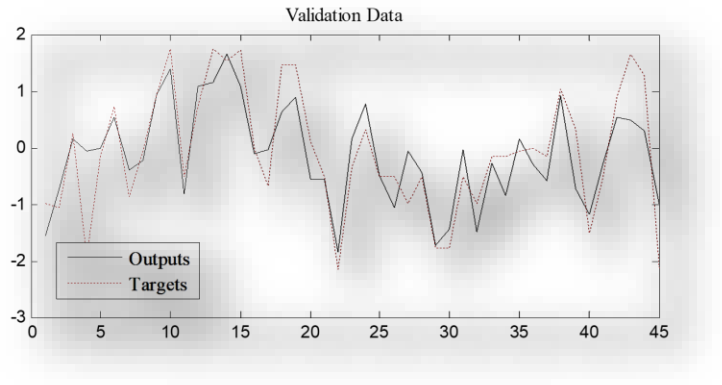

Figure 2. Overall network error in relation to the epochs for the evaluation data

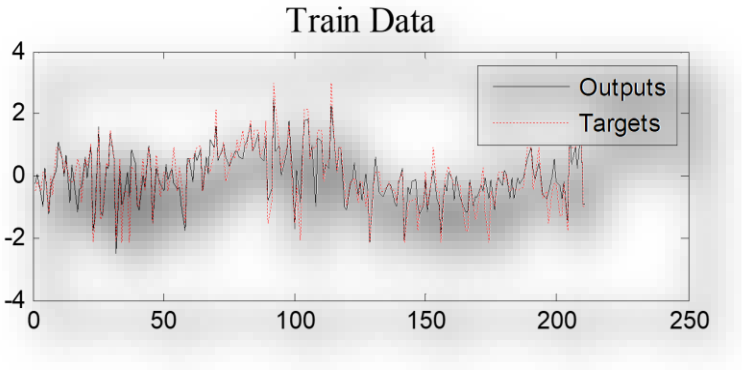

Figure 3. Overall network error in relation to the epochs for the training data

DISCUSSION AND CONCLUSION

As already mentioned, both potential and actual users of financial information are keen to become aware of the ability to create liquidity and, in some cases, to distribute it among the shareholders of the companies. Awareness of the determinants of dividend policies makes predicting the future behavior of the companies possible, providing a clear picture of the companies' liquidity distribution capability. It is highly important to the corporate executives

because the acquired information can be used both in the process of managing the company and in market assessment of their performance. Therefore, part of the power and attention of corporate executives is concentrated on a matter that is referred to as the dividend policy. More significant than dividend policy, nonetheless, is exploring the roots of specific dividend policies adopted by the companies. This can pave the way for chief economic decision-makings for various stakeholders, particularly the investors, because the reasons and determinant factors derived from the roots not only help explain the behavior of companies in the past, but also provide a tool for predicting their future movements and directions in this area.

The overall purpose of this study was to provide an appropriate model for predicting the dividend. The MLP network is used in this research in line with the results of previous research, which confirmed the superiority of nonlinear models in predicting the dividend. Having studied the relevant literature, seven basic accounting variables were considered as the input variables of the network. According to the results of the training, a three-layer architecture with 35 neurons in the first and second layers (with sigmoid tangent activation function) and one output (Purelin activation function) were selected. The learning rate of the network was considered as 1.5. Based on the results of the present study, it can be concluded that the data related to the internal information of the companies (such as earnings per share, operating cash flow, total assets, current ratio, the ratio of the market value to the book value per share, current ratio, and beta) can effectively be used to predict the dividend per share. This research also presented a model in which the benchmark for the dividend per share can be predicted as an artificial neural network output. Moreover, the architectures with a desirable performance level and training capabilities in acceptable time from multi-layer artificial neural networks with error propagation training algorithm were presented. Being converged, it not only showed the dependence of the network inputs on the output, but also proved that it is possible to predict the output. Reaffirming the superiority of nonlinear models in dividend prediction, it shows that the MLP network model has functioned well in predicting the dividend. The basis for deciding on the accuracy of the predictions by the MLP network is the performance measurement criteria for the testing data. Among the three performance measures, the lower the MSE and RMSE values are, with less error the predictions of the network will be. As a result, the model will be more efficient. In the present study, the mean squared error was 0.49. The R2 coefficient determines the variation of the dependent variable relative to the variations of the independent variables. In other words, it shows how many percent of the variations in the dependent variables are explained by the independent variables. The R2 value varies between zero and one, with 1 expressing the complete matching of the data. As a result, the more R2 value is closer to 1, the more favorable it will be. Based on testing data, the independent variables used in this study were able to explain 81% of the changes in the dividend. It should also be noted that the research results confirmed the research hypothesis.

Recommendations based on the research

1. Investors are advised to use this model to predict the dividend for investing in the stock market companies, and to consider the dividend as one of the influencing factors in decision-makings.
2. Corporate executives are recommended to disclose the independent variables used in this study as factors affecting the dividend predictions through some notes accompanying their financial statements.

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