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EXAMINING THE FINANCIAL RATIOS AND PROFITABILITY OF COMPANIES BY USING ANFIS: A STUDY ON LEATHER AND CLOTHING INDUSTRIES TRADED IN BIST

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ABSTRACT

This study aims to predict Return on Equity (ROE), Return on Assets (ROA), and Return on Sales (ROS) of the textile industry companies traded in Borsa İstanbul (BİST). For this purpose, a dataset was prepared using 7-year (2013-2019) liquidity, financial structure, operation, and rate of return data of 20 companies operating in the textile industry. The financial ratios of these companies were subjected to principal components analysis and it was determined that the first 4 components explained approx. 84% of all the data. These first 4 components with eigenvalues higher than 1 were modeled using ANFIS and, as a result of the experimental study, it was determined that the model was successful at predetermining the companies' return on equity at the level of 81%, return on assets at the level of 79%, and net profit margin at the level of 71%.

Keywords: Financial Management, Return on Equity (ROE), Return on Assets (ROA), Return on Sales (ROS), Fuzzy Set Methods

Jel Codes: C10, C49, C51, M00

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FİNANSAL ORANLAR İLE FİRMA KARLILIKLARININ ANFIS YÖNTEMİ İLE İNCELENMESİ: BİST'DE İŞLEM GÖREN TEKSTİL GİYİM EŞYASI VE DERİ SEKTÖRÜ ÜZERİNE BİR ARAŞTIRMA

ÖZ

Bu çalışmanın amacı, Borsa İstanbul'da (BİST) işlem gören tekstil sanayi işletmelerinin öz sermaye karlılığı (ROE), Aktif karlılığı (ROA) ve Net kar marjı (ROS) oranlarının önceden tahmin edilmesidir. Bu amaca yönelik tekstil sektöründe faaliyet gösteren 20 firmanın (2013-2019) yedi yıllık likidite, finansal yapı, faaliyet ve karlılık oranları hesaplanarak veri seti oluşturulmuştur. Firmaların finans oranları temel bileşenler analizine tabi tutulmuş ve ilk dört bileşenin toplam verinin yaklaşık %84'ünü açıklayabildiği tespit edilmiştir. Özdeğeri 1'den büyük olan ilk 4 bileşen ANFİS'le modellenerek yapılan deneysel çalıma sonucunda işletmelerinin öz sermaye karlılığını %81, aktif karlılığını %79 ve net kar marjını ise %71 oranında önceden tahmin etmede başarılı olduğu tespit edilmiştir.

Anahtar Kavramlar: Finansal Yönetim**,** Öz Sermaye Karlılığı, Aktif Karlılık, Net Kar Marjı, Bulanık Mantık

Jel Kodları: C10, C49, C51, M00

INTRODUCTION

Examining the financial tables, in which the changes in assets and sources of the companies occurring as a result of the business operations are summarized, by making use of different analysis methods enables determining the financial performance, weaknesses, and superiorities of the companies. The companies, which are operating in a fierce competition environment, use the data, which they obtain through financial analysis methods, in planning their business activities, improving their performance, and ensuring the continuity. Moreover, the information obtained from the analyses also makes it possible for shareholders and managers to assess the current situation and to make strategic decisions for the future. Financial ratios are obtained by proportioning the data in the financial tables to the relevant items. The financial ratios allow comparing the current situation of the company by the years and with other companies in the sector (Selimoğlu and Orhan 2015, 23).

Ratio analysis is the most commonly used financial analysis. Ratio analyses are clustered under 4 classes. The first of them is the liquidity analysis, which is used in assessing the working capital adequacy of company and short-term solvency, whereas the second one is financial structure ratios used for determining the long-term solvency and distribution of the source structure used in the funding. The third class is the operating ratios, which are used in investigating the relationship between asset usage ratios and assets and sales, whereas the fourth one is the profitability analysis examining the performance during the business operations (Karapınar, Bayırlı, Bal, Altay, and Bal, 2007, 689).

The main goal of companies is to maintain their existence forever and to achieve continuous growth. Profit plays an important role for companies to achieve this goal. The profit is defined as the sum of earnings of a company during a specific

operating cycle. In the present study, it is aimed to answer the question if the profitability ratio, which is the main goal of companies and plays an important role, can be predicted by relating to other financial ratios. When this question is answered, the use of the previous data in estimating the profit that companies will achieve at the end of term would play an important role in planning activities of companies. For this purpose, ANFIS method combining the neural networks developed by Jang and the fuzzy logic method was preferred. Since it is a study aiming to estimate the company profitability by making use of financial ratios, this study will provide a new perspective and novelty to the literature in comparison to the other studies.

I. LITERATURE REVIEW

The fuzzy logic approach is considered as a sub-branch of artificial intelligence works. Despite two important logic suggestions of Aristo, it was developed as a product of very important logic studies. It can be seen that the fuzzy logic approach, which has been first used in the steam engine system, is very widely used nowadays. The use of fuzzy logic in financial management is a very new subject. The use of fuzzy logic in stock price estimations, credit rating, portfolio selection, and risk analysis has become a very popular practice. Some of the studies using this approach are presented below.

In their study titled "Estimation of Stock Prices with Fuzzy Logic Approach: A Research in BIST Industry Sector",

Kanat and Dilek (2018) established a system providing buy-sell signal by combining technical analysis, fundamental analysis, and market anomalies. Then, they used it on BIST 30 companies by relevant method and different criteria. Making use of the new system established with fuzzy logic approach and repeating the analysis on the relevant shares for the period between early 2005 and the last day of year 2016, they revealed that the analyses conducted using fuzzy logic yielded better results when compared to the classical logic and that the use of analysis methods and anomalies together might be more useful than the use separately.

Yıldız and Akkoç (2016), in their study carried out using Adaptive Network-Based Fuzzy Inference System (ANFIS) for the period 2000-2013, reported that the relationship between working capital and profitability is not linear and the highest profitability corresponds to the turning-to-cash period of 90 days.

Koç and Ulucan (2016), in their study, aimed to determine the failures of companies operating in real industry. For this purpose, they used the data of companies traded in Textile and Technology Index of BİST (2006-2013), calculated the Altman Z scores, and then tried to estimate these scores by using the model established with ANFIS. As a result of their analysis, it was determined that ANFIS is an efficient method for estimating the company failures.

Mangale, Meena, and Birchha (2015), in their study titled "Prediction of Stock Values Based on Fuzzy Logic Using Fundamental Analysis", used the

principal analysis with fuzzy logic approach in predicting the stock prices. Using the system they designed, the authors aimed to determine the real values of stocks and claimed that the system they designed might yield successful results in long-term price predictions.

In their study, Yörük, Karaca, Hekim and Tuna (2013) predicted the rate of return on stock by using the Adaptive Network-Based Fuzzy Inference System (ANFIS). The researchers used the balance sheet and income statement items of 40 industrial companies, which were traded in İMKB 100 index, announced in the period 2003-2007 and they compared the real ROS values with the values predicted using ANFIS analysis. As a result of the comparison, they found 4 input variables, which were found to be significant among 14 variables, to be used in ANFIS. Using these significant variables, they conducted the same experiment and the ANFIS model yielded almost the same prediction success. In conclusion, it was shown that it is possible to reduce the risk of investors and companies by making use of fewer input variables.

Esen (2013), in a study titled "Practice of Technical Analysis with Fuzzy Logic Approach: The Case of IMKB 30", selected 12 stocks from İMKB-30 index by using certain criteria. The 17-year data were used in the implementation. The 17-year period was first used for the measurement period and for the optimization of signal values providing the maximum revenue. Second, this period was used as the prediction period. Esen measured if the model developed as a result of the implementation yielded a revenue higher than normal.

Birgili and Esen (2013), in their study titled "Practice of Technical Analysis with Fuzzy Logic Method: The Case of IMKB 30 Banking Stocks", used the technical indicators (ADX, CCI, and RSI) and fuzzy logic approach in trading decisions for banking stocks traded in İMKB 30 index.

Divya and Kumar (2012), in their study titled "The Investment Portfolio Selection Using Fuzzy Logic Genetic Algorithm", used the fuzzy logic and genetic algorithms and carried out a study on portfolio selection. They claimed that more successful results can be obtained by using these two subtypes of artificial intelligence together (Divya and Kumar, 2012, 2105).

Gülgör (2010), in a study titled "Portfolio Selection with Classical and Fuzzy Analytical Hierarchy Process in İMKB 30 Index and Comparison of Their Performances", compared the classical logic approach to the fuzzy logic approach in establishing the optimum portfolio. In that study, the fuzzy hierarchy process and the classical hierarchy approach were used in the portfolio selection and the authors concluded that the fuzzy hierarchy process was more efficient. By using the 2000-2008 return data of stocks traded in İMKB-30 index, 7 stocks with the lowest correlation were selected. Sharpe criterion was used in determining which method yielded the better results. The Sharpe score of fuzzy logic system was found to be

22.61%, whereas that of classical system was found to be 20.90%. This finding suggests that the fuzzy logic system provided more return for every unit of risk.

Boyacıoğlu and Avcı (2010) carried out a study on predicting and modeling the IMKB stock return index by using ANFIS. The authors used six macroeconomic variables and three indices as input variables. As a result of their study, they reported that the model established predicted the monthly return of IMKB-100 Index with 98.3% accuracy rate.

Khcherem and Bouri (2009), in their study titled "Fuzzy Logic and Investment Strategy", developed a system with behavioral finance approach using the fuzzy logic. In their study, daily stock prices of 25 companies within the period between 2001 and 2008 were considered. Dividing this period into two, the authors used the first period in order to determine the rules. In their study, they achieved successful results by combining the investor behaviors and technical values such as return, momentum, and stochastic. The results they achieved revealed that the human behaviors might also be assessed using the fuzzy logic approach.

Thiagarajah, Appadoo, and Thavaneswaran (2007), in their study titled "Option Valuation Model with Adaptive Fuzzy Numbers", used the fuzzy numbers in assessing the options rather than using classical numbers. In their study, the Black-Scholes Equation was utilized and the fuzzy numbers, rather than absolute numbers used in the literature, were preferred. In their study, the fuzzy numbers were preferred for the variables, which have no specific characteristic, such as interest rates, fluctuation rate, and stock prices. The authors used the European-type call options. As a result of their study, it was determined that the fuzzy-based Black-Scholes option pricing model was useful.

Pelitli (2007), in a study titled "Fuzzy Logic Approach in Portfolio Analysis and Application Sample", used the data of stocks, which were traded in İMKB-50 index, for the period between 2001 and 2006. In their study, the authors addressed designing the optimal portfolio by making use of a fuzzy linear programming approach. Their study, avoiding the subjective decisions, aimed to make more accurate decisions and a specific portfolio was established based on the index.

Gamil, El-fouly and Darwish (2007), in their study titled "Stock Technical Analysis using Multi-Agent and Fuzzy Logic", aimed to create a system that might help the investors, who invest in stock market, with their decisions. The data were obtained from NASDAQ and then the fuzzy logic rules were adapted using genetic algorithm, which is one of the most effective methods in transforming the fuzzy logic rules. The rates of estimation success in analyzing the short-, medium-, and long-term transactions were 100%, 90%, and 80%, respectively. Based on the findings, the authors concluded that it was a very good decision support system but the results of analysis were not offering absolute accuracy.

Cheung and Kaymak (2007), in their study titled "A fuzzy logic-based trading system", created trading signals with the fuzzy logic approach by using

certain technical analysis indicators. Then, the authors aimed to create optimal portfolios using these signals. They compared the performances of created portfolios to the performances of portfolios created using different methods. Differing from similar studies, the authors optimized the fuzzy logic in their study by using the genetic algorithm model. Although other hybrid models such as artificial neural networks can be used in optimization, genetic algorithm was preferred because it has a more flexible structure.

Cheng, Quek and Mah (2007) used the Adaptive Network-Based Fuzzy Inference System (ANFIS) in predicting the actions of investors in the stock exchange (when to buy and sell). As a result of their analysis, the authors showed that ANFIS model was successful in learning and predicting but it was very complex for estimating the market behaviors.

Doesken, Abraham, Thomas, and Paprzycki (2005), in their study titled "Real Stock Trading Using Soft Computing Models", tested different artificial intelligence models in terms of their capabilities of measuring the performances of stocks by using 13-year data of Microsoft and Intel stocks. It was found that Microsoft stock worked more efficiently in modeling when compared to Intel stock and that its best and worst returns on investment were 103% and 66%, respectively. Moreover, it was also emphasized that selecting the right stocks is as more important as establishing the accurate model.

Dong and Zhou (2002), in their study titled "Exploring the Fuzzy Nature of Technical Patterns of US Stock Market", analyzed the stocks of 1451 companies. The authors aimed to mimic persons' abilities such as making decision and process analysis under uncertainty conditions. The data were obtained from daily data pool of 2000 Center for Research in Security Prices (CRSP). The stock prices obtained were corrected for the irregularities arising from stock division and dividend distribution. Since significant revenue differences were observed between two portfolios in terms of the other indicators, it was emphasized that accurately determining the membership degree is of vital importance in the fuzzy logic approach.

Lam (2001), in a study titled "A Genetic Fuzzy Expert System for Stock Market Timing", combined the genetic algorithm model and fuzzy logic and aimed to find more reliable trading signals in stock exchange market. In their study, the genetic algorithm was used in optimizing the fuzzy rules. As a result of the analysis, it was determined that genetic algorithm contributed to fuzzy system in creating more consistent trading signals.

Dourra and Siy (2001), in their study titled "Stock Evaluation Using Fuzzy Logic", assessed the data obtained from technical analysis indicators by using fuzzy logic approach and created stock trading signals. Technical analysis method incorporates many indicators in its structure and it is necessary to determine which

one to use. Since the results of indicators include no exact accuracy, the fuzzy logic approach can be used in this field.

Atsalakis and Valavanis, in their study titled "Forecasting Stock Market Short-Term Trends Using a Neuro-Fuzzy Based Methodology", considered the past prices of stocks and tried to estimate the stock price trend for the next day as long as possible. The main methodology is based on the neural network – fuzzy logic created from stock exchange and ANFIS control. In their study, it was emphasized that it was not possible to estimate the exact future prices of stocks even by using intelligent systems but the trend (upwards, downwards, and horizontal) could be estimated. Moreover, it was stated that also the market parameters explaining the exchange market activities should be known in estimating the stock price trend. It was estimated that, if the effects of these parameters on the stock prices could be monitored by following them, it would be possible to help the investors with their decisions on trading the equities.

II. STUDY METHODOLOGY

A. OBJECTIVE OF STUDY

The present study aims to predict the Return on Equity (ROE), Return on Assets (ROA), and Return on Sales (ROS) of the textile industry companies traded in Borsa İstanbul (BİST) by using their financial ratios.

B. VARIABLES

By making use of the financial tables of 20 textile industry companies traded in Borsa İstanbul (BİST) published by Public Disclosure Platform (KAP) for the period of 2013-2019, their liquidity ratios, financial structure ratios, operating ratios, and profitability ratios were used as variables. These ratios are used since they are widely used in the literature. The financial ratios used are presented in Table 1.

Table 1: Financial Ratios Used in the Study

Liquidity Ratios	Current Ratio	Current Assets / Short Term Liabilities (STL)
	Acid-Test Ratio	(Current Assets –Stocks) / STL
	Cash Ratio	(Liquid Assets + Effects) / STL
	Stock Dependency Ratio	STL – (Liquid Assets + Effects)/ Stocks
Financial Structure Ratios	Leverage Ratio	Total Foreign Assets / Total Liabilities
	Financing Ratio	Equity Capital / Total Foreign Assets
	Debt / Equity Ratio	Total Foreign Assets / Equity Capital
	Real Assets / Equity Capital	Real Assets / Equity Capital
	Real Assets / Constant Capital	Real Assets / Constant Capital
	Constant Capital Dependency Ratio	(Stocks + Trade Receivables – Trade Liabilities) / Constant Capital
	Accounts Receivables Turnover	Net Sales / Trade Liabilities

Operating Ratios	Real Assets Turnover Rate	Net Sales / Real Assets
	Stock Turnover	Cost of Sales / Average Stock
	Asset Turnover	Net Sales / Asset Turnover
Profitability Ratios	Return on Equity	Net Profit / Equity Capital
	Economic Rantability	Profit Before Taxes and Interest / Total Liabilities
	Business Volume Rantability	Operating Profit / Net Sales
	Gross Sales Rantability	Gross Sales Margin / Net Sales
	Operating Assets Rantability	Net Profit / Current Assets
	Return on Sales (ROS)	Net Profit / Net Sales
	Return on Assets (ROA)	Net Profit / Total Assets
	Return on Equity (ROE)	Net Profit / Equity Capital

Kaynak: Ceylan and Korkmaz, 2015, 43-72

III. METHODS

In the present study, it is aimed to predict the company's profitability by using the financial ratios. For this purpose, the ANFIS model developed and introduced by Jang in year 1993 and having various advantages was used (Jang, 1993; 670). A two-stage method was preferred in this study because the higher number of variables increases the number of rules in ANFIS system and has a negative effect on the system performance. In the first stage, the number of financial ratios was reduced by using the principal components analysis. Then, using this reduced number of ratios in ANFIS system, the company profitability estimations were performed.

A. PCA (PRINCIPAL COMPONENTS ANALYSIS)

Since 14 different financial ratios were used as independent variables, the multicollinearity poses an important problem for the linear models. Besides this problem, it is difficult for ANFIS model to work with too many variables because the increase in the number of variables dramatically increases the number of rules and causes difficulties in teaching the model. In order to overcome these two problems, it is necessary to reduce the number of variables. In this study, the Principal Component Analysis was used in reducing the number of variables (Cheng et al. 2007, 117). Principal Component Analysis has been used in reducing the number of dimensions in many studies and yielded successful results (2, 3). Principal Components Analysis requires the Bartlet test and evaluating the KMO value.

B. ANFIS (ADAPTIVE NETWORK-BASED FUZZY INFERENCE SYSTEM)

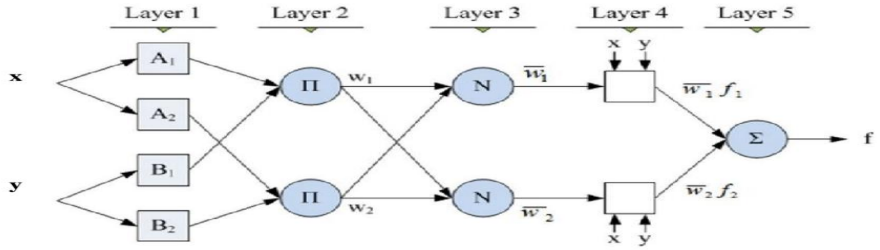
ANFIS is a method developed by Jang and is based on the use of neural networks and fuzzy logic methods in combination. ANFIS system incorporates "if, then" rules and these rules are created and adapted by the system using the data.

The structure of an ANFIS system with 2 inputs, 1 output, and 2 rules is presented in Equation 1, Equation 2 and Figure 1.

Rule 1: If x=A_1 and y=B_1, then $f_1 = p_{1x} + q1y + r_1$ (1)

Rule 2: If x=A_2 and y=B_2, then $f_2 = p_{2x} + q_{2y} + r_2$ (2)

Figure 1. Structure of ANFIS system



The model incorporates 6 layers, where the neurons in the same layer are from the same function family. The layers are input, fuzzification (1), rule (2), normalization (3), defuzzification (4), and output (5). In the first layer, the memberships of the input variables are determined using fuzzy clusters. In the second layer, the weighing coefficient is calculated by multiplying the cluster membership values. In the third layer, these weighing coefficients are normalized. Then, in the last layer, the output values of ANFIS system are obtained by multiplying these coefficients by the rule outputs. At the stage of teaching the ANFIS, the fuzzy cluster values and rule output values are determined and the system is achieved.

IV. ANALYSIS AND RESULTS

Before the application, the financial ratios calculated were subjected to the Bartlet test, which is required for the principal components analysis, and KMO value was obtained. The analysis showed that the data were suitable for the principal components analysis. KMO value was found to be 0.88 (good) and Bartlet test statistic to be p = 0.12 (statistically significant).

The financial ratios of the companies were subjected to principal components analysis and the eigenvalues and explanation percentages are presented in Table 2.

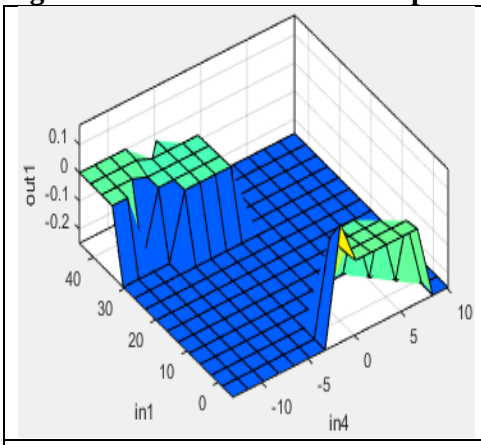
Table 2. Eigenvalues and Total Variance Percentages

Components	Eigenvalue	Explained Variance	Cumulative Variance
1	5.074	36.239	36.239
2	3.367	24.052	60.291
3	1.737	12.405	72.696
4	1.540	10.998	83.694
5	.762	5.442	89.135
6	.435	3.105	92.240
7	.337	2.404	94.644
8	.314	2.246	96.890
9	.161	1.147	98.037
10	.103	.738	98.775
11	.070	.498	99.273
12	.054	.389	99.662
13	.042	.298	99.959
14	.006	.041	100.000

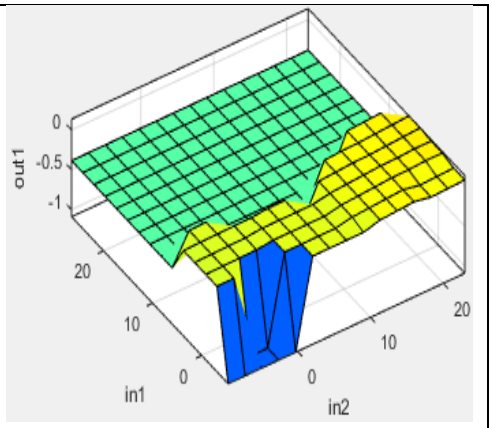
As seen in Table 2, the first 4 components explain approx. 84% of the total variance. These first 4 components with eigenvalues higher than 1 were used in the rest of the analysis. The values obtained from principal components analysis and the profit data were used without normalization.

The factor loads obtained from PCA constitute the inputs of ANFIS and the profit ratios constitute the output of ANFIS. The surface showing the status of output variable based on the input variables of ANFIS system created is illustrated in Figure 2.

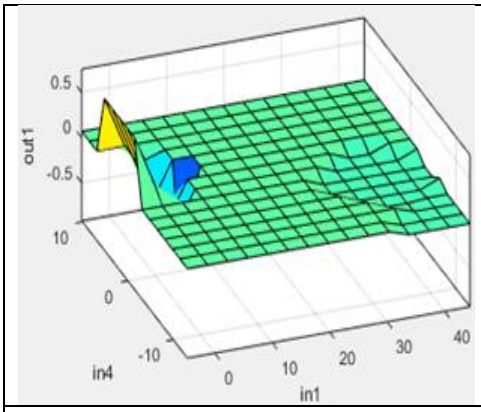
Figure 2. Surface Scheme of Output Variable



a. ROE



b. ROA



c. ROS

The success values obtained from test procedure performed with 5-times crossing are presented in Table 3. It can be seen in this table that ANFIS system is very successful in estimating the Return on Equity.

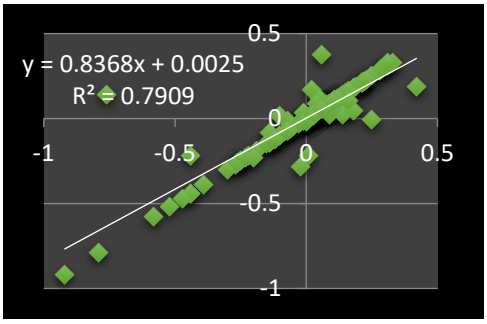
Table 3. Performance values

	MAE*	MSE**	RMSE**	R^2
ROS	0.216	0.138	0.3714	0.86
ROA	0.189	0.096	0.3098	0.83
ROE	0.156	0.051	0.2258	0.79

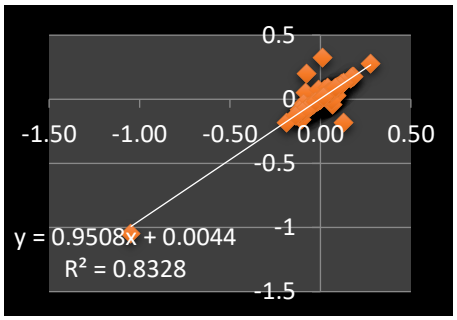
*Mean Absolute Error, **Mean squared error, ***Root mean squared error

The relationship between the estimation values, which were obtained by applying all the datasets consisting of companies' data in ANFIS, and the real values is presented in Figure 3.

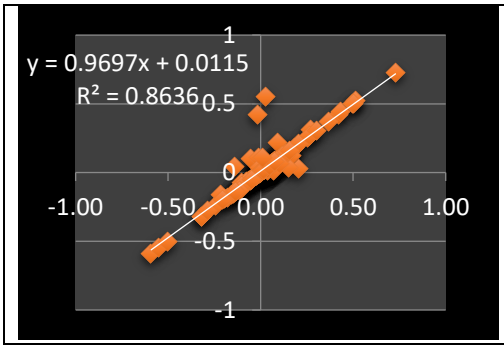
Figure 3. Relationship between real and estimated values



a. ROE



b. ROA



The distribution of profitability values in Figure 3 was obtained from the distribution of financial ratios. Given the distributions, it can be seen that the real values are in parallel with the estimated profitability values. This consistency is very important for estimating the possible profit or loss.

CONCLUSION AND DISCUSSION

In literature, it can be seen that there are many studies carried out on estimating the successes and failures of companies by using the financial ratios. In order to find the answer of the question if the profitability ratios can be estimated by using the financial ratios and to contribute to the relevant literature, the datasets were obtained by calculating the liquidity ratios, financial structure ratios, operating ratios, and profitability ratios of 20 textile companies traded in BİST companies by using their data published in KAP for the period between 20013 and 2019.

The dataset includes 14 different financial ratios. These ratios constitute 14 variables in ANFIS system. The higher number of variables causes a higher number of rules in ANFIS system and it creates complexity rather than understandability. For ANFIS system to function efficiently, the principal components analysis was performed in order to reduce the number of variables in parallel with the objective study. By reducing the number of variables, the number of rules in ANFIS system was also decreased and the understandability was improved. The number of financial ratios was reduced from 14 to 4. The profitability of companies was obtained using these 4 independent variables. As a result of the analysis, 3 different profitability ratios (ROS, ROA, and ROE) could be very successfully estimated.

It is important that the return on equity could be very successfully estimated. The return on equity indicates how high revenue the shareholders could achieve upon the capital they invested. In other words, it indicates the return of 1 unit of capital. The return on equity is an important criterion for assessing the management performance. A return on equity increasing in the course of time indicates that the company is managed effectively, whereas a decreasing ratio indicates a poor management performance. The pre-estimation of this ratio would allow companies to take their management performance under control during the operation period, as

well as providing the investors, who are trading in the stock exchange, with important information.

The present study can be reproduced using different companies and different financial ratios and the success of the suggested model can be revealed. With the suggested model, the companies can estimate their final profit rates by using their first-quarter data in this system. Moreover, this system can also guide the investors in their investments by estimating the profitability.

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