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Comparing Neural Network and Multiple Regression Models to Estimate Dividend Payout Ratio

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Abstract: The objective of this paper is comparing the predictive power of neural networks and regression model to estimate dividend payout ratio. In other words, this research wants to find a model that predicts an accurate of dividend payout ratio. Among the different theories and ideas from researchers in the field of finance, in this study, signaling theory, agency theory and residual theory of dividend have been studied. To examine these theories, the variables are determined and the necessary information for 133 companies during a period of six years (2004 - 2010) was collected. For analysis of data, statistical methods based on multiple regression and artificial neural networks have been used. According to results of this paper, a comparison between regression and neural network models, using the R software, version 2/12, indicating a more accurate prediction of the neural network model.

Key words: Dividend profit · Dividend payout ratio · Neural networks · Multiple regression

INTRODUCTION

Forecasting future in a dynamic economy and capital market is one of the most important issues that discussed among financial researchers. Classical methods such as regression, although have a relative successes in these areas, the results could not satisfy researchers in this field. Non-linearity of economic and financial data is considered and researchers understood the limitations of these techniques. But using of these techniques has been considered because these techniques interpret the estimated coefficients easily. Therefore, some people want to achieve more accurate models. Development of neural network technology that may be unique in the analysis of available data are caused that specializes used these techniques in analyzing and processing data. The use of nonlinear methods in finance is another effort to improve the predictive variables. Using artificial intelligence and neural networks in forecasting financial variables is one of these techniques. Boundaries the financial knowledge of corporate is developed and this developing will be accelerated during the next decade. In this respect, the results of scientific research will have a great important in solving problems. Extensive changes has occurred in recent decades in size, complexity and scope of operations and functions of financial managers and it has caused financial managers should take more responsibilities. One of the important duties of financial managers is dividend profit. Because the policy dividend payment is an important matter for companies, financial theories should be considered in this section. In this paper to reflect dividend policy, the proportion of DPS (the dividend earnings per share) variable to EPS (earnings per share) variable has been considered and artificial neural network model to predict the dividend payment with respect to the factors examined in this study will be used and results are compared to regression models.

Literature Review: Dividend policy has been a new topic in the financial literature. This question is still ambiguous in the financial literature that why companies pay a part of its earnings [1]. Emerging markets increased the ambiguous of this question. In these markets, new research was conducted to explain the behavior of firms in the dividend [2]. Companies are listed in Tehran stock exchange dividend the net profits of each year and by changing in net profit, dividend profit is also changed. The companies in Tehran Stock Exchange do not have a stable dividend policy [3]. Therefore; prediction of

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dividend policy can be a good guidance in decision making. There are different methods for forecasting. Users of financial information will be looking for a more accurate forecast of the dividend policy.

The Factors Effect on Dividend Policy: Gill [4] to find the determinants of payment profit, 500 companies were examined and concluded that the total dividends payout is function of profit margin, sales growth, debt-to-equity ratio and tax. Hassan Mirza [5] analyzed the information of the 100 companies listed on Karachi Stock Exchange using the least squares regression and result show that there is a negative correlation between the stock dividends and managerial and individual ownership cash flow sensitivity size and leverage. But there is a positive correlation between the stock dividend and operating cash-flow and profitability. Lee [6] have done a research about optimal payout ratio in the market and were examined the effect of total risk, systematic risk and growth rate on the payout ratio. Chen [7] were examined the effect of variables such as Cash flow variability 'Ownership dispersion' ownership Insider 'ratio of free cash flows to total assets' ratio of net fixed assets to total assets 'firm's size' beta firm's equity 'Past growth' future growth' stability of past dividends and imputation tax credit on the dividend payout. Norhayati [8] have done a research that show EPS, ROE and CFPS are important factors in determining dividend payout. Al-Malkawi [9] determined the Factors that effect on dividend payment that include cost, size, profitability, financial leverage, growth and investment opportunities. Charalambidis [10] were examined the relationship between firm size, capital structure, financial leverage, profitability, liquidity and cash flow to dividend payout. In this regard, further investigation by Amidue [11] in Ghana, Naceur [12] and Kanwer [13] has been done. In Iran, Eskandar [14] found a negative relationship between the level of dividend pay out and investors and positive relationship between dividend payment and institutional focus. Jahankhani [15] stated that if a company has a high growth, the cash returns will be increase. According to these investigations, 7 variables have been used in this study and we will explain these variables as follow:

Theories Are Related to Dividend Payment and the Variables Considered as Determinants of Dividend Payment: A dividend policy issue from different perspective of theories is debatable, in this study, the signaling theory, agency theory and residual theory of dividend will be discussed.

Signaling Theory: Signaling theory states that informing about stock profit has new information for the market and managers can use stock profit for signaling and delivering the news to their shareholders. According to this concept, the company expects to have increased in future profits, their stock dividends increase.The increase in stock dividends, carrying a message that is expected to improve company performance [16]. Senior management of a company have a lot of information about the company's strategy and its future earnings and this information will lead to the inequality problem [17]. When we offer a asymmetric information between managers and markets, dividend profit may play a role of transformer confidential information to outside of company [18].

Variable Is Considered for Signaling Theory

The Dividend Payout Ratio of Last Year: Dividends payout contains information for the market. High proportion of last year payment shows that the company expects to improve performance and profitability in the current year and with increasing profits, corporate are expected to pay a high dividend. Thus the dividend payout ratio of last year is one of the determinants of payout in the current year.

Agency Theory: According to this theory, one or more principal, determine the one agent so that he try to perform services on behalf of their. In Agency theory, Jensen [19] stated that in companies that ownership share of manger is high, due to align the goals of shareholders and management is less and in the companies that are a major shareholder, they can easily monitor the activities of management [20]. Also, Jensen [19] stated that agency problems resulting from conflicts of interest are in every type of activity, whether the hierarchy of the attorney - client or not. In addition to conflict of interest between shareholders and managers, there is a conflict between shareholders and bondholders and lenders. Dividends paid to shareholders, bondholders and other creditors may be less wealth.Thus, debt contracts often limit dividend payment to repay of loans is guaranteed.

Variables are considered for Agency theory

Ownership Dispersion: Stocks of companies are available in a lot of people who have different tastes and interests. There is another interpretation of this variable: According to agency theory, more scattering of ownership make a lot of agency problems and thus create more need for shareholders to monitor the work of managers. If the division can act as a regulatory mechanism, with increasing ownership dispersion, dividend payout also increases [7].

The Ratio of Free Cash Flows to Total Assets: Free cash flow = Net cash flow from operating activities - net cash flow from investing activities.

This method of calculation of free cash flow is not applicable in Iran. In Iran, the method of calculation of cash flow is as follows:

Free cash flow = Net cash flow from operating activities (Net cash flow from return of investment + payment of profit for financial supporting - payment of profit) + tax - net cash flow from investing activities

The Ratio of Net Fixed Assets to Total Assets: In this study, the variable used to measure the conflict of interest between shareholders and bondholders is the ratio of net fixed assets to total assets. Titman [21] found in their research that with increasing this ratio, the agency problems between shareholders and bondholders will decrease, because these assets may be used as collateral against loans and bonds and the dividend payment will be increased. In Iran, this interpretation can not be used because the bond holders and lenders can not limit dividend payout.

Residual Theory of Dividend and Cost of Transaction: According to this theory, first the company minus their needs from profit and residual of profit are divided between stockholders [22]. If the costs of distribution of the company's stock price is important, the company prefers to use a accumulate profit, instead of foreign resources for investment.

Variables Are Considered for Residual Theory of Dividend

Size of Company: Transaction costs are related to the company size. Based on the results of previous research, larger firms have lower costs of distribution. In fact; there is a negative relationship between transaction costs and size of company [7].

Financial Leverage: High beta for stock share of company, as the theory states that stock companies are risky or vulnerable [23]. Based on the results of previous research, high financial leverage ratio, give the large beta.

Revenue Growth:

$$\text{Revenue growth} = \frac{\text{Revenus of currentyear} - \text{Revenus of last year}}{\text{Revenus of last year}} \quad (1)$$

Rozeff [23] argues that if revenue growth is rapid, managers are more willing to hold funds for reinvestment that is achieved with a relatively low pay. On the other hand, we can also be assumed that companies have more growth, pay more stock profit. The positive or negative relationship depends on the company's strategy.

Variables: Variables examined in this study are summarized in Table 1 and shown as follows:

Population of this Study: The population of this study include companies are listed in Tehran Stock Exchange. In this study, for determining sample, the elimination method is used.This means that based on the requirements and limitations of this research, some company will eliminate. These restrictions and requirements as follow:

- This Company before 2004 is listed in Tehran Stock Exchange.
- This company was profitable during the 2010 and 2004.
- This company during the six years (2004 -2010) has paid dividend.
- This company should not be a member of investment companies, banks and financial institutions.
- This company has a enough information.

Finally, applying these restrictions, 133 companies were examined as a sample.

Statistical Model of this Research: In this study, seven variables are used to predict the dividend payout ratio. Data are related to these variables, for 133 companies during 6 years, were divided into two parts. Set of teaching or learning of the network includes 55 percent of all records, set of test records or test of network, includes 45 percent of all records. In order to compare their explanatory power of linear models and neural network model, first the linear model, for training and testing data, can be estimated separately. Then the model with neural network models will compare.

Regression Model: In this study, two multiple regression model is investigated. First model include 7 variables and as follows:

$$DPR_{it}=\beta_0+\beta_1 DPR_{i\,t-1}+\beta_2 DISPERS_{it}+\beta_3 COLLATS_{it} +\beta_4 FCF_{it}+\beta_5 SIZE_{it}+\beta_6 LEV_{it}+\beta_7 GROW_{it}+\varepsilon_{it} \quad (2)$$

Table 1: Summary of variables examined in the study

Variables	Explain
Y:DPR_{it}	Dividend payout to company i, in year t
X_1:$DPR_{i\,t-1}$	Dividend payout to company i, in year t-1
X_2:$DISPERS_{it}$	Ownership dispersion
X_3:$COLLATS_{it}$	Ratio of fixed assets to total assets, in year t
X_4:FCF_{it}	Ratio of free cash flow to total asset, in year t
X_5:$SIZE_{it}$	Size of company i, in year t
X_6:LEV_{it}	Financial leverage of company i, in year t
X_7:$GROW_{it}$	Revenue growth of company i, in year t

Table 2: information about variables

						Percentile		
Variable	Mean	Median	Standard deviation	Min	Max	25	50	75
$DPR_{i\,t}$	0.7693	0.8042	0.2865	0.0151	3.125	0.6159	0.8042	0.9316
$DPR_{i\,t-1}$	0.7709	0.8073	0.2672	0.0151	2.576	0.6285	0.8073	0.9340
$DISPERS_{it}$	8.3580	8.2620	1.1413	4.6530	13.325	7.749	8.262	8.776
$COLLATS_{it}$	0.2515	0.2093	0.1779	0.0001	0.8805	0.1120	0.2093	0.3541
FCF_{it}	0.0448	0.0349	0.1352	-0.502	0.5483	-0.028	0.0349	0.1127
$SIZE_{it}$	27.005	26.873	1.3179	24.341	35.01	26.075	26.873	27.747
LEV_{it}	0.6340	0.6506	0.1595	0.156	0.9427	0.5376	0.6506	0.7454
$GROW_{it}$	0.2246	0.1635	0.5026	-0.734	9.468	0.0338	0.1635	0.3128

Table 3: Multiple regression coefficients of first model

Variables	Estimate	Std. Error	t value	Pr(>|t|)
$DPR_{i\,t}$	0.5650542	0.2971177	1.902	0.058
$DPR_{i\,t-1}$	0.2649929	0.0599807	4.418	$1.32e^{-05***}$
$DISPERS_{it}$	0.0002851	0.0146802	0.019	0.958
$COLLATS_{it}$	0.0824351	0.0885407	0.931	0.352
FCF_{it}	0.1912878	0.1183478	1.616	0.107
$SIZE_{it}$	0.0008952	0.0109155	0.082	0.935
LEV_{it}	-0.0702403	0.0946624	-0.742	0.459
$GROW_{it}$	-0.0415591	0.0413528	-1.005	0.316
Multiple R-squared: 0.07576				
Adjusted R-squared: 0.05763		F-statistic: 4.18 on 7 and 357 DF		p-value: 0.0001924

Signif.Codes: ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 4: Estimation of parameters and coefficients of second multiple regression model

Variables	Estimate	Std. Error	t value	Pr(>|t|)
(intercept)	-8.485260	4.679824	-1.813	0.07068
$DPR_{i\,t-1}$	0.764286	0.214580	3.56	0.00042^{***}
FCF_{it}	1.459886	0.696528	2.096	0.03682
$SIZE_{it}$	0.746847	0.302101	2.472	0.01391
$DPR_{i\,t-1}^2$	-0.355983	0.129883	-2.741	0.00645
	-0.015329	0.005749	-2.667	0.00803
Multiple R-squared: 0.1489				
Adjusted R-squared: 0.09684		F-statistic: 2.858 on 21 and 343 DF		p-value: 3.821e-05

Signif.Codes: ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 5: The results of 14 neural network models that have been estimated with different structures

MSPR	MSEL	Number of	Number of units(neurons)in
0.1145	0.0945	28	3
0.1175	0.0806	37	4
0.1203	0.0659	46	5
1.7137	0.0750	55	6
4.2707	0.0747	64	7
1.2779	0.0915	73	8
0.7313	0.0786	82	9
1.7592	0.0732	91	10
0.1240	0.0719	100	11
35.7844	0.0597	109	12
0.0798	0.0536	118	13
35.6894	0.0592	127	14
0.0887	0.0810	136	15
0.0497	0.1071	145	16

Table 6: Comparing models (regression and neural networks)

	Multiple Regression Models		
Characteristic of models	First-Order	Second-Order	Neural Network Models
Number of parameter	8	22	118
MSEL	0.0743	0.0712	0.0536
MSPR	0.0883	0.0808	0.0798

Table 7: Results of the estimated models in structure of 7-13-1

MOM	Learning Rate	Sum Of Squares Error (testing)	Sum Of Squares Error (training)
0.80	0.05	148.46	219.1
0.85	0.05	54.32	224.08
0.90	0.05	122.64	216.26
0.95	0.05	97.89	216.97
0.80	0.10	92.64	206.28
0.85	0.10	72.81	214.07
0.90	0.10	110.58	204.55
0.95	0.10	84.39	210.94
0.80	0.15	84.39	202.38
0.85	0.15	83.53	212.08
0.90	0.15	95.52	196.58
0.95	0.15	164.17	209.62
0.80	0.20	87.87	216.64
0.85	0.20	52.09	212.24
0.90	0.20	56.83	218.18
0.95	0.20	99.57	208.45
0.80	0.25	142.99	204.33
0.85	0.25	81.11	217.91
0.90	0.25	158.07	202.39
0.95	0.25	156.74	210.38
0.80	0.30	80.18	219.18
0.85	0.30	105.78	197.34
0.90	0.30	91.55	208.12
0.95	0.30	54.48	201.20
0.80	0.35	62.61	206.25
0.85	0.35	115.32	208.02
0.90	0.35	67.09	221.19
0.95	0.35	106.98	228.46
0.80	0.40	84.91	213.93
0.85	0.40	108.63	210.73
0.90	0.40	66.29	218.41
0.95	0.40	106.77	202.06

Table 8: The important of factor that affect dividend payout

Variables	Importance	Normalized Importance
$GROW_{it}$	0.393	100
$DPR_{i\,t-1}$	0.229	58.4
$DISPERS_{it}$	0.173	44.1
FCF_{it}	0.107	27.3
LEV_{it}	0.04	10.1
$COLLATS_{it}$	0.033	8.5
$SIZE_{it}$	0.024	6.2

Another model that is considered for regression, in addition to seven variables includes the interaction between these variables (second model):

$$Y= \beta_0+ \beta_1x_1+ \beta_2x_2+ \beta_3x_3+ \beta_4x_4+ \beta_5x_5+ \beta_6x_6+ \beta_7x_7+ \beta_8 x_1^2+\beta_9x_2^2+ \beta_{10} x_3^2+\beta_{11} x_4^2+\beta_{12} x_5^2+ \beta_{13}x_6^2 + \beta_{14} x_7^2+ \beta_{15} x_1 x_4+ \beta_{16} x_1 x_7+ \beta_{17} x_2 x_5+ \beta_{18} x_2 x_6+ \beta_{19} x_3 x_6+ \beta_{20} x_4 x_6+\beta_{21}x_5 x_6+ \varepsilon_{it} \quad (3)$$

Neural Network Model: Neural networks are used in many areas such as creating models, time series analysis, pattern recognition, signal processing and control [24]. Neural networks are a technology of information processing that are inspired from brain and nervous systems and through the arrangement of input, output are made. Linear variables used in the linear regression, to create multi-layer perceptron (MLP) are used. Multi-layer perceptron is a common form of neural network that are used today [25]. In this study, the error back propagation learning algorithm is used. Error back propagation algorithm is the most useable method for training multilayer neural networks. Error propagation network is expressed with the error mean square error (MSE).This is the most common error function that is used in neural networks.

The Findings of this Research

Examine the Model Using of Regression Analysis: In this study to evaluate the neural network model, the relationship between independent and dependent variables were analyzed using multiple regression analysis. For this purpose, the R software, version 2/12 is used. First, the first order model is considered.

According to Table 3, the final model will be follows:

$$DPR_{it} = 0.56 + 0.26\ DPR_{i\,t-1} + \varepsilon \quad (4)$$

Another regression model is a second multiple regression model. The results of second regression model are follows:

According to Table 4, the second model of regression will be follows:

$$DPR_{it} = - 8.48 + 0.76\ DPR_{i\,t-1} + 1.46\ FCF_{it} + 0.74\ SIZE_{it} – 0.36\ DPR_{i\,t-1}^2 -0.015\ SIZE_{it}^2 + \varepsilon \quad (5)$$

Estimates a Neural Network Model: As previously mentioned, in this research, software R version 2/12 is used. Before training the neural network for different structures, each input pattern fits the research data structures, become arrays of input - output. For estimate the neural network model, total of data were divided into two parts that include training data and testing data. For modeling, the training data was used. Accordingly, 14 models were estimated with different structures. Next, according to the best model that is selected in each structure, the model was tested. The results are summarized in Table 5.

Based on the Table 5, the best prediction is for a model with 13 neurons.

Comparison of Models: However, in this section, we compare the models:

According to Table 6, MSEL and MSPR for neural network model is lower than the regression models. The neural network provides the best forecast for us. Given the software R can not determine the importance of the variable, using SPSS software in structure 7-13-1 and 32 model with a learning rate of 0.05, 0.1,0.15,0.2,0.25,0.30,0.35,0.40 and the MOM 0.8,0.85,0.9,0.95. Among these models, a model with a learning rate of 0.15 and the MOM 0.9 has the lowest sum of squares error in the training data. Based on neural network models, the important of factors are shown in Table 8:

According to this model, the variables $GROW_{it}$, $DPR_{i\,t-1}$ and $DISPERS_{it}$ are the most important factors that determine the dividend payment.

CONCLUSION

The purpose of this study is to compare the predictive power of neural networks and least squares regression model to estimate the dividend payout ratio and the another purpose of this study is to assess the importance of factors that affect dividend payment. Using of R software, version 2/12, total of data were divided into two parts that include training data and testing data. Two multiple regression models were estimated with different parameters and to estimate the appropriate neural network model, 14 models with different structures were estimated and try to choose a structure that has the lowest MSE for training and testing data. Accordingly, the best neural network model in this paper has a structure 7-13-1. In fact, the best model was created with a hidden layer and 13 neurons in the middle layer. Compared to neural network and regression models, neural networks models have a less MSE than two regression models and predicting the dividend payout ratio by using of neural networks is more accurate than multiple regression models.

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