



Full Length Research Article

A COMPARISON OF ARTIFICIAL NEURAL NETWORK AND DECISION TREE FOR PROFITABILITY IN TECHNOLOGY SECTOR

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ABSTRACT

Profitability is always a main consideration for businesses. Business and academicians have researched in order to determine the factors affecting profitability due to the importance of this issue. In this study, return on assets is modeled and compared with two different methods. Artificial Neural Network and Decision Tree are established with financial Statements of technology sector on BIST (Borsa Istanbul). The two models were evaluated in the study. Their strengths relative to each other were determined.

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INTRODUCTION

A main purpose of business is to get the profit. Therefore, it is important to know the profit and profitability. For business, to explain and modeling profitability is gaining importance day by day due to increasing competition. Factors which are explaining profitability are wanted to know. In the study, we will be modeling profitability with artificial neural network and decision tree methods. We have used financial data for two models. Financial analysis searched relationship between items in financial statements. Nissim and Penman made analysis with 38-year data of manufacturing business is traded on the New York Stock Exchange. In this study, the impact on profitability of the commercial and financial debt was investigated (Nissim and Penman, 2001). Between profitability and dept / equity ratio was shown to be a negative correlation (Eritos and Neokosmides, 2002). Stock price estimates with artificial neural network. As a result of this study, artificial neural network's modelling is better result than linear regression (Tektaş and Karataş, 2004). The natural logarithm of total of sales was found to have a positive effect on profitability (Chen and Zhau, 2005).

Return on equity's analysis was made by regression on technology companies traded in Turkey stock exchanges and NASDAQ. In result of this study, return on equity is affected most profit margins and asset turnover (Ege and Bayrakdaroğlu, 2007). Analysis was made over tourism companies. In this analysis, asset size, market share, capital, receivables turnover, stock turnover and asset turnover in effect on return on assets was examined (Karadeniz and İskenderoğlu, 2011). Companies are classified according to industry and service sectors using CHAID algorithm with financial data (Albayrak and Yılmaz, 2009). Dreiseitl and Ohno-Machado established was compared logistic regression and neural network's modelling (Dreiseitl and Ohno-Machado, 2002). Profitability is classified to be well or bad with financial performance. In this study, decision tree analysis is used (Koyuncugil and Özgülbaş, 2008). Decision tree, linear regression and artificial neural networks were compared on a same sample (Kim, 2008). Artificial neural networks are used to estimate the stock price. Studies have shown that the more successful performance than regression analysis (Karaatlı, Güngör, Demir and Kalaycı, 2005). A study has examined the financial situation of small company how they can do their own financial statements (Bodur and Aktan, 2006). Profitability of service and industrial companies is worked and found that profitability is affected 18 variables (Albayrak and

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Akbulut, 2008). Share certificates in insurance sector have been estimated with artificial neural networks. In particular, a high degree of success has been estimated for first month (Akcan and Kartal, 2011).

Technology sector in the world and turkey

Companies have been active in different areas like as industrial, service, technology, etc. Together with development of technology, companies began to benefit from advanced technology and equipment. Technology sector which is conducting activities on these technologies began to gain importance with each passing day. The sector has become a growing sector in the world and Turkey. Technology sector in the Turkey reached 83.1 billion TL by 18 percent growth in 2015. Research is expected to grow between 15-20% for this sector in Turkey (TUSIAD report, 2015). In 1980, the developments in information and communication technology offered many opportunities to business community. The share of trade of technology sector showed a very rapid increase until the 2000s. After the 2001 crisis, the sector recovered and time of sector was observed to 19% growth rate over. In the 21st century, developments have gained speed. Technology has increased importance of development due to current developments in this sector and other sectors. Information and technology became important to all sector in world countries, especially in economy (Bulu, Eraslan and Kaya, 2006; Aydın, 2012).

Financial structure

According to the Turkish Language Institution, profit is pecuniary gain provides shopping, advantage and benefit. As economic and financial, profit is entrepreneurs' part gets from production. As trade, mean of profit is difference between cost price and sale price. Profitability is also situation of profitable according to the Turkish Language Institution (TDK, 2016). Profit is an amount in currency but profitability is a rate (Bekir Baykara, 1994). Financial analysis includes process that is establishment, measured and interpreted of relationship among items in the financial statements. Analysis provides making predictions about future of a company by examining performance of this company in history and current period. Financial analysis is selection, evaluation and interpretation of financial data in process of investment and financial decision-making (Aydın, Şen and Berk, 2012; Drake, 2016; FinansalYönetim, 2012). When studies on profitability are investigated, several different variables are reached. Some of those, are obtained from financial statements, are selected. In table 1, the variables and formula of the variables in the study are given from literature (Korkmaz and Karaca, 2014; Oruç, 2009; Karadeniz and İskerdoğlu, 2011; Eriotis, Frangouli, Ventoura-Neokosmides, 2002; Tugas, 2012; Akhtar, 2004; Kısakürek and Aydın, 2013; Omran, 2004; Akbulut, 2011; Okuyan, 2013; Chen and Zhao, 2005; Karaca and Başçı, 2011). There are 17 variables in table. One of them is the dependent variable of the study.

METHODS

We have used financial data for two models. There are ten companies in technology sector on BIST. We select nine

companies and take the financial data of their 2007-2015 years. Because a company's financial data is not attainable and homogeneous data set is being necessary. Decision tree and neural networks were compared on same sample. In the next chapter we will touch these two methods and their results will be discussed.

Artificial neural network

Artificial neural network is a computer-based system which is modeling and matching output and input sets. On the basis of artificial neural network are neurons. Neurons are connected to each other with updatable weights. Neural cells have basically input data from output or other neural, weights, activation functions and output. Artificial neural networks are also created by combination of these neurons. Artificial neural network consists input, output and secret layers (Akcan and Kartal, 2011; Haykin, 2005; Altman, Marco And Varetto, 1994). According to network structure, there are two type artificial neural networks: feed-forward and feed-back. In the feed forward-neural networks, input and input's weights are calculated and then, the results of this function are transferred to next layer. The process is stopped when it arrives on secret layer. However, it is sometimes connected to the previous layer in feedback neural network. An output of feedback neural network is connected other every neuron's input (Haykin, 2005). In this study, profitability model have been established with artificial neural networks by MATLAB R2015. Data set have been partitioned 80 to 20 percent for testing and learning stages. 16 samples of the 81 pieces in data are separated by systematic random sampling for testing. Network is selected as feed-forward in MATLAB. It was determined five layers for neural networks model in the study, so that first layer has seven, another layers have three neurons. This is the most optimal as a result of the experiment. Tansig function is selected because there are negative values in the data. For the output of the model and actual values are compared, when the model results and actual values are graphed, R-squared value is found as 0, 9257 (Uğuz, 2016). According to this value, compatibility of the model can be said to be very good.

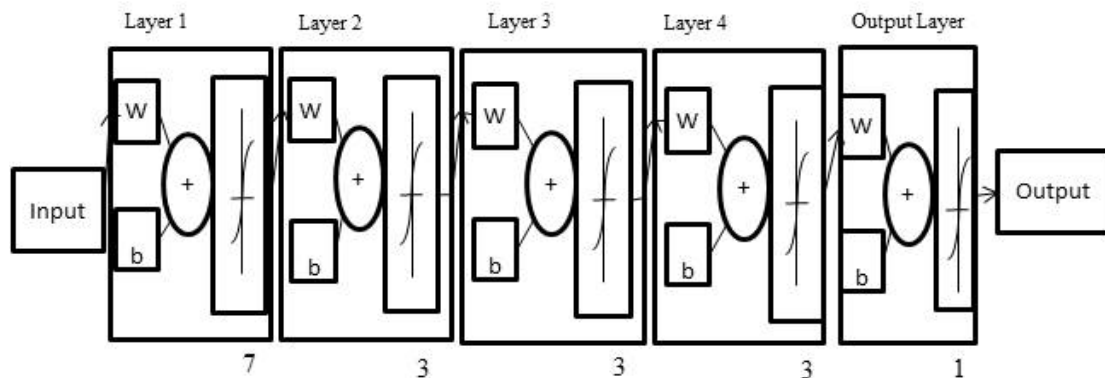
Decision tree

Decision tree is known as a discipline in the middle of the 1950s, is an area research-based learning. Decision trees have decision nodes, leaves and branches. Decision tree analysis is a tree-building technique starting from a maximum gain of variable information that node (Magerman, 1995; Quinlan, 1986; Albayrak And Yilmaz, 2009). A lot of decision tree algorithm is designed for selection and partition on decision nodes. These are 3, C4.5 and C5.0, CHAID, C&RT, QUEST, CART. CHAID algorithm uses chi-square as identification criteria. The algorithm was developed by Kass in 1980. It makes analysis all type of independent variables. The algorithm uses F test for continuous variables, chi-square test for categorical variables and make two and more than partitions. Thus, it can produce a larger tree (Sonia Singh and Priyanka Gupta, 2014; Kass, 1980; Ture, Tokatli and Kurt, 2009). Creating a decision tree with CHAID algorithm steps are as follows:

Table 1. Dependent and Independent Variables and Theirs Formula

	Name Of Variable	Formula Of Variable
Dependent Variable	Return On Assets	Net Income / Assets
	Sales Size	Ln(Sales)
	Liquidity Ratio	Current Assets - Stocks / Short-Timeterm Foreign Resources
	Leverage Ratio	Total Foreign Resources / Total of Liabilities (Assets)
	Current Ratio	Current Assets / Short-TimetermForeign Resources
	Growth Of Asset	Asset at t-time - Asset at (t-1)-time / Asset at (t-1)-time
	Financial Expenses	Financing Expenses / Total Liabilities
	Short Term Leverage Ratio	Short-Term Foreign Resources / Total Liabilities (Assets)
	Long Term Leverage Ratio	Long-Term Foreign Resources / Total Liabilities (Assets)
	Asset Turnover	Net Sales / Total of Assets
	Capital / Total Source	Equity / Total Source
	Average Collection Period Receivables	365x (Short-Term Trade Receivables / Net Sales)
	Debt Ratio	Total Debt / Total Assets
	Net Sales / Assets	Net Sales / Real Assets
	Earning Power in Shareholder's Equity	Net Profit / Equity
	Equity Turnover	Net Sales / Equity
	Business Size	Ln(Assets)

Table 2. Artificial Neural Network Model



Step 1: For each independent variable X, Y dependent variable taking into account, category-pair has less important or largest p-value is found.

Step 2: $\alpha_{combine}$ is compared with the predetermined value.

Step 3: P-values are calculated with suitable Bonferroni correction for variables.

Step 4: Adjusted argument with the smallest p-value is chosen as the most important variable and compared with α_{split} .

CHAID algorithm used earning power of equity for main part. This variable was made with five sections. In decision tree, the leaf nodes are obtained after one or more decision node(s). Finally, decision tree analysis obtained by CHAID algorithm has twenty eight leaf nodes. The average value for each leaf node is predictive value in this partition. Example, 20th leaf node can be reached by looking two variables. These variables are earning power in shareholder's equity and sales size. If earning power in shareholder's equity is greater than 0,165 and sales size is less than 15,259, the leaf node is obtained. The predictive value of this leaf node is 0, 5328 for return on assets. The number of samples in this leaf node (N) is 1 and this is 1,2% of the data set. Similarly, other leaf nodes can be examined. For other leaf nodes, it is possible to look another decision nodes and variables. There are 28 leaf nodes in total in the decision tree analysis. The predictive values of these leaf nodes are given in the table 5.

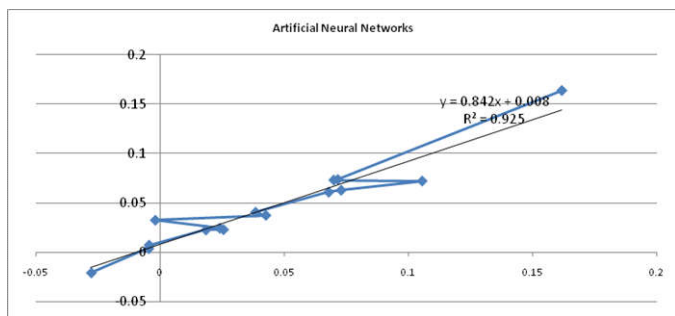


Table 3. Graphic of Artificial Neural Networks Real and Estimates Values

In this study, decision tree model was established with SPSS 20. Decision tree analysis used eight of sixteen independent variables. These variables picked in the decision node. The variables are net sales/ asset ratio, current ratio, liquidity ratio, earning power in shareholder's equity, financial expense ratio, sales volume, average collection period of receivables and shareholder's equity turnover ratio.

RESULTS AND DISCUSSION

A main purpose of business is to get the profit. Therefore, it is important to know the profit and profitability. For business, to explain and modeling profitability is gaining importance day by day due to increasing competition. In this study, decision tree and neural networks have been focused. Decision tree analysis used CHAID algorithm in the model and it is used in eight variables in the partitioning process. CHAID algorithm is determined to earning power in shareholder's equity first partitioning and divided into five main categories.

Table 4. First Partitioning with CHAID Algorithm

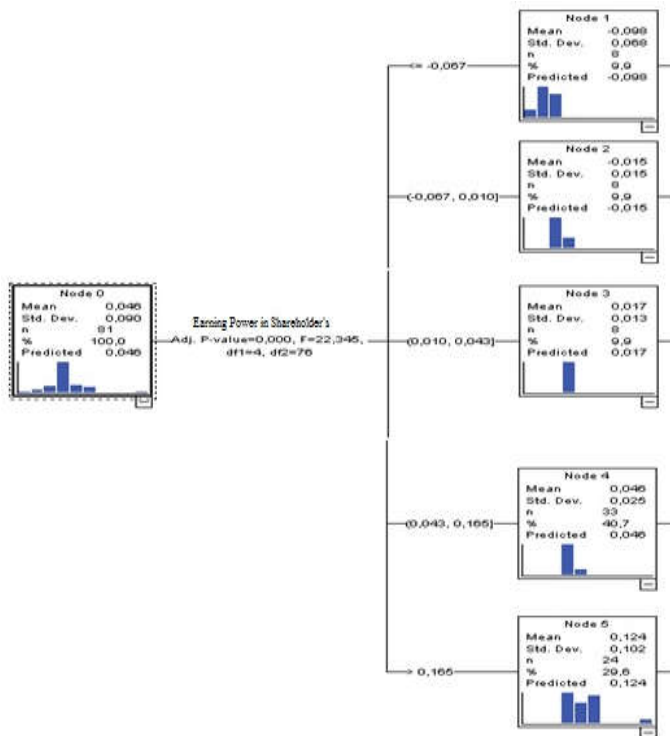


Table 5. Means of Leaf Nodes

Leaf	N	%	Mean
20	1	1,2%	,5328
37	8	9,9%	,1661
38	4	4,9%	,1271
36	3	3,7%	,1031
39	4	4,9%	,0737
35	8	9,9%	,0614
40	7	8,6%	,0433
27	1	1,2%	,0391
34	14	17,3%	,0367
26	1	1,2%	,0326
33	8	9,9%	,0236
25	1	1,2%	,0227
30	1	1,2%	,0146
28	1	1,2%	,0081
10	1	1,2%	,0081
32	1	1,2%	,0074
31	1	1,2%	,0070
29	1	1,2%	,0069
13	1	1,2%	,0038
9	1	1,2%	-,0105
14	1	1,2%	-,0113
12	1	1,2%	-,0220
15	1	1,2%	-,0275
11	1	1,2%	-,0297
24	2	2,5%	-,0307
8	1	1,2%	-,0320
23	5	6,2%	-,0964
7	1	1,2%	-,2397

After that, these five main branches were branching with the help of other variables. It was the most suitable tree model of return on assets. When we look at the decision tree model, variable criteria are different according to followed path. As it can be analyzed on two variables in decision tree analysis, it can be analyzed on more than variables. There is no reduction in the number of independent variables in the neural networks analysis. Therefore, all of the variables are used in the model.

When installing the model of artificial neural networks, the number of layers and the number of neurons in these layers must be determined. In this study, as a result of tests, five-layer model is chosen as the most suitable which is including four secret layers and one output layer. Due to the lack of a fixed number of layers and precise rules, making tests are required to determine neural network model. It is not possible to give meaning of weight in layers. This avoids also the interpretation of the model. But it is successful to obtain values close to the actual values. In process of decision making, if reduction of dimension is not needed or wanted, artificial neural networks may be preferred. In this method, all variables can take position. If reduction of dimension is needed or wanted, decision tree analysis would be more appropriate. This analysis comes to the forefront partitioning. When decision maker wants to give more importance to the partitioning, he could see it as preferable. Decision tree analysis is expressed profitability with eight variables, but artificial neural networks are with sixteen. Decision tree analysis allows reduction on variables, but artificial neural networks cannot. It uses all variables. Decision tree analysis is simple to interpret. It can be interpreted on leaves and branches. However, artificial network model can't be interpreted and explained. Results of neural network are very close to actual values. This can be chosen reason of neural network. Artificial neural network is successful about results.

As a practice, technology sector was discussed. Testing applied to other sectors is expected to be subject of future studies. Decision tree analysis was used CHAID algorithm in this study. Using algorithms running on continuous data except CHAID is expected to be subject of future studies. Similarly, using feed-back network model in artificial neural network is expected to be subject of future studies.

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