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A Fuzzy Logic Based Technical Indicator for BIST 30 Index and Islamic Index

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Abstract

Fuzzy logic, originally introduced by Lofti Zadeh in the 1960's, resembles human reasoning in its use of approximate, vague, noisy or imprecise data/information and uncertainty to generate decisions. According to Sriram (2005), fuzzy theory was designed with a specific purpose of mathematically representing vagueness and provides formalized procedures for tackling the impreciseness inherent in many variables in a multitude of problems. Crises, bubbles, fiscal politics etc. makes investing difficult in financial markets. These issues haphazardly raise and cause irregular characteristics which also raise risk. On the other hand, traders and market participants try to reduce risk and increase returns. We try to make dependable suggestion tool which contains a few technical indicators using fuzzy logic modeling. In financial markets technical analysis is commonly used to provide trading decisions. Technical analysis presumes that there are trends and patterns in financial assets' movements. In this study, BIST-30 and Islamic (Participation) Index data is used between March 2012 and November of 2014 taken from Borsa Istanbul. The aim of the study is to create a new technical analysis indicator using fuzzy logic method which could be an alternative to popular indicators used by traders. BUY and SELL signals given by indicators' after closing prices are assumed to be applied in the next day opening prices when calculating the indicators' performance. The performance of the indicator for BIST-30 and Islamic index is measured by modified sharpe ratio and compared to widely used indices like MACD, MA, RSI and OBV. The Sharpe ratio is used to calculate risk adjusted return. It shows the rate of return as opposed to risk . The asset which has the higher Sharpe Ratio is considered to yield better return for the same amount of risk.

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Keywords: Fuzzy Logic, Technical Indicator, BIST 30 Index, BIST Islamic Index

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1. Introduction

Crises, bubbles, fiscal politics etc. makes investing difficult in financial markets. These issues haphazardly raise and cause irregular characteristics which also raise risk. On the other hand, traders and market participants try to reduce risk and increase returns. We try to make dependable suggestion tool which contains a few technical indicators using fuzzy logic modeling.

In financial markets technical analysis is commonly used to provide trading decisions. Technical analysis presumes that there are trends and patterns in financial assets' movements. The success of technical analysis depends interpreting the right signals. This is why, human expertise and experience is important for traders to detect changing signals in market conditions. Recommendation structures based on technical analysis often use merely predetermined rules. Fuzzy systems have the potential to adding the human experience into the trading systems.

1.1. Literature Survey

Fuzzy logic, originally introduced by Lofti Zadeh in the 1960's, resembles human reasoning in its use of approximate, vague, noisy or imprecise data/information and uncertainty to generate decisions. According to Sriram (2005), fuzzy theory was designed with a specific purpose of mathematically representing vagueness and provides formalized procedures for tackling the impreciseness inherent in many variables in a multitude of problems.

Technical indicators are used in conjunction with fuzzy systems in many studies. Zhou and Dong estimate the ambiguity in financial assets by using fuzzy process. Their algorithm makes easier to spot trends in price movements by traders. Lin et al. use a fuzzy system with KD technical index to forecast stock indices movements. KD index is a stochastic oscillator, which consist of two lines namely K and D, where D is smoothed version of the K line. Their study displays that the fuzzy systems performance is notably better than linear regression models, neural networks and other investment strategies.

Cheng et al (2001) proposed a new fuzzy time-series model which incorporates the adaptive expectation model into forecasting processes to modify forecasting errors. Shiva (2002) presented a computational method of forecasting based on high-order fuzzy time series. Wong et al (2008) proposed traditional time series method (ARIMA model and Vector ARMA model) and Fuzzy Time Series Method (Two-factor model, Heuristic model, and Markov model) for the forecasting problem.

Ahmed, Raaffat and Nevins (2007) proposed a multi agent and fuzzy logic model for stock market decision making based on technical analysis. The model was tuned and modified using genetic algorithms.The model was verified and tested using real data form NASDAQ stock symbols.

Chueng and Kaymak (2007) tried to create a trading model that combines fuzzy logic and technical analysis to search trends in financial assets. The fuzzy system was designed to mimic human behavior in interpreting technical indicators. The membership functions of the fuzzy system are optimized by using a genetic algorithm.

2. Methodology

In this study, BIST-30 and Islamic (Participation) Index data is used between March 2012 and November of 2014 taken from Borsa Istanbul.

Islamic Index is an exchange-traded fund (EFT) based on the Participation Index. Fund shares are traded on the Istanbul Stock Exchange. The companies in the index are determined on the basis of open market value of the companies and according to the index criteria. Companies for this index are selected properly according to

Participation 30 Index criteria by considering field of activity and some financial rates. Stocks in the index are subject to quarterly periodic reviews.

BIST- 30 index shows 30 most valuable companies traded in Istanbul stock market. It consists 30 companies selected from among companies traded in National Market, real estate investment trusts in Corporate Products Market and venture capital trusts.

The aim of the study is to create a new technical analysis indicator using fuzzy logic method which could be an alternative to popular indicators used by traders. BUY and SELL signals given by indicators' after closing prices are assumed to be applied in the next day opening prices when calculating the indicators' performance.

For this study, daily closing and opening prices of the respective indexes of 2012 -2014 year was taken from the Istanbul stock exchange. BUY / SELL signals were generated for four different well known technical indicators and the performance of the index was calculated for the case of transactions carried out with these signals.

Signals generated from the fuzzy indicator, which is the mixture of MACD/RSI/SO and OBV indicators, was also calculated for the same period. Then performances were compared.

The performance of the indicator for BIST-30 and Islamic index is measured by modified sharpe ratio and compared to widely used indices like MACD, MA, RSI and OBV. The Sharpe ratio is used to calculate risk adjusted return. It shows the rate of return obtained for the risk taken. The asset which has the higher Sharpe Ratio is considered to yield better return for the same amount of risk. It is a measure which is calculated as the average return minus the risk-free return divided by the standard deviation.

For this work Sharpe ratio is modified as fallows,

Sharpe ratio = Return of the portfolio / Standard Deviation of the daily returns

Fuzzy logic variables may have value that ranges in degree between 0 and 1 whereas binary logic values are fixed and exact. Fuzzy logic is often applied by advanced trading models that are designed to catch the market movements. The aim of the system is to examine the markets of thousands of underlying assets and to support the traders with the best trading offer.

The fuzzy system contains three modules; the technical analysis module, the convergence module and the fuzzy inference module.

In technical analysis historical data is used to calculate indicators. In this study prices from 2102 to 2014 is used for each index.

The convergence module changes the calculated technical indicators into new fuzzy indicator within predetermined rules.

The fuzzy inference System (FIS) module creates a new trading signal based on the new fuzzy indicator.

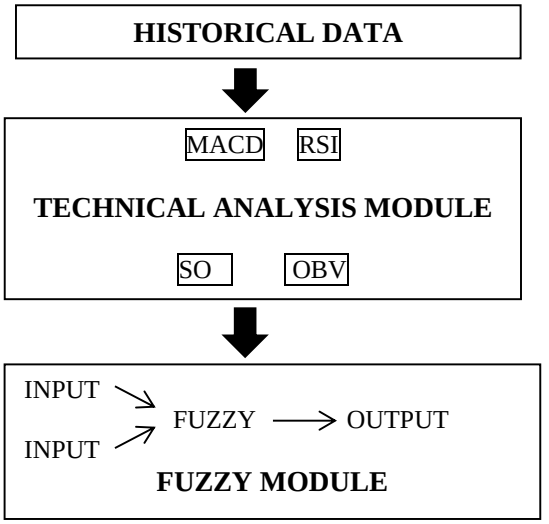

Figure 1: Fuzzy Modeling system

Technical Analysis Module

Technical analysis was developed around 1900 by Charles Dow. Based on mathematical calculations, technical analysis is a method for predicting future price movements. Technical analysis methods produced at different times and collected the same theory in the 1970s, based on common principles. In technical analysis, traders decide buy/sell decisions according to signals. Traders try to catch patterns and trends which may be hidden in underlying asset prices.

In this work we choose the following four technical indices. These indicators are considered successful forecasting feature.

- Moving-Average-Convergence-Divergence (MACD).
- Relative-Strength-Index (RSI).
- Stochastic-Oscillator (SO).
- On-Balance-Volume (OBV)

Moving Average Convergence/Divergence (MACD)

MACD was created by Gerald Appel in the late 1970s. It is one of the most frequently used indicators in technical analysis and is considered one of the best known indicators. This indicator calculates two exponential moving averages, which measures energy in the underlying asset prices. The MACD calculates two different moving averages and draws the graph of the difference of these two moving averages. When the MACD line is in positive territory, it shows the shorter term moving average is above the longer term moving average and suggests the potential upward movement. When the MACD line is in negative territory - this foresees that the shorter term MA is below the longer term and suggests downward momentum. When the MACD line crosses over the centerline, it signals a crossing in the moving averages.

We use 26-day and 12-day exponential moving averages in this work which are considered to be the most common ones. The signal line is created by using a nine-day exponential moving average of the MACD values.

IF MACD is higher than the signal bar, then BUY suggestion
IF MACD is lower than the signal bar, then SELL suggestion

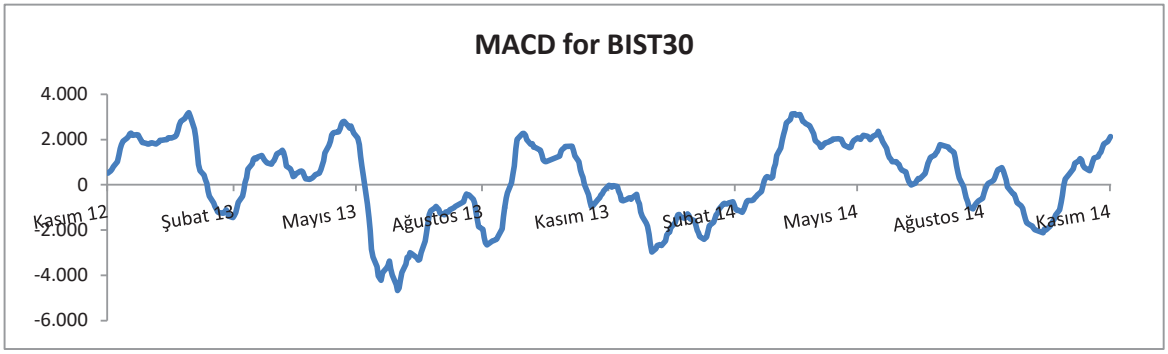

Figure 2: MACD analysis for BIST30 Index between November 2012 and November 2014

Relative-Strength-Index (RSI)

The Relative Strength Index (RSI) tries to find out if an asset is overbought or oversold.

When RSI is calculating, the average of the days when index rises is divided by average of the days index fall. Generally 9 - 15 days RSI is preferred by market participants. In this work we use 14 days.

RSI value ranges between 0 and 100. Trading rules as fallows;

IF RSI is higher than 70 (implies overbought), then it is considered as a SELL signal
IF RSI is between 30 and 70, then it is considered as a HOLD signal
IF RSI is lower than 30 (implies oversold), then it is considered as a BUY signal

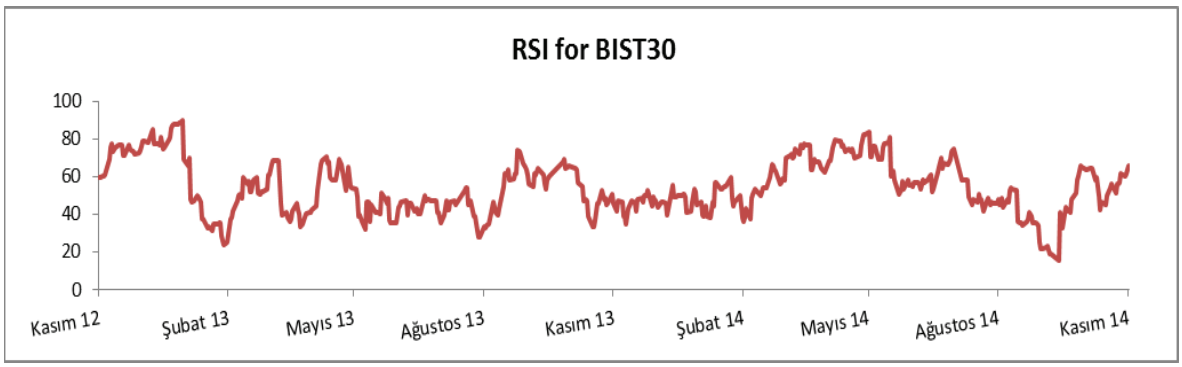

Figure 3: RSI analysis for BIST30 Index between November 2012 and November 2014

Stochastic-Oscillator (SO)

The Stochastic Oscillator (SO) is a momentum indicator that uses support and resistance levels according to recent trading range. When SO is higher than 80 it means asset is over-bought and when it is lower than 20, it indicates oversold conditions. The first line is the % K, which is a measure used to formulate the idea of momentum behind the oscillator. The second line is the % D, which shows the moving average of % K.

The two variables % K and % D are;

$$\%K(nT) = \left(\frac{R(nT) - R_{min}(nT)}{R_{max}(nT) - R_{min}(nT)}\right) 100 \quad (1)$$

$$\%D(nT) = \sum_{(n-3)}^{n} \frac{\%K(nT)}{3}, \qquad n \geq 3 \quad (2)$$

Where Rmin(nt) is the lowest R(nt) over a trading period; Rmax(nt) is the highest R(nt) over a trading term, % K is the force behind the oscillator, %D is the moving average of % K, n is the number of trading term in time T.

The trading rules are as fallows;

IF SO increases above 80 then it is considered as overbougth territory – SELL signal
IF SO is between 20 – 80 then it is considered as a HOLD signal
IF SO is below 20, then it is considered as a oversold territory - BUY signal

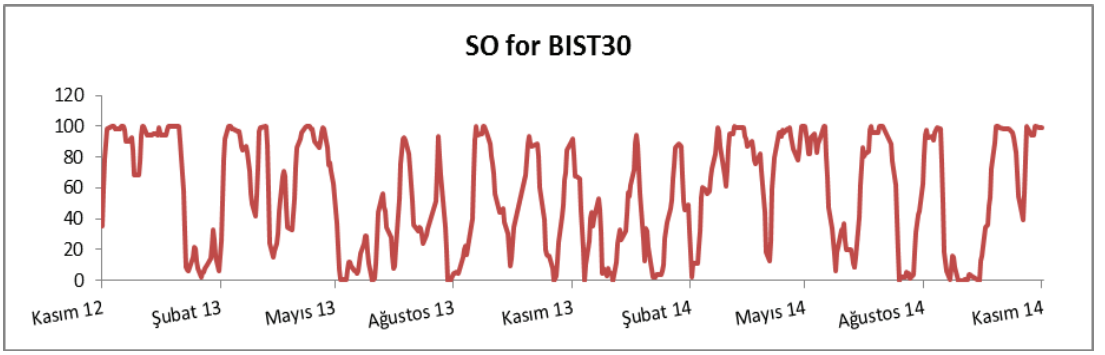

Figure 4: SO analysis for BIST30 Index between November 2012 and November 2014

On-Balance-Volume (OBV)

OBV is a momentum based indicator that uses volume flow to forecast financial instrument movements. On Balance Volume is a measure created by Joseph Granville in the 1960s.

OBV assumes there is an information asymmetry between professional investors and small investors. Professional and intuitional investors begin to buy an asset when retail investors are selling. Transaction volume may increase even as the price remains comparatively flat. In time, prices will rise because of volume. At that point, sophisticated investors begin to sell, and retail investors begin buying.

If the volume of transactions has increased compared to the previous day, then today's volume is added to yesterday's, and is considered "up volume." However, if the volume of transactions decreased compared to the previous day, today's volume is subtracted from yesterday's OBV and is considered "down volume."

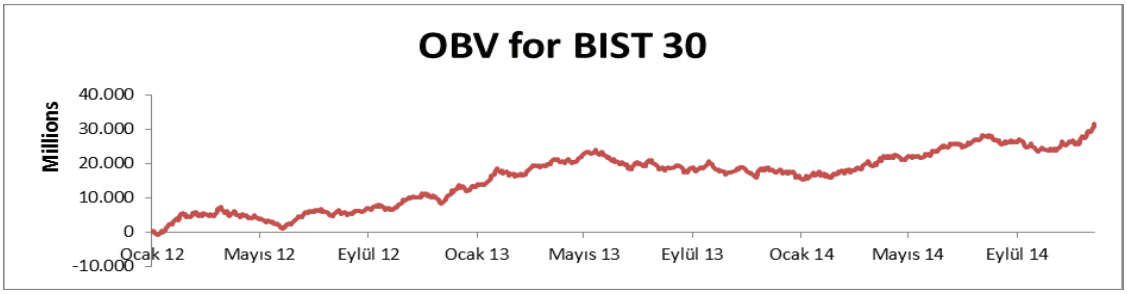

Figure 5: OBV analysis for BIST30 Index between January 2012 and October 2014

Convergence Module

The convergence module changes the calculated technical indicators into new fuzzy indicator within predetermined rules. The distinction between the MACD and the trigger signal can be calculated and used as entry to the fuzzy system. The outcome of the convergence module is used as the entry variables for the fuzzy system.

Table 1: Input Variables for the FIS

Variable	Membership Function	Range
MACD	Low / High	Low = below signal line / High= above signal line
RSI	Low / Medium / High	Low = below 30 / Medium = between 30 and 70 / High= above 70
SO	Low / Medium / High	Low = below 20 / Medium = between 20 and 80 / High = above 80
OBV	Low / Medium / High	Low = trend is downward / High = trend is upward

For MACD indicator, there are two membership functions. When the MACD is above the signal line, it is considered HIGH signal for trading. There are three membership functions in RSI indicator, low-medium and high. RSI signal is considered HIGH when its value is higher than 70. If RSI value is lower than 30, membership function is accepted as LOW. Same rule applies for SO, but 80 is considered HIGH instead of 70. For the low membership function 20 is the threshold as different from RSI. Lastly, when there is rising trend, the membership function of OBV is described as HIGH, when there is descending trend it is considered LOW.

Fuzzy Inference System (FIS)

Fuzzy inference system uses fuzzy theory to map inputs to outputs.

Mamdani's fuzzy inference method is the most common method. Mamdani's method was among the first control systems built using fuzzy set theory. It includes six steps; creating fuzzy rules, fuzzifiying the inputs, combining the inputs according to rules, finding output membership function, finding output distribution and finally defuzzifying the output distributions.

Mamdani's work depends on Lotfi Zadeh's 1973 paper on fuzzy algorithms. Mamdani-type inference requires the output functions to be fuzzy sets. After the fuzzification process is done, there is a fuzzy set for each output variable that needs defuzzification.

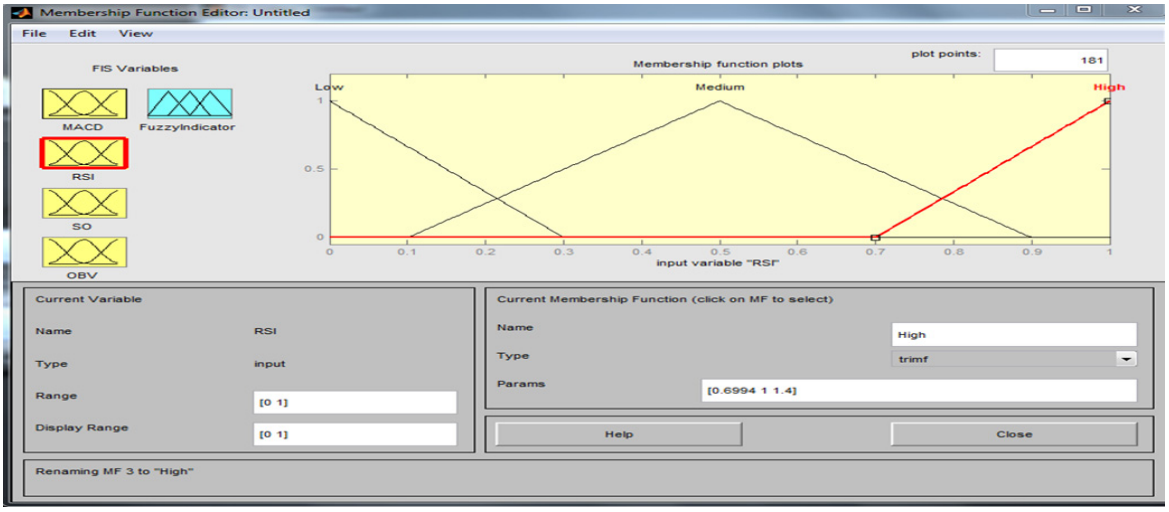

Figure 6 : The Membership Function : Enables display and edit the membership functions associated with the enrty and output variables of the FIS

The fuzzy rules are mix of the technical indicators stated above and decided by technical trading market participants.

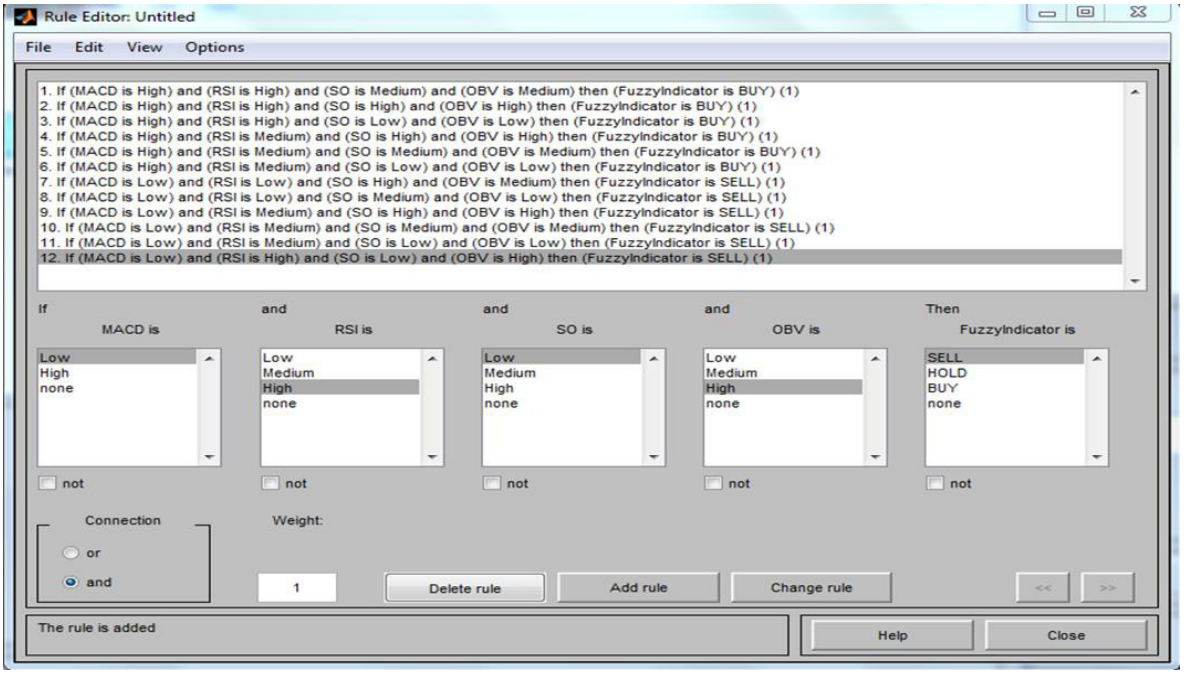

Figure 7 : The Rule Editor allows the identification of the fuzzy rules in FIS

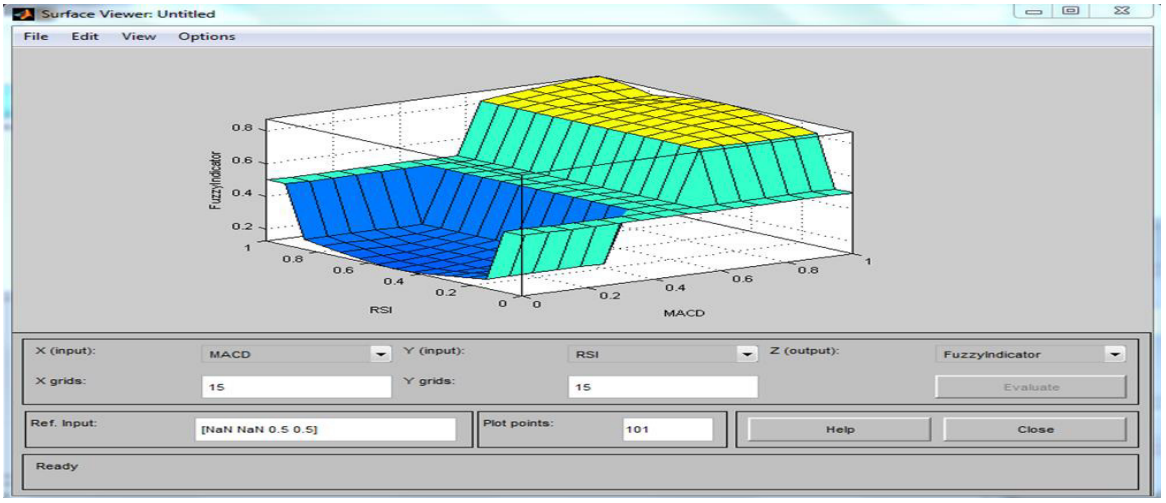

Figure 8 : The Surface Viwer : Creates a 3-D surface from entry variables and the output of an FIS

3. Results

For the table below, BIST-30 index, technical indicators (MACD, RSI, SO and OBV) and fuzzy indicators' returns and standard deviations' are calculated for three different time intervals.

Table 2 : The performance of selected indicators for BIST30 Index

SHARPE	Days	BIST -30	MACD	RSI	SO	OBV	Fuzzy Indicator
16/03/2012 - 06/02/2013	225	28,10	18,06	32,95	14,18	23,12	35,29
07/02/2103 - 02/01/2014	225	-9,99	10,05	-4,73	-6,18	-9,07	6,63
03/01/2014 - 28/11/2014	227	19,63	11,24	23,19	10,50	17,59	20,92
16/03/2012 - 28/11/2014	677	27,24	42,76	49,31	1,61	26,70	66,12

For the table below, Islamic index*, technical indicators (MACD, RSI, SO and OBV) and fuzzy indicators' returns and standard deviations' are calculated for three different time intervals.

Table 3 : The performance of selected indicators for Islamic Index

SHARPE	Days	Islamic Index	MACD	RSI	SO	OBV	Fuzzy Indicator
04/07/2012 - 18/04/2013	200	27,44	43,35	10,16	14,02	21,10	43,48
19/04/2013 - 07/02/2014	199	-6,42	3,43	-23,81	-1,75	-6,96	3,43
10/02/2014 - 28/11/2014	199	21,55	12,87	16,28	10,44	23,82	12,09
04/07/2012 - 28/11/2014	598	23,79	53,12	-14,02	9,62	31,43	52,23

* Islamic (Participation) Index is an exchange-traded fund (EFT) based on the Participation Index. Fund shares are traded on the Istanbul Stock Exchange. It is prepared by Bizim Securities Inc. and calculated by the Borsa Istanbul. The companies in the index are determined by Bizim Securities Inc. on the basis of open market value of the companies and according to the index criteria. (Reuters code : KTLMEf.IS)

4. Conclusion

The indicator proposed in this paper can be characterized as a technical indicator because analyses the past prices of stocks, and outputs a signal for trading. The approach used for the indicator is fuzzy logic with the aim of creating a new indicator combining commonly used indicators. The fuzzy rules takes the technical indicators as inputs, creates membership functions and translates the fuzzy output into trading recommendations.

Sharpe ratio of fuzzy indicator, between 16/02/2012 and 28/11/2014, is the highest value compared to other indicators with the value of 66.12 for BIST-30 Index. For Islamic Index, it is the second best indicator with the sharpe ratio value of 52.23 between the same dates.

Fuzzy indicator seems to prove its effectiveness comparing to BIST-30, Islamic Index, MACD, RSI, SO and, OBV at selected time intervals. Sharpe ratio of fuzzy indicator is in top two in almost every time interval. This means if investment decisions are made with fuzzy indicator instead of well-known technical indicators, better results would be obtained in terms of risk/return. In order to prove the effectiveness of the new proposed fuzzy indicator, performance was tested in four different time interval with two indices. This model promotes long-term investing strategy with low risk.

In further research, this new indicator can also be tested in developing countries stock exchanges such as Bovespa (IBOV), Shanghai Stock Exchange Composite Index (SHCOMP) or Moscow Exchange Indeces (MICEX and RTS). If a pattern is seen for different countries and for different periods, proposed fuzzy index could be used for trading.

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