Prediction of Firm Value with Financial Structure Items: An Implementation on Metal Industry

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Abstract

Firm value is an important measure for creditors on credit process and for investors in investment decisions. So estimating of firm value is important previously. In this study, a model which estimates firm value was established, by using the values of capital structure like short term liabilities, long term liabilities and equity capital. The research sector is Metal Industry and Metal Goods, Machinery And Tool Industry and the used data which covers 2004-2008 years gathered from the official web site of Istanbul Stock Exchange (ISE). By using Adaptive-Network-based Fuzzy Inference System (ANFIS) firm values were estimated. It is clear that at the end of the study ANFIS model has predicted the market value of the firm in (t+1) period with small error rates.

Keywords: Firm Value, Capital Structure, Anfis Modeling

1. Introduction

Changing and globalizing economic conditions changed the success criteria of firms. Nowadays, increasing the market value becomes important factor while profit maximization was on the top of the priorities list of firms in 1900s. Firm value concept which becomes popular lastly creates an important study field for the finance society.

Firm value can be defined as "the value if firm is sold with its whole tangible and intangible assets." The concept of firm value changed with time. Cash flows were important for the firm valuation in past while firm value is evaluated in a wide range by using different approaches called as modern approaches that emerges nowadays. These approaches advocate that firms don't consists of from cash flows but there are other variables that can have impact on firm value.

Aim of firm value evaluation in all approaches and methods is to maximize firm value. For this purpose, it is important that resources of firms, equity capital and liability which generate capital structure and the ratio of equity capital and liability.

Artificial intelligence models are based on neural networks, genetic algorithm and fuzzy neural techniques. These techniques can learn to detect complex patterns that are hidden in data and cannot be uncovered easily. Mathematically, these AI techniques are universal non-linear function predictors capable of capturing and modeling almost any input output relationships (Tan et. al. 2011). AI models also have advantages over statistical models. Relatively, they are more efficient and effective than statistical models in prediction and pattern recognition. Unlike most of the statistical models, they do not require any specific distribution of data or underlying theory. They are able to manage non-linear or complex relationships better and at the same time accommodate relatively larger number of variables.

Soft computing techniques are widely applied to stock market problems. They offer useful tools in forecasting noisy environments like stock markets, capturing their non-linear behavior (Atsalakis & Valavanis, 2009). Although Anfis has been applied in several studies, few of these have contributed to research in the financial area. This study contributes to the field of financial research. The main goal of this study is to explore the predictability of firm value on ISE index of metal goods by using ANFIS modeling. Index of Metal Goods includes the manufacturers of; gas cylinder, home appliances, nail, air conditioning, solar collectors, welded pipes, agricultural machinery, nuts and bolds, rim, motor casting parts, metal pipes and cables. This

industry covers different sub sectors because of its structure and it realizes the production of variety of end products. The firms who products the inputs to the above mentioned firms are also in this index. Construction firms need the products of metal goods and this increases the importance of the value of the firms that are operating in metal goods.

According to the projections of Oxford Economics construction sector is expected to growth with 5.2% while this ratio is 6.4% and 10.1% in automotive and metal goods respectively. With these projections the importance of the firm values in the metal goods sector becomes clearer. This study will contribute to the literature with examining this subject. This study is also important, because it tries to predict the values of the firms in such a big growing sector (Iron and Steel Sector Report, 2010).

2. Literature review.

There are a lot of studies in literature. Huge part of this studies are about the firm value and the capital structure (Modigliani and Miller, 1958), (Elton and Gruber, 1971), (Özaltın, 2006),(Burca, 2008) or relationship between firm value and dividend allocation policies (Miller and Modigliani, 1961),(Doğukanlı, 1994),(Ünsal, 1998),(Karaca, 2007),(Belkayalı, 2004).

Masulis (1993) developed a linear regression with least squares method in order to determine the effect of the change in the capital structure to the firm value. At the end of his studies he found a positive relationship between firm value and changes in stock prices. And there is a positive relationship between the change of firm value and change in debt.

Yenice (2001) aimed to measure the effect of the capital structure on the firm value and the efficiency in his study. He used the data of 37 firms that operates in a subfield of production industry between the years of 1999-2000. His results indicate no meaningful relations.

Bayrakdaroğlu and Ege (2008), examined the three-month financial statements of insurance firms that are in the index of IMKB between the years 2000 and 2004. They used multivariate regression analysis in order to put forward the relationship between debits, provisions and other debits and current value and the efficiency of firm. According to their results there is no statistically meaningful relationship between firm value and capital structure but there is a negative relationship between firm efficiency and the capital structure.

Other studies about this fields firm value is handled with different aspects. In 1992 Fama and French researched the relationship between firm value and stock returns. Firm value is represented by Book Value / Market Value (BV/MV). Results indicate positive relationship between firm value and returns. (Fama and French, 1992:427-465).

Arkan (2010) prepared a study about the relationship between financial structure of firms and the value of firm. He conducted multiple regression analysis and correlation to the data including 127 firms on the index of ISE. According to his results a 1% increase or decrease in equity leads to a 1.1% increase or decrease in firm value.

Anfis is generally used in the prediction of the returns of stocks in literature. Grosan et. al. (2005) used a new artificial intelligence technique called Multi Expression Programming (MEP) in prediction of stock index and compared the results with artificial neural network with Levenberg-Marquardt learning algorithm, support vector machine, Takagi-Sugeno Neuro-Fuzzy model and Difference Boosting Neural Network. Results indicate a lower error rate in MEP when compared with other AI techniques.

Afoloabi and Olude (2007) used Self Organizing Maps with ANFIS for predicting the stock price. At the end of the study it becomes clear that SOM are showed less variance than other techniques.

Yunos et al. (2008) developed an ANFIS model in order to predict the daily movements of Kuala Lumpur Compound Index (KLCI). In order to verify the efficiency of ANFIS model they made two experiments and results indicate the efficiency of ANFIS.

Abbasi and Abouec (2009;11336) tried to predict price trend of the Khodro Company operating in Tahran Stock Exchange with ANFIS. Results indicate that ANFIS can predict the stock prices with small error rates.

Atsalakis and Valavanis (2009) tried to predict the other day's stock price with ANFIS. In this study a lot of possibilities are tried with changing the parameters via trial and error method. Results indicate the sufficiency of the model to predict the stock price prediction.

Boyacıoğlu and Avcı (2010) used ANFIS to predict the stock market returns. There were 9 input variables, 6 of which macroeconomic variables. At the end of their study they were 98.3% successful in the prediction of the ISE-National 100.

ANFIS is being used in financial studies because it makes easier the prediction of future values. But it hasn't been used in firm value foresight. The importance of this study is that it is the first study that uses the ANFIS to predict the firm value.

3. Theory of adaptive neuro-fuzzy inference system (ANFIS)

A specific approach in neuro-fuzzy development is the Adaptive Neuro-Fuzzy Inference System (ANFIS), which has shown significant results in modeling nonlinear functions (Jang et al., 1997). The ANFIS is a new improved tool and a data driven modeling approach for determining the behavior of imprecisely defined complex dynamical systems (Kim & Kasabov, 1999). The basic idea behind the neuro-adaptive learning techniques is very simple. These techniques provide a method for the fuzzy modelling procedure to learn about the data set, and to compute membership function parameters that will best suit the associated fuzzy inference system (FIS) for given input/output set. The ANFIS learning method works similarly to the neural networks one (Jang, 1993)

The advantages of FL for grade estimation is clear because it prepare a powerful tool that is flexible and in lack of data with its ability which is if-then rules would able to solve the problems. As discussed, one of the biggest problems in FL application is the shape and location of membership function for each fuzzy variable which solve by trial and error method only. In contrast, numerical computation and learning are the advantages of neural network, however, it is not easy to obtain the optimal structure (number of hidden layer and number of neuron in each hidden layer, momentum rate and size) of constructed neural network and also this kind of artificial intelligent is more based on numerical computation rather that than symbolic computation. Both FL and NN have their advantages, therefore, it is good idea to combine their ability and make and strong tool and also a tool which improve their weak as well as lead to least error. Jang (1993) combined both FL and NN to produce a powerful processing tool named NFSs which is a powerful tool that have both NN and FL advantages and the most common one is ANFIS.

Neural Networks and Fuzzy Logic are the two key technologies that have recently received growing attention in solving real world, nonlinear, time variant problems. Because of their learning and/or reasoning capabilities, these techniques do not need a mathematical model of the system which may be difficult, if not impossible, to obtain for complex systems. Although these techniques have had successes in solving many real world problems, they have limitations as well. Intelligent combinations of these two technologies can exploit their advantages while eliminating their limitations.

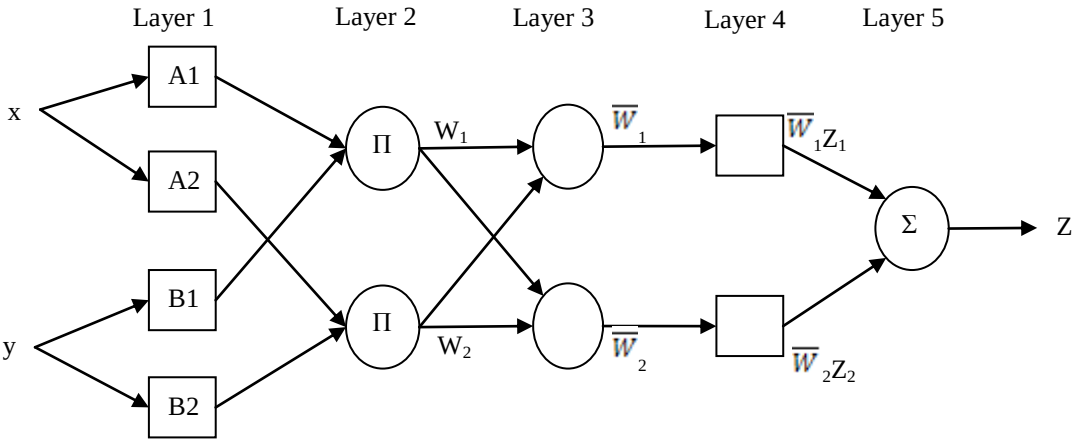

Figure 1. **A typical ANFIS architecture (Jang 1993). Here, x and y are the inputs and z is the final output, A1, A2, B1 and B2 are the linguistic label (small, large, etc.) associated with this node function, wi is the normalized firing strength that is the ratio of the ith rule's firing strength (Wi) to the sum of the first and second rules' firing strengths (W1 and W2) and Π is the node label.**

It consists of five layers (fig. 1.); the first layer carries out a fuzzification process. In the second layer, each node output is the product of the antecedent part of the fuzzy rules. The third layer normalizes the membership functions (MFs). The fourth layer executes the consequent part of the rules and the fifth layer computes the overall output as the addition of all incoming signals.

Adaptive-Network-based Fuzzy Inference System (ANFIS) is a Sugeno-type (Sugeno & Kang, 1988) fuzzy system in five-layered feed-forward network structure. ANFIS can be used to optimize membership functions and has the advantage of being able to construct fuzzy IF-THEN rules representing these optimized membership functions.

Since ANFIS is much more complex than the fuzzy inference systems discussed so far, you are not able to use all the available fuzzy inference system options. Specifically, ANFIS only supports Sugeno systems subject to the following constraints:

- First order Sugeno-type systems
- Single output derived by weighted average defuzzification
- Unity weight for each rule

An error occurs if your FIS matrix for ANFIS learning does not comply with these constraints. Moreover, ANFIS is highly specialized for speed and cannot accept all the customization options that basic fuzzy inference allows, that is, you cannot make your own membership functions and defuzzification functions; you'll have to make do with the ones provided. Using the Adaptive Neuro-Fuzzy Inference System (ANFIS) Editor, you can shape membership functions by training them with input/output data rather than specifying them manually. The toolbox uses a back propagation algorithm alone or in combination with a least squares method, enabling your fuzzy systems to learn from the data.

The most important reason for combining fuzzy systems with neural networks is to use learning capability of the neural network. While the learning capability is an advantage from the view point of a fuzzy system, from the viewpoint of a neural network there are additional advantages to a combined system. Because a neuro-fuzzy system is based on linguistic rules, we can easily integrate prior knowledge in to the system, and this can substantially shorten the learning process. One of the popular integrated systems is an ANFIS, which is an integration of a fuzzy inference system with a back-propagation algorithm (Jang, 1997; Lin, 1996).

In order for a FIS to be mature and well established so that it can work appropriately in prediction mode, its initial structure and parameters (linear and nonlinear) need to be tuned or adapted through a learning process using a sufficient input–output pattern of data. One of the most commonly used learning systems for adapting the linear and nonlinear parameters of an FIS, particularly the first-order Sugeno fuzzy model, is the ANFIS. ANFIS is a class of adaptive networks that are functionally equivalent to fuzzy inference systems (Jang, 1993).

4. Data set

The data which belongs to the firms that are registered to ISE index of Metal Industry and Metal Goods, Machinery and Tool Industry are used. Data also covers the years 2004-2008. In order to realize the purpose of the study secondary data is used. Data collected from the financial statements of firms for related years.

Firm value is an important measure for creditors on credit process and for investors in investment decisions. So estimating of firm value is important previously. In this study, a model which estimates firm value was established, by using the values of capital structure like short term liabilities, long term liabilities and equity capital. The research sector is metal industry and the used data which covers 2004-2008 years gathered from the official web site of Istanbul Stock Exchange (ISE).

In this study input variables are as follow: short term liabilities, long term liabilities and equities. Output variable is firm value. Market values that are issued by Istanbul Stock Exchange were used as firm value. Market value variable is the value in the period of (t+1).

Short term liabilities are the liabilities that have to be paid at most in one year or at the end of the activity period. Long term liabilities are the liabilities that are gathered from credit institutions, capital markets or the third part institutions and have a due date more than one year. Equities are representing the investments that come from firm owner or partners, priorities and undistributed profits.

To get a better ANFIS model and increase the performance, a data normalization process needs to be done. In the process of normalization the data is ranged between [0,1] or [-1,1]. This process is required in order to optimize the input and output neurons (Doğan, 2010:83). In this study Equation (1.1) is used to normalize the data:

$$X_n = \frac{X_0}{X_{max}} \qquad [1.1.]$$

Normalized data is separated as 75% for training and 25% as test data.

5. Development of ANFIS models

Fuzzy Logic Toolbox of MATLAB was used to build an ANFIS model. Using membership functions (MFS) of all types (trimpf, trampf, gauss etc.) for all input variables and linear for all outputs, the number of MFs assigned to each input variable is chosen by trial and error. After training and testing the number of MFs was fixed for each input variable, when the ANFIS model reaches to the acceptable satisfactory level. ANFIS architecture and training parameters at satisfactory level were illustrated in table 1.

Table 1. **ANFIS architecture and training parameters**

Membership Functions (MF) type	Gaussmf
Number of nodes	286
Number of linear parameters	500
Number of nonlinear parameters	30
Total number of parameters	530
Number of training data pairs	23
Number of checking data pairs	8
Number of fuzzy rules	125
NumMFs input 1	5

NumMFs input 2	5
NumMFs input 3	5

ANFIS models defined with rules and membership functions that are in convenient with input-output sets. In the process of defining the suitable membership function, the results are examined for every membership function. The membership function that returns the least error rate has been chosen.

6. Results and discussions

The accuracy of the results of the developed models are assessed using some statistical verification criteria such as R^2, MSE and MAE corresponds to the coefficient of correlation, mean square error and the mean absolute error. R^2 measures the statistical correlation between the predicted and actual values. This method is unique in that it does not change with a scale in values for the test cases as the previously mentioned measures do. Also note that here a higher number means a better model, with a 1 meaning perfect statistical correlation and a 0 meaning there is no correlation at all. This performance measure is only used for numerical input and output. MSE is the principal and most commonly used measure; sometimes the square root is taken to give it the same dimensions as the predicted value itself. Many mathematical techniques (such as linear regression) use the mean-squared error because it tends to be the easiest measure to manipulate mathematically. MAE is an alternative: just average the magnitudes of the individual errors without taking account of their sign. Mean-squared error tends to exaggerate the effect of outliers—instances whose prediction error is larger than the other but absolute error does not have this effect: all sizes of error are treated evenly according to their magnitude.

MSE and MAE values are calculated with equation 1.2 and 1.3, R^2 is calculated with the Excel's correlation coefficient formula.

$$MSE=\frac{\sum_1^N (x_i-y_i)^2}{N} \qquad [1.2.]$$

$$MAE=\frac{\sum_1^N |x_i-y_i|}{N} \qquad [1.3.]$$

In equation 1.2; N stands for the number of observation, x_i stands for actual data, y_i stands for the predicted data.

As can be seen in Table.2 some combinations are tested with changing the number and style of membership function. The least error rate belongs to Model 2.

Table 2. **Properties of the ANFIS models**

Model No	**MF TYPE**	**Number of MF**	**TRAIN**			**TEST**		
			R^2	**MAE**	**MSE**	**R^2**	**MAE**	**MSE**
Model 1	gaussmf	4 5 5	0.997864	0.008128	0.0002	0.984221	0.024766	0.001039
Model 2	**gaussmf**	**5 5 5**	**0.998065**	**0.007787**	**0.000181**	**0.987071**	**0.024766**	**0.001039**
Model 3	trimf	4 4 5	0.996241	0.011202	0.000348	0.723375	0.318772	0.15901

Model 4	gbellmf	4 5 5	0.99591	0.01211	0.000382	0.941193	0.024766	0.001039

In Model 2, MAE and MSE values are smaller than the other models for both the train and the test data. R^2 value is also smallest in model 2. For these reasons Model 2 is chosen for the rest of the analysis.

Values that are predicted with ANFIS method and relationship between the predicted values and actual values can be seen in figures.

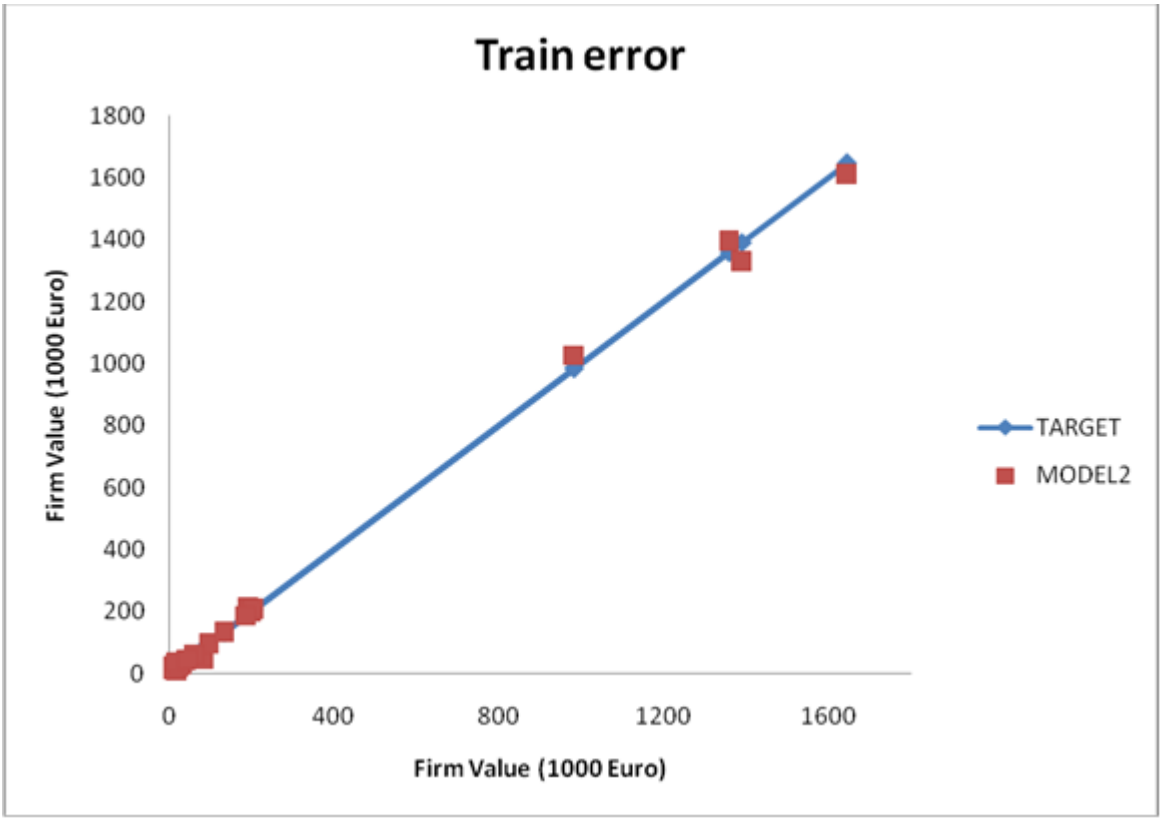

Figure 2 . The relationship between target data and actual outputs for training data.

In this figure actual data and predicted data can be seen. Input and ouput data is calculated with the currency of euro. The values predicted by ANFIS are closely related with the actual values as can be seen in Figure.2.

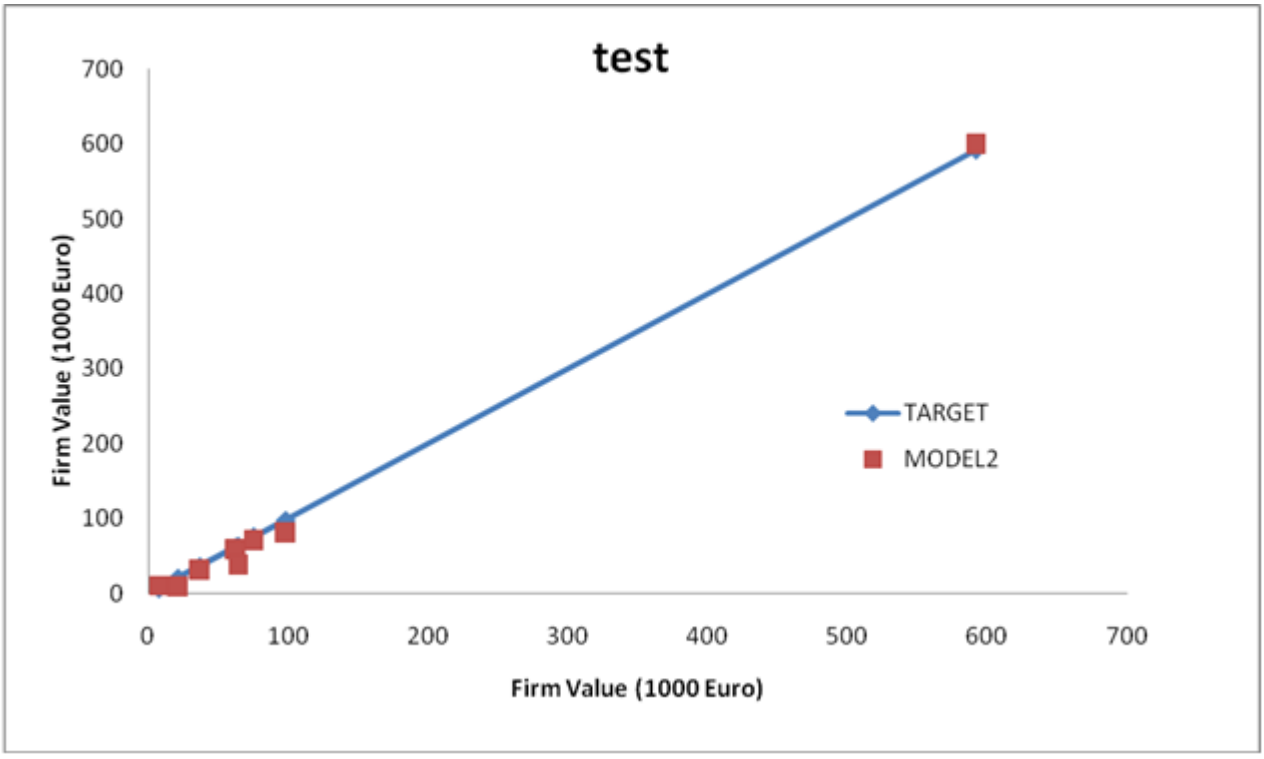

Figure 3. The relationship between predicted values and actual values for testing data.

In this figure the predicted values can be seen. ANFIS model returns quite well for predicting the future firm value.

The accuracy of the results of the developed models are assessed using some statistical verification criteria such as R^2, MSE and MAE corresponds to the coefficient of correlation, mean square error and the mean absolute error. R^2 measures the statistical correlation between the predicted and actual values. This method is unique in that it does not change with a scale in values for the test cases as the previously mentioned measures do. Also note that here a higher number means a better model, with a 1 meaning perfect statistical correlation and a 0 meaning there is no correlation at all. This performance measure is only used for numerical input and output. MSE is the principal and most commonly used measure; sometimes the square root is taken to give it the same dimensions as the predicted value itself. Many mathematical techniques (such as linear regression) use the mean-squared error because it tends to be the easiest measure to manipulate mathematically. MAE is an alternative: just average the magnitudes of the individual errors without taking account of their sign. Mean-squared error tends to exaggerate the effect of outliers—instances whose prediction error is larger than the others but absolute error does not have this effect: all sizes of error are treated evenly according to their magnitude.

The concept of firm value gathered interest from researchers especially in recent years. There are a lot of studies about the relationship between firm value and the capital structure. RMSE and MAE values are quite low while R^2 is very high.

7. Conclusion

As a result predicting the firm value with one year before is performed with low error rates. The correlation rate between the predicted firm values and actual ones are quite high on both of the train and test data (Train: 0.998. Test:0.987).

In this study different from other studies about the relationship between capital structure and firm value the relationship is investigate with ANFIS model. This model facilitated to research the relationship between capital structure and firm value. Also it allows calculating the firm value with financial structure items. It is thought that this study will be useful to see the usage of ANFIS model on the future studies and researches on financial field.

This study can also be improved with different time series or with different data set belong to various industries.

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