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MEASURING ASYMMETRIC INFORMATION AND ERROR WITH
TECHNICAL ANALYSIS INDICATOR BASED ON FUZZY LOGIC

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Foreword

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Abstract

This thesis examines three widely used oscillators, the Exponential Moving Average which provides an average price, the Moving Average Convergence Divergence which is a momentum indicator that shows the strength of price movement in a market, and the Relative Strength Index which aims to indicate overbought or oversold market condition in relation to recent price levels. We must also understand indices, which include daily closing values which are compared for their asymmetric information and error, and help for better understanding on price movements of financial markets by the right decision percentage of the same indicator signal, which comes from different trading strategies. To compare the values of oscillators equally, we define output values of these three oscillators by giving terms such as Buy-Buy, Buy-Sell, Sell-Buy and Sell-Sell. However, outputs of these three oscillators were different from each other most of the time, for a given period. The uncertainty which emerges in this case can therefore be concluded by using the Fuzzy Logic approach, which sets for one resolution instead of three to solve the problem. In addition, Fuzzification also results in a better ability to forecast and decide the timing of stock market entry and exit. In order to test this approach's validation and examine the correlation between oscillators and indices, one could compare the signals that have been generated by Fuzzification and the signals that have been generated individually from technical indicators.

Keywords: *EMA, MACD, RSI, Fuzzy Logic, Financial Markets.*

TEKNİK ANALİZ GÖSTERGESİ BULGULARININ BULANIKLAŞTIRILARAK ASİMETRİK EŞBÜTÜNLEŞTİRME VE HATA DÜZELTMESİNİN ÖLÇÜLMESİ

ÖZET

Bu tez yaygın olarak kullanılan üç osilatörü denetledi, Üssel Hareketli Ortalama son dönem fiyat verilerine ağırlık verir, Hareketli Ortalama Uyumu/Uyumsuzluğu iki farklı hareketli ortalama arasındaki farkı gösterir, Göreceli Güç Endeksi son fiyat verilerine göre aşırı alımı ve aşırı satışı işaret eder. Bu osilatörden gelen verileri dengeli bir biçimde karşılaştırmak için, biz bu üç osilatörün çıktı sonuçlarına bazı terimler vererek tanımladık, bunlar Buy-Buy (Al-Al), Buy-Sell (Al-Sat), Sell-Buy (Sat-Al) ve Sell-Sell (Sat-Sat). Ancak aynı zaman dilimine ait bu üç osilatörden gelen çıktı verileri genellikle birbirinden farklılık gösterdi. Ortaya çıkan belirsizliği, belirsizlikle bütünleşerek bu sorunların üstesinden gelmeye çalıştık. Bu durumda bulanık mantık yaklaşımı ve bulanık kümeler kuramını kullanarak üç karar yerine bir karar almak problem çözdü. Ve aynı zamanda, bulanıklaştırma borsa giriş ve çıkış zamanlamalarını sinyalizasyonunda daha iyi tahmin ve karar verme yeteneği sağladı. Bulanıklaştırmadan oluşturulan sinyaller ve teknik göstergelerin oluşturduğu sinyaller indeks ve osilatör bazında korelasyonu incelendi. Ayrıca, endekslerin günlük kapanış verileri asimetrik eşbütünleştirme ve hata durumu kontrol edildi. Farklı yatırım stratejilerinden oluşan aynı teknik analiz sinyalinin doğru karar yüzdesi finansal piyasaların para hareketlerini daha iyi anlaşılabilmesi için karşılaştırıldı.

Anahtar Kelimeler: *EMA, MACD, RSI, Bulanık Mantık, Finansal Piyasalar.*

ABBREVIATIONS

EMA	: Exponential Moving Average
MACD	: Moving Average Convergence Divergence
RSI	: Relatively Strength Index
RS	: Relatively Strength
NYSE	: The New York Stock Exchange
BIST	: Borsa İstanbul
NIKKE225	: Nikkei heikin kabuka 225
SOXX50	: The Euro stocks 50
NASDAQ	: National Association of Securities Dealers Automated Quotations
GDX	: VanEck Vectors Gold Miners
PC	: Personal Computer
MA	: Moving Average
E-M-R	: EMA-MACD-RSI

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1. INTRODUCTION

Technical indicators are common instruments of economy used globally since the 19th century. Technical analysis is commonly used in measuring asymmetric information and error between the indexes as they offer a wide range of applications, such as finding the trend and forecasting the near future. In addition, it is a way to understand the future value of financial assets or stocks. Currently, amongst the traders in the stock market industry, measuring asymmetric information and error results, by using technical analysis with the help of Fuzzy Logic, is the prevalent method of trading because indexes share similar global trends and also help to find the differences amongst the indexes.

However, when using Fuzzy Logic to determine the technical analysis results, there are two major disadvantages. Of these, one is that stationary market conditions have unique movements on their own. As a result, sometimes correcting the price movements amongst indexes affects the technical analysis results and alters them incorrectly. However, most of the time, large market movements do correlate amongst the indexes.

When sometimes technical analysis results did not match the control group results, this brought about doubt because technical analysis without fundamental analysis does not give accurate results. Given the correlation between indices and indexes - with the help of the technical analysis results - it will help traders profit more, therefore this thesis is focusing on this topic. The aim of this thesis is to measure the correlation between the indices and indexes for a potential profit increase for traders globally, by understanding the working mentality of stock markets.

One of the hypotheses for this study is that globalism effect exists in economy. Furthermore, technical analysis results - with the help of Fuzzy Logic - can be developed to better the global trading system accurately.

This thesis is divided into four chapters. The first chapter is the introduction, while the second chapter discusses technical analysis in detail and Fuzzy Logic in general. It also discusses the difference between fundamental and technical analysis. The third chapter shows how the model of methodology can be used to answer the thesis statement, and the fourth chapter is the conclusion.



2. TECHNICAL ANALYSIS & INDICATORS

In this part of the thesis, information about fundamental analysis is first given to compare the distinction between fundamental analysis and technical analysis. Next, general information about technical analysis is given, in addition to the information of three technical indicators: EMA, MACD, and RSI, which are explained briefly with their formulas and theories.

2.1 Fundamental Analysis

Fundamental analysis is a strategy for research that reviews fundamental budgetary data to gauge benefits, free market activity, industry quality, administration capacity, and other natural matters influencing a security exchange's esteem and development potential. The subsequent data can help you look through different points of view. The essentials of those characteristic certainties about an organization can be utilized to gauge monetary execution and, to some degree, stock value developments. Non-fundamental techniques are overall known as defining the Fundamentals, which is what you need for technical analysis. Fundamentalists state that those who use technical analysis only study financial analyzing, which is historical data and is of no (utilization) relevance. As needs to be, such data has nothing to do with how a stock market cost will move tomorrow or the following day. Both crucial and technical analysis utilizes patterns, however in various ways. The basic approach utilizes recorded data to conjecture money related outcomes.

Technical analysis is profoundly visual and largely disregards the fundamental introduction of free market activity, accepting rather that current value patterns manage future value development. Basically, the technical analysis results help in outlining the low and high support levels apparent. These levels are taken from an investigation of a stock's current value changes.

The Authentic versus Current Information One approach to recognize key and technical analysis is on the premise of point where Fundamentals are verifiable; technical markers are current or forward-kicking. The technical indicators are false on any solid chronicled data, so the whole start of working from the present date forward is imperfect on the off chance that it happens in disconnection.

The Dow Jones Industrial Average makes the above point very well. In the event that the average moves more than 200 in either course, a respond particle among huge quantities of financial specialists. Some observe the bearing of the move as an indication of a move in market feeling; others trust the move will be turned around the next day. Many speculators track authentic development of the market and what they trust implies for what is to come. For example, some trust that if the record goes up in January it will go up for the whole year, and the other way around. Others trust that market developments are managed by whether the National League or National team wins the World Cup. These attempts at estimating are imperfect and can't give any long haul shrewdness. You can't anticipate "Heads" or "Tails" for a coin hurl in light of the pattern, in light of the fact that each hurl is a different and arbitrary trial with a fifty-fifty plausibility. With regards to the plausibility, the longing for dependable and effortlessly recognized pointers is solid.

At last, even the expert understands the issues of forecasting and comes back to the basics. The defect in numerous technical indicators is that chronicled data is misread or twisted. An outline trader, for instance, will see an example of a security exchange's cost climbing. At that point, the trader will reason that in light of this example, the following development will be descending. This is not upheld with any financial hypothesis at all. Three things can happen to the market cost of a stock: it can rise, it can fall, or it can stay unaltered. Since there are only three states of nature, even without using any hypothesis one can make correct decisions with a 33% of chance. While technical analysis focuses on the investigation of market activity, fundamental analysis

concentrates on the financial strengths of free market activity that make costs move higher, lower, or remain the same.

The fundamental approach looks at all of the relevant variables influencing the cost of a market with a specific end goal to decide the inborn estimation of that market.

Both of these ways to deal with market estimating endeavor to tackle a similar issue, that is, to decide whether the bearing costs are probably going to move or not.

On the off chance that this characteristic esteem is under the current market value, then the market is overrated and ought to be sold. In the event that market cost is underneath the natural esteem, then the market is underestimated and ought to be purchased. The fundamentalists prioritize the reason for market development, while those that use technical analysis focus on the impact.

The natural esteem is what the fundamentals demonstrate as being really worth in light of the law of free market activity. Numerous Fundamentalists have a working-learning of the essential principles of diagram analysis. The technical trader, obviously, trusts that the impact is all he or she needs or has to know and that the reasons, or the causes, are pointless.

The issue is that the diagrams and fundamentals are regularly in strife with each other. In the meantime, numerous technical traders have no less than a passing consciousness of the fundamentals. They simply approach the issue from various ways. Most traders group themselves as either technical analysts or Fundamentalists.

Fundamental analysis does exclude an investigation of value activity. It is conceivable to exchange money related markets utilizing only the technical approach. Expressed another way, advertise value goes about as a main marker of the fundamentals or the tried and true way of thinking-existing apart from everything else. One clarification for these appearing disparities is that market value tends to lead the known fundamentals. On the off chance that the fundamentals are reflected in market value, then the investigation of those fundamentals ends up plainly pointless.

It is farfetched that anyone could exchange off the fundamentals alone with no thought of the technical side of the market.

The technician figures out how to be agreeable in a circumstance where advertise development can't help contradicting the supposed tried and true way of thinking.

While the known fundamentals have, as of now, been reduced, the costs are currently responding to the obscure fundamentals. In tolerating the premises of technical analysis, one can perceive any reason why technicians trust their approach is better than the fundamentalists. Probably, the most emotional bull and bear showcases in history have started with next to zero saw change in the fundamentals. Considering the means the broker must experience before making a market responsibility, it can be seen that the right utilization of technical standards end up noticeably. Basically, sooner or later, fundamentalists regard the analysis that is collected before the actual decision making..

Since edge prerequisites are so low in prospects exchanging (normally under 10%), a moderately small value move in the wrong heading can constrain the merchant out of the market with the subsequent loss of all or the vast majority of that edge.

In security exchange exchanging, by difference, a merchant who discovers himself or herself on the wrong side of the market can just choose to clutch the stock, trusting that its shrink will organize a rebound sooner or later. Analysis and timing are opposed to each other. This last point is settled on clearer if the basic leadership process is separated into two separate stages: analysis and timing.

On account of the high use, calculate the fate's markets; timing is particularly critical in that field. Stocks respond to comparable monetary variables and value activity. One market or gathering may give profitable pieces of information to the future bearing of another market or gathering of business sectors.

The technician can focus his or her consideration and assets in those business sectors that show solid slanting propensities and disregard the rest. Therefore, the technical

trader can turn his or her consideration and money to exploit the rotational way of the business sectors. For a certain something, markets experience dynamic and torpid periods, inclining and non-trending stages.

More often than not, those inclining periods are trailed by calm and moderately trendless economic situations, while another market or gathering assumes control.

▶ The trader can, without much of a stretch, take after the same number of business sectors as sought, which is not valid for his or her fundamental partner. The significance of item, bond, and stock patterns as monetary markers are vital. Considerably, the patterns in these prospects which advertises more often than not, appear well before they are reflected in conventional monetary pointers that are discharged on a month to month or quarterly premise, and more often than not reveal to us what has happened as of now. Therefore, outlines of item markets like gold and oil, alongside Treasury Securities, can disclose to us a considerable measure about the quality or shortcoming of the economy and inflationary desires. The bearing of the U.S. dollar and remote currency fates additionally give early direction about the quality or shortcoming of the separate worldwide economies. Rising product costs for the most part allude to a more grounded economy and rising inflationary pressure.

Falling product costs, for the most part, caution that the economy is abating alongside expansion. Also, technical pointers that measure the strength or weakness of the more extensive market, like the NYSE propel, decrease line, the new highs-new lows, or rundown are intensely utilized.

Security exchange examination is constructed vigorously with respect to the development of expansive market midpoints, for example, the BIST30 Industrial Average. With the development in professionally man-matured cash in the fates business, and the multiplication of multimillion dollar open and private assets, the greater part of which are utilizing these technical systems, enormous convergences of cash are pursuing just a modest bunch of existing patterns. Of a great deal, more worry

than the traders is the tremendous development in the utilization of automated technical exchanging systems in the stock market. Since the universe of stock markets is still very little, the potential for these systems currently bending in Turkey, value activity is developing. Here once more, even the issue of concentrated wholes of cash utilizing technical systems is most likely self-amending.

Technical traders couldn't, in any way shape or form, cause a noteworthy market move just by the sheer energy of their purchasing and offering. These systems are for the most part pattern following in nature, which implies that they are altogether modified to distinguish and exchange significant patterns. Notwithstanding, even in situations where contortions do happen, they are of quality rally currently in Turkey, in nature, and don't bring about significant moves. On the off chance that the majority of the systems began doing likewise in the meantime, brokers would make alterations by making their systems pretty much delicate. Some utilize stops to enter the market, while others get a kick out of the chance to utilize market arranges or resting limit orders. Regardless of the possibility that most professionals agreed on a market conjecture, they would not all fundamentally enter the market in the meantime and in the same direction.

On the off chance that anybody were to truly scrutinize this part of method all anticipating, he or she would need to likewise scrutinize the validity of each other type of gauging in view of recorded data, which incorporates all monetary and fundamental analysis. It is astonishing how regularly pundits of the technical approach raise this point in light of the fact that each known strategy for determining, from climate anticipating to principal investigation, construct totally with respect to the investigation of past data. So it appears that the utilization of past value data to anticipate the future. Technical analysis is supported by this. In this way, the value diagram itself goes under the heading of the clear, while the analysis specialists perform on the value data which falls into the domain of the inductive. An illustrative insight alludes to the graphical introduction of data, for example, the value data on a standard bar diagram.

Another question frequently raised concerns the legitimacy of utilizing past value data to anticipate what is to come. What other sort of data is there to work with? The fields of measurements make a qualification between descriptive insights and inductive measurements. An inductive measurement alludes to speculations, predictions, or extrapolations that are construed from that data.

The initial phase in determining the business or financial future comprises, in this way, of social affair observation.

2.2 Technical Analysis

Technical analysis or technical examination and determination is very crucial in contributing to the fundamental approach. In other words, technical examination and determination is the investigation of numbers, costs, or prices, with graphs and charts to make information easier to visualize.

Foundations of cutting edge technical examination and determination originated from the Dow Theory, by Charles Dow who invented and tested this theory in 1902. Stemming either straightforward or in a roundabout way from the Dow Hypothesis, these roots incorporate such standards as the inclining way of costs, costs marking down all known data, affirmation and uniqueness, volume reflecting changes in cost, and support/resistance. Industrial Average is an immediate posterity of the Dow Theory. Mr. Dow's commitment to advanced technical examination and determination can't be downplayed. His concentration on the rudiments of security value development offered, ascend to a totally new strategy for breaking down the business sectors. It is the cost at which one individual agrees to buy and another agrees to offer. The cost at which a monetary master will buy or offer depends essentially on his yearnings. If he suspects that the security's cost will rise, he will get it; if the money related master envisions that the cost will fall, he will offer it.

These direct declarations are the purpose behind a vital test in gagging security costs, since they insinuate human longings. As we all in all know firsthand, individuals are

neither easily quantifiable nor obvious. This reality alone will shield any mechanical trading system from working dependably.

The finance point of view, technical analysis is a security investigation approach for estimating the course of costs through the investigation of past market information, principally cost, and volume. In another point of view, technical analysis can be classified as a quantitative analysis that can help us to take basic venture choices. Quantitative analysis and behavioral financial matters utilize a large portion of similar devices of technical analysis, which is a part of dynamic administration and stands in disagreement to quite a bit of present day portfolio hypothesis.

According to Grimes, the essence of technical analysis is to identify markets that have a temporary imbalance of buying and selling pressure, and to limit our trading to those environments (Grimes, 1986).

On the off chance that individuals were all sensible and could isolate their feelings from their speculation choices, then, crucial examining the assurance of value in view of future income would work gloriously. Also, if all individuals would have the same totally sensible desires, costs would simply change when financial reports or critical news are released. Financial specialists are compelled to look for "ignored" principal information with an end goal to discover underestimated securities.

Generally, the inputs for technical analysis are stock prices and volume. For the stock prices, closing, opening, maximum, minimum, or average stock prices can be used. By using simple mathematical calculations, one can construct different technical indicators. As it were, technical analysts trust that cost and volume information give markers of future value developments and that by analyzing this kind of information, data might be extricated on fundamental use for growth.

2.2.1 Exponential Moving Average

Technical analysts have been using moving averages now for several decades. Moving Averages are categorized as part of a "Time Series Analysis." "Moving average" was first employed in 1901, but the name was given to it later, by a math historian, Jeff Miller. The moving average is very practical and an accurate indicator which shows the average of a value over a period of time. For instance, to calculate a 15-day moving average of a stock, add up the last 15th day closing prices and divide them by 15. The most common moving average periods are 12, 20, 30, 50, 100, 200, and yearly. Shorter time periods mean the more sensitive moving average to value changes, the longer time period means less sensitive moving average to value changes. This technique for smoothing data points was used for decades before this, or any general term, came into use.

In 1909 G. U. Yule described the "Instantaneous averages" which R. H. Hooker calculated in 1901 as "Moving-averages." Yule did not adopt the term in his textbook, but it entered circulation through W. I. King's Elements of Statistical Method. By placing more weight on recent values one can calculate the values of Exponential Moving Average (EMA). The following equation is for the calculation of EMA:

$$EMA_{today} = Price_{today}K + EMA_{yesterday}(1 - K)$$

where,

$$K = 2/(N + 1)$$

N = the period of the EMA

$Price_{today}$ = the current closing asking price

$EMA_{yesterday}$ = the previous EMA value

EMA_{today} = the current EMA value

In other words, EMA is calculated by applying a percentage of today's stock price to yesterday's moving average. In this case, when you apply/use EMA to predict the future price or analyze the stock movements, it means you place more weights or values to the recent prices. In this research, we calculate the EMA with period 12. Due to the fact that the period gets smaller, sensitivity can be measured more effectively and will be more reactive to the latest value changes; therefore 12 period has been chosen.

2.2.2 Moving Average Convergence Divergence

The MACD (Moving Average Convergence-Divergence) technical indicator, created in late 1979 by Mr. Gerald Appel, is a standout amongst the most widespread technical markers in exchanging. MACD is valued by traders ubiquitously for its effortlessness and adaptability since it can be utilized as a momentum or pattern pointer.

Mr. Appel is a standout amongst the most productive inventors of technical exchanging instruments, a hefty portion of which have turned out to be well known around the world. The MACD and MACD-Histogram are viewed as basic exchanging apparatuses by numerous investors. The MACD is utilized for outlining trends by speculators and traders alike, on major monetary sites and in technical investigation programs.

MACD is a normally utilized pattern following technical pointers that demonstrate the connection between two unmistakable moving averages and it is figured by subtracting a 26-day moving average of a security's price from a 12-day moving average of its price. A 9-day EMA of the MACD, which is called signal line, is calculated and placed on the top of the MACD. MACD is intended to produce trend-following trading signals in view of moving-average crossovers. When MACD cycles above and below center the zero line, one can see a trend or momentum strength in both ways. The calculation of MACD includes four steps that are shown below:

Step 1: Calculate a 12-period EMA.

Step 2: Calculate a 26-period EMA.

Step 3: Create MACD line: Subtract the 26-period EMA from the 12-period EMA

Step 4: Create signal line: Use MACD line in Step 3 to calculate a 9-period EMA

The result value becomes an indicator that oscillates above and below 0 (Steven B. Achelis, 2000)

- When the value of MACD is above 0, it indicates that the 12-day moving average is higher than the 26-day moving average.
- When the value of MACD falls below 0, it indicates that the 12-day moving average is less than the 26-day moving average.

The trading rules for MACD indicator are as shown below:

- If the value of MACD is above the signal line, this indicates a buy decision.
- If the value of MACD is below the signal line, this indicates a sell decision.

2.2.3 Relatively Strength Index

The Relative Strength Index (RSI) is a standout amongst the most mainstream technical pointers, which is helping traders to decide overbought and oversold value levels and it also points out buy and sell signs. RSI has turned out to be very helpful for traders.

RSI was produced by J. Welles Wilder, Jr., distributed in a book in 1978, also in Futures magazine. In that time, it was called New Concepts in Technical Trading Systems, and in Commodities magazine in the June 1978 issue (Penn, 2009). RSI is a momentum oscillator and all things considered it quantifies the rate of progress of a given security's cost. Since it is additionally a limited oscillator, it permits to spot overbought and oversold areas on the value graph. Identifying overbought/oversold levels and the fundamental purchase and offer flags the way that RSI is a limited oscillator permits us to recognize overbought and oversold levels effectively.

RSI values that are more than 70 are overbought and out of control and values beneath 30 are oversold, yet these qualities can be conformed to suit specific needs and markets. 80 could be utilized as an overbought line in a solid uptrend and 20 as an oversold line in a solid downtrend. The least difficult purchase signs are created when RSI crosses the oversold line - it can be an intersection from above and from underneath, contingent upon the form we pick. On the other hand, the easiest offer signs are created when RSI crosses the overbought line – here, it additionally can be an intersection from above, and from beneath, again, relying upon the rendition we pick. Getting to be overbought or oversold does not really flag a pattern inversion; in solid patterns a security can progress toward becoming overbought or oversold ordinarily before the pattern turns around. The outline beneath represents the possibility of overbought/oversold levels and centerline crossovers: GDJ progressed toward becoming overbought toward the finish of April, and in addition in the initial two weeks of May. Bearish centerline hybrids occurred amidst January, in the second half of February, March, and May. It moved toward becoming oversold at the end of January and in the primary week of February.

Divergences amongst RSI and value give one of the most grounded purchase and offer signs. Since divergences are available on the outlines of numerous pointers and are a more broad wonder, we have chosen to commit isolate articles to both bullish and bearish divergences. As they happen frequently on the diagrams of numerous advantages, we urge you to acclimate yourself with these terms.

Disappointment swings are examples framed exclusively on the RSI graph, in example, they don't mull over the security's cost. As per Wilder, they give exceptionally solid purchase and offer signs. The accompanying chart portrays the possibility of both bearish and bullish disappointment swings. Bearish Failure Swing happen when RSI shapes another high over the overbought line, then skips back beneath it, frames a lower high underneath the overbought line and after that goes down considerably underneath the past low, which is known as the offer point.

Bullish Failure Swing happens when RSI frames a new low beneath the oversold line, then ricochets up above it, shapes a higher low over the oversold line and after that goes up considerably over the past high, which is known as the purchase point.

When utilizing RSI we have to answer different inquiries: how long would it be a good idea for us to incorporate for computation? What qualities ought to be considered overbought and oversold? These qualities are called parameters. Despite the fact that the creator of RSI recommended one arrangement of parameters: 14 days think back period and 30 and 70 as oversold and overbought lines, separately, it appears to be truly improbable that these qualities are ideal for each market and each financial specialist. For example, long haul financial specialists could lean toward a less delicate form with a moderately long think back period and higher overbought and lower oversold levels, to dispense with coincidental whipsaws. Likewise, these ideal parameters may change after some time as the business sectors advance.

The way toward finding ideal parameters is called streamlining. One can (from a certain point of view) perform such an advancement by outwardly reviewing different blends of parameters, such a procedure would likely yield off base outcomes and would unquestionably be awkward. Also, utilizing this "manual" approach is difficult to discover and screen ideal qualities for some business sectors, not to mention different pointers. Subsequently it is generally encouraged to utilize PCs.

RSI is perhaps the most commonly used technical indicator amongst traders due to its simplicity and performance (Jobman, 1994:1). However, even though it works well when the market is trendless, during bull or bear market conditions (when there is a clear trend) its performance degrades (Sahin & Ozbayoğlu, 2014:1). In addition, RSI is a technical analysis oscillator showing price strength by comparing upward and downward close-to-close movements (Sagi, 2012). This indicator was first introduced by Welles

Wilder in an article published in 1978. It is generally used to understand and realize the overbought and oversold conditions in a particular stock.

$$RSI = 100 - 100 / (1 + RS) \quad \text{where,}$$

RS : U/D

U: Average of N positive close days

D: Average of absolute values of N negative close days

By doing simple mathematical calculations, one can transform the above RSI formula to the below RSI formula:

$$RSI = 100 \left(\frac{RS}{1 + RS} \right)$$

RS is named as the relative strength. From the formula defined above, we can conclude that if the value of RS is equal to 1, the value of RSI becomes 50, which is the center value of the RSI. RSI takes values between 0 and 100, with numbers above value 70 indicates overbought conditions, and below value 30 indicates oversold conditions. For instance, if the value of RSI is 90, then the value of RS has to be 9. Since RS is the ratio of average gains to average loss, the amount of average values of positive closing days is 9 times greater than average values of negative days. If the value of RSI is 80, the value of RS has to be 4. With the same situation as in the previous example, the amount of average values of positive closing days is 5 times greater than the average values of negative days. If the value of RSI is 10, then the value of RS has to be 0.11. If the value of RSI is 20, then the value of RS has to be $\frac{1}{4}$. This means that the amount average values of positive changes is one over four times greater than average values of negative changes.

Traditional interpretation and usage of the RSI is that RSI values of 70 or above indicate that a security is becoming overbought or overvalued and RSI values of 30 or below indicate that a security is becoming oversold or undervalued condition.

Unexpected high volume price movements can create false buy or sell decision in the RSI. That's because RSI should be used with caution or in conjunction with other, confirming technical indicators. To avoid false signals or decisions from the results of RSI, some traders only use RSI readings above 80 to point out overbought conditions and RSI readings below 20 to indicate oversold conditions

Traders usually use trend lines to support RSI, and one can see support or resistance levels in the RSI reading. Price new low and high value will not corresponded as new high or low RSI readings. For instance, a share ascends in price to \$38 and the RSI makes a high perusing of \$54. After retracing weak bearish movement somewhat descending, the share makes a new high of \$40, however the RSI just ascents to \$50. The RSI has slightly down warded from the movement of cost.

RSI is a standout amongst the most mainstream and broadly utilized specialized pointers that furnishes us with numerous approaches to produce purchase and offer signs. These incorporate programmed line-hybrid flags are more advanced visual ones, in light of divergences and disappointment swings. It can likewise be utilized to tell the general condition of the market being referred to by recognizing ranges where the market is overbought and oversold. In any case, one needs to remember, that it is not (as some other specialized marker so far as that is concerned) a completely programmed device – there are dependably decisions to be made as to parameters. Regardless of the possibility that there is dependably the default, pre-characterized sets of parameters, nobody can ensure that they will dependably work and that they will produce the most elevated benefits. Keeping in mind the end goal to moderate the danger of utilizing incorrect markers, we recommend utilizing streamlined, checked, and observed pointers. Due to our thesis trading strategy which is a daily trading strategy, we try to catch strong trends. Therefore, we consider above 70 as a buy signal and below 30 as a sell signal.

2.3. Data Clustering

The goal of data clustering, also known as cluster analysis, is to discover the natural grouping(s) of a set of patterns, points, or objects (Webster Online Dictionary, 2008).

Technical indicator works with different approaches, therefore usually different technical indicators give different decision results. Different technical indicators also give different forms of suggestions and it's hard to compare these results effectively.

- **Underlying structure:** to gain insight into data, generate hypotheses, detect anomalies, and identify salient features.
- **Natural classification:** to identify the degree of similarity amongst forms or organisms (phylogenetic relationship).
- **Compression:** as a method for organizing the data and summarizing it through cluster prototypes.

Clustering systems are for the most part unsupervised techniques that can be utilized to compose information into gatherings in light of similitude amongst the individual information. Generally, grouping (clustering) calculations don't depend on presumptions basic to customary factual techniques. For example, the fundamental factual dissemination of information are helpful in circumstances where minimal earlier information exists. The capability of grouping also can be defined as clustering; calculations to uncover the fundamental structures in information can be misused in a wide assortment of utilizations, counting arrangement, picture handling, design acknowledgment, displaying and recognizable.

2.3.1 Fuzzy logic

When Aristotle and his ancestors contrived their hypotheses of rationale and arithmetic, they concocted the alleged Law of the Excluded Middle, which expresses that each

suggestion should either be true or untrue. A horse is either fast or not fast; it unmistakably can't be both fast and not fast. Be that as it may, not everybody concurred, and Plato demonstrated there was a third option, other than true and untrue. In the nineteenth century, the first known binary set theory (0, 1) was invented by German mathematician George Cantor. Jan Lukasiewicz was a polish philosopher who proposed a third logical option in 1920 where he mentioned sets with possible membership values of 0, 1 and $\frac{1}{2}$. Fuzzy logic is an expansion of the Boolean logic by Lotfi Zadeh in 1965 in light of the scientific hypothesis of fuzzy sets. Mr. Lotfi Zadeh published two other studies in 1971 and 1973. Mamdani and Assain applied the fuzzy control system to the steam engine in 1975. After that, Holmblad and Ostergaard applied the first fuzzy controller for a complete industrial system in 1978.

Fuzzy logic depends on the hypothesis of fuzzy sets, which is a speculation (generalization) of the traditional set hypothesis. Saying that the hypothesis of fuzzy sets is a speculation of the traditional set hypothesis implies that the last is a unique instance of fuzzy sets hypothesis. To make an analogy in set hypothesis talking, the established set hypothesis is a subset of the hypothesis of fuzzy sets which is a speculation of the classical set hypothesis.

By presenting the idea of commitment on confirmation of a condition, one is empowering a condition to be in a state other than true or untrue. Fuzzy Logic gives an extremely profitable adaptability to thinking, which makes it conceivable to consider mistakes and vulnerabilities.

One preferred standpoint of Fuzzy Logic so as to formalize human thinking is that the guidelines are set in regular dialect. Here are a few principles of direct that a student takes after, accepting that he wouldn't like to lose his driving permit: "If the light is red... in the event that my speed is high... what's more, if the light is close... at that point I brake hard. On the off chance that the light is red... in the event that my speed is low...

what's more, if the light is far... at that point I keep up my speed. On the off chance that the light is orange... in the event that my speed is normal... furthermore, if the light is far... at that point I brake delicately. In the event that the light is green... in the event that my speed is low... also, if the light is close... at that point I quicken. Instinctively, it appears that along these lines, the information factors like in this case are around refreshing by the cerebrum, for example, the level of check of a condition in Fuzzy Logic.

Fuzzy logic offers a few one-of-a-kind components that settle an especially decent decision for some control issues. It is inalienably powerful since it doesn't require exact, commotion free information sources and can be customized to flop securely if a criticism sensor stops or is crushed. The yield control is a smooth control work in spite of an extensive variety of information varieties. Since the Fuzzy Logic controller forms client characterized rules administering the objective control framework, it can be adjusted and changed effortlessly to enhance or definitely modify framework execution. New sensors can without much of a stretch be consolidated into the framework basically by producing suitable representing rules. Fuzzy Logic is not constrained to a couple criticism data sources and maybe a couple control yields, nor is it important to quantify or process rate-of-progress parameters with the goal for it to be actualized. Any sensor information that gives some sign of a framework's activities and responses is adequate. This enables the sensors to be cheap and loose along these lines keeping the general framework cost and multifaceted nature low. Due to the govern based operation, any sensible number of sources of information can be handled (1-8 or more) and various yields (1-4 or more) created, despite the fact that characterizing the rule base rapidly ends up plainly mind boggling if an excessive number of data sources and yields are decided for a solitary execution since tenets characterizing their interrelations should likewise be characterized. It is ideal to break the control framework into smaller lumps and utilize a few smaller Fuzzy Logic controllers circulated on the framework, each with

more constrained obligations. Fuzzy Logic can control nonlinear frameworks that would be troublesome or difficult to demonstrate numerically. This opens entryways for control frameworks that would ordinarily be considered unfeasible for mechanization.

2.3.2 Fuzzy sets

A collection of distinct defined objects are a classical or crisp subset. A subset is for the most part signified by a capital letter (D, E, F, . . .), where elements are categorized by lower case letters (d, e, f, ...). The enrollment of a component b to a subset B can be translated as far as logic: b is an element of B or not = 1 or 0. In this point, fuzzy subsets withdraw from their classical partners. An example of a fuzzy set and a crisp set with Gaussian membership function can be seen in Figure 2.1.

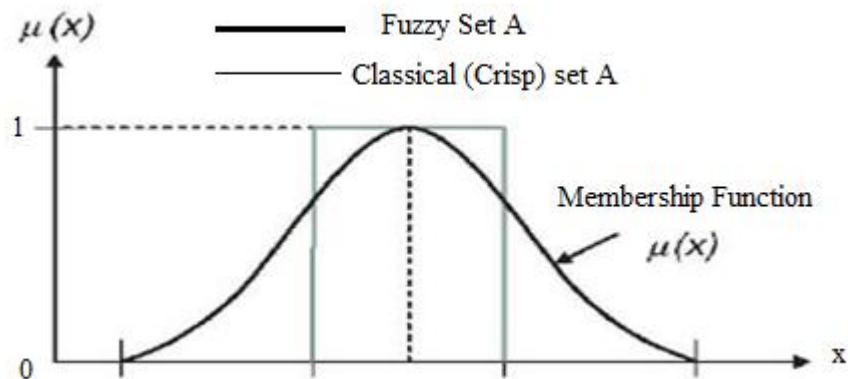


Figure 2.1 Membership Function

In a fuzzy subset, participation is not just 1 or 0. Similarly, as truth esteems can take esteems in the interim $[0, 1]$, enrollment can likewise be in the range of 0 and 1. For example, 15 degrees is not a full member of the set of cold weather, but it is also not entirely false, and therefore, not entirely not a member of the set of cool weather.

In other words, fuzzy sets can be defined as a set without a crisp, clearly defined boundary. In classical set theory, one element is a member of the set or not. However, in Fuzzy Logic, the truth of any statement becomes a matter of degree. Any statement can

be fuzzy. One can consider logic as questions with “Yes” or “No” answers for everyone. Questions such as: Is today Monday, is water liquid, and is yellow a color? On the other hand, one can consider Fuzzy Logic as questions which people have different answers to. Is Tom tall? Is this room cold or not? These types of questions can have different answers depending on the people, maybe on their culture or perspectives.

A membership function is a curve that defines how each point in the input space is mapped to a membership value between 0 and 1 (Matlab, 2016:8). For any membership function, it has to take values between 0 and 1. For the application process, one can use any type of function that satisfies this rule. For instance, Matlab as a programming package, includes 11 different types of membership functions that you can use without giving the definition of the function. One can construct simple membership functions using straight lines such as triangular, trapezoidal, Gaussian, and generalized bell membership functions. One can see the graphs of functions in Figure 2.2.

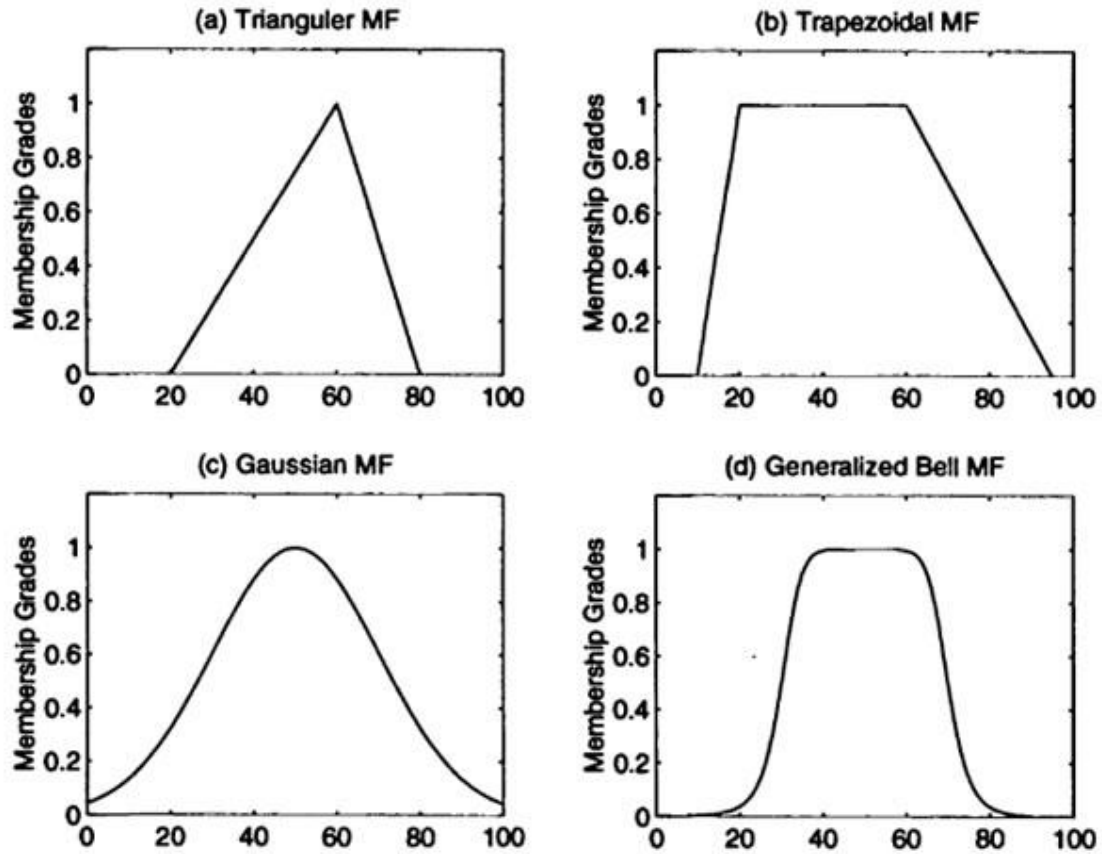


Figure 2.2 Membership Function Types Reference: MATLAB toolbox

For the application process, generally, these types of membership functions are people's first choices because of the simplicity. Also, one can use continuous membership functions such as Gaussian membership function and continuous functions have the advantage of being smooth and non zero at all points.

To sum up, fuzzy sets describe vague concepts such as hot weather and tall people. These sets admit the possibility of partial membership in it and also, the degree that belongs to a fuzzy set on any object is denoted by a number which takes a value between 0 and 1.

2.3.3 Linguistic variables and fuzzy if-then rules

Linguistic variable can also be defined as a variable where its values are words in a spoken language. As can be exemplified, temperature is a variable if its values are linguistic rather than numerical, in example, cold, not cold, very cold, hot, not very hot, not very cold, etc., rather than 14, 15, 16, 17. In other terms, a linguistic variable is defined as (X, T, U, M) .

- Linguistic variable name: X
- Linguistic values set X can take: T
- U is a universe of discourse
- M is related to a rule, which is related to each linguistic value X , being its meaning, $M(X)$, where $M(X)$ indicates a fuzzy subset of U . The meaning of a linguistic value X is characterized by a compatibility function, $c : U \rightarrow [0, 1]$, which associates with each u in U its compatibility with X .

In a Fuzzy Logic system, a rule base is constructed to control the output variable. A fuzzy rule is a simple if-then rule with a condition and a conclusion.

- IF (temperature is cool OR cold) AND (target is warm) THEN command is heat.

In addition a single fuzzy if-then rule assumes the form as the following statement:

If x is in A then y is in B ,

Where A and B are linguistic variables which are defined by fuzzy sets on the ranges X and Y . The first part of the statement is defined or called as an antecedent and the second part of the statement is defined as a consequent. One can define and operate with the minimum function, or operate with the maximum function. The most important thing which can differ the fuzzy logic from logic is the existence of the function behind the truth table. Rather than just the truth table itself, now you can consider any number between 0 and 1.

In the application process, one can also combine the rules:

If x is in A and y is in B then C is in C

OR

If x is in A or y is in B then C is not in C,

Where A, B, and C are linguistic variables which are defined by fuzzy sets on the ranges X, Y, and Z.

2.3.4 Fuzzification and rule generation

Fuzzification is a process where inputs basically turn into an output. Every time the shape and interval of the membership functions are changed, the computation of all the functions for the membership function's variable has to be done again.

After the input and output membership function and variables are defined, the decision matrix of the fuzzy system or rule base (if-then rules) has to be created. The input variable transforms to an output variable with the help of defined rules by experts. More or less, rules can be defined depending on the number of membership functions for input and output variables.

By computing the degree of membership to the membership function of the output, it takes a value between 0 and 50 to show the degree of membership to a given membership function of that specific variable. The degrees of membership of the output variable can be taken through a combination of the degrees of memberships of the input variables.

2.3.5 Defuzzification

A decision problem is that an output should be a number (crisp value) and not a fuzzy set. Therefore, one must transform the fuzzy set that was obtained in step 2.3.4 into a numerical value, which is the final crisp output. Defuzzification has to be performed

according to the membership function of the output variable. The purpose of these steps is to obtain a crisp value. In this study, the membership functions of the output have the same shape and qualitative category as input membership functions. There are different algorithms for defuzzification, some of which are Central Average, Left Most Maximum, and Right Most Maximum. The method of Centroid is used in this study. It is one of the most common defuzzification methods which returns to the center of the area under the fuzzy set.

2.3.6 Graphs of the relations between inputs

In this study, we generated the output surface for the fuzzy inference system, plotting the first output variable against the first three input variables. Fuzzy systems with three input variables use the midpoints of their respective ranges as reference values. In figure 2.3, graphs of variable relations can be seen.

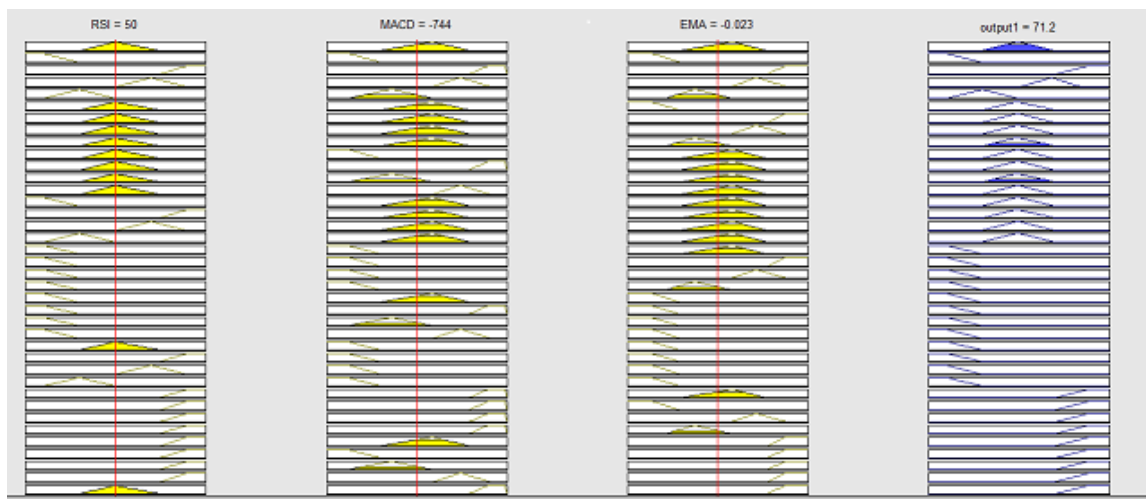


Figure 2.3 Variables Relation

3. MODELING

In this part of the study, the steps of the application process are explained individually. Our main hypothesis is to show the importance of using Fuzzy Logic to predict the future price changes or returns and to show the efficiency of using more than one technical indicator.

Step 1: Construct/Decide the data set

The first step is to get move the market data into Excel, by going to the Yahoo Finance web page and downloading historical data directly, and then loading it into Excel. In this study, we downloaded all daily data series for four indices between 2008 and 2015.

Step 2: Check the daily closing price movements to see the existence of asymmetric correlation.

We used the excel cor() function to get the correlation between our variables. Simply, we put the BIST30, NIKKE225, Dow Jones, and SOXX50 closing values on the same sheet and used cor() function.

Step 3: Create your indicator

Now, we can use our data to construct an indicator or indicators. In this thesis, we constructed the EMA, MACD, and RSI. We used formulas explained in Chapter 2 to find the values of the indicators; trivially each indicator has different calculations with respect to different formulas.

Step 4: Compare same time decisions

After calculating EMA, MACD, and RSI signals for BIST30, NIKKE225, Dow Jones, and SOXX50, we put the same day signals together for each market and checked how

often they gave the same signals. We also checked for similarities in each market in terms of same decisions generated at the same time. same time decision combinations.

Up to now, the values of only three indicators were calculated. Simple trading decisions such as Sell, Buy, and Hold were chosen because they are the most used and effective methods. Obviously though, more complex decisions exist, such as Variables that have a position with four and five signal classifications. Recommendations are included in further steps.

Step 5: Create more sensitive trading decisions

Instead of traditional classifications as buy, hold, and sell, we include multiple terms for each of the ratings as well as a couple of new terms: Buy-Sell and Sell-Buy. We explain formulations below.

For MACD calculation, the MACD histogram is constructed by taking the difference between the MACD signal line value from the MACD value ($MACD - MACD\ SIGNAL = HISTOGRAM$).

- If today's MACD Histogram value is positive and yesterday's value was negative, then Buy-Buy will be given.
- If today's MACD Histogram value is negative and yesterday's value was positive then Sell-Sell decision will be given.
- If today's MACD Histogram value is positive and yesterday's value was positive then Sell-Buy decision will be given.
- If today's Histogram value is negative and yesterday's value was negative then Buy-Sell decision will be given.

For RSI, we divided RSI into four sections equally.

- If today's RSI value is between 0 and 25 then Sell-Sell decision will be given.

- If today's RSI value is between 26 and 50 then Buy-Sell decision will be given.
- If today's RSI value is between 51 and 75 then Sell-Buy decision will be given.
- If today's RSI value is between 75 and 100 then Buy-Buy decision will be given.

For EMA, we used EMA and daily closing values.

- If today's closing value is greater than yesterday's closing value and today's EMA value then Buy-Buy decision will be given.
- If today's closing value is less than yesterday's closing value and today's EMA value then Sell-Sell decision will be given.
- If today's closing value is greater than today's EMA value and less than yesterday's closing value then Buy-Sell decision will be given.
- If today's closing value is greater than yesterday's closing value and less than today's EMA value then Sell-Buy decision will be given.

Step 6: Calculate the control group values of the created trading system and compare the test results.

Also, for the control group, we used daily High, Low, and closing values. For each signal variable, we generated four rules:

1. Buy-Buy signal will be given if these conditions exist:
 - If today's closing value is less than tomorrow's highest value
 - If today's closing value is less than tomorrow's closing value
 - If today's closing value is less than or equal to tomorrow's lowest value
 - If today's closing value is equal to or greater than today's lowest value
2. Sell-Sell signal will be given if this conditions exist:
 - If today's closing value is equal to or less than today's highest value
 - If tomorrow's closing value is equal to or greater than tomorrow's highest value

- If today's closing value is greater than tomorrow's closing value
 - If today's lowest value is greater than tomorrow's lowest value
3. Sell-Buy signal will be given if this conditions exist:
- If today's closing value is equal to or greater than today's lowest value
 - If today's closing value is less than tomorrow's highest value
 - If today's closing value is less than tomorrow's closing value
 - If today's closing value is greater than tomorrow's lowest value
4. Buy-Sell signal will be given if this conditions exist:
- If today's closing value is equal to or less than today's highest value
 - If today's closing value is greater than tomorrow's closing value
 - If today's lowest value is greater than tomorrow's lowest value
 - If today's closing value is less than tomorrow's highest value

If the results of the sixth step are accurate, we can apply the Fuzzy Logic model to the system.

Step 7: Assign input and output variables for the Fuzzy Logic system

Give the linguistic variables inputs and output. In this thesis EMA, MACD, and RSI are the given names for inputs and OUTPUT1 is the output name for variables.

Step 8: Assign fuzzy sets

As well as defining the linguistic variables, there is need to give each one a range of possible values to represent the fuzzy membership functions. We defined linguistic terms of the linguistic variables as EMA, MACD, RSI and OUTPUT1 and associated them with fuzzy sets. We used five linguistic terms/fuzzy sets to represent the variables which are Buy+, Buy, Do Nothing, Sell, and Sell+.

Step 9: Define fuzzy rules

After defining the membership functions for input and output variables, the fuzzy expert system is constructed to define a set of fuzzy rules which will relate the observations to the fuzzy sets.

Step 10: Calculate the output values of the fuzzy logic system and compare/test the results with the basic rules or results which are calculated from one of the indicators; whether or not we are Buy or Sell position (decision) on the close of the prior day, and whether we have the right decision or not. In function form, if Buy, then multiply the prior day's equity by the ratio of today's close to yesterday's close, if Sell then multiple the prior day's equity by the ratio of yesterday's close to today's close, otherwise do nothing. After that, we have the daily loss or gain raw percentages. Note that we used cash to make it more understandable. In this study, the start point is a cash value of \$100,000 and then increment or decrement that by the results.

3.1 Practical Application of Explained Methods

In this study, daily values, of four different indices are used to analyze similarity to check if it is accrued or not. The selected indices are BIST30, NIKKE225, Dow Jones, and SOXX50, each representing a different country. In another words, to test if these decisions are profitable or efficient, we use these four indexes' historical prices from 2009 to 2015. BIST30 is the Borsa Istanbul 30 Index, which is a capitalization-weighted index composed of National Market companies, except investment trust. The Dow Jones Industrial average is a price-weighted average of 30 significant stocks traded on the New York Stock Exchange. The NASDAQ NIKKEI225 Stock Average is a price-weighted index comprised of Japan's top 225 blue-chip companies traded on the Tokyo Stock Exchange. The EURO SOXX50 is a stock index which is a price-weighted index comprised of the Euro zone stocks.

The time period which is chosen as a sample are the years between 2008 and 2015. Figure 3.1 illustrates a randomly selected two-month closing values of BIST30

NIKKE225, Dow Jones, and SOXX50. One can find the graphs of the closing prices of these four indexes in Appendix Figure A.1, A.2, A.3 and A.4.

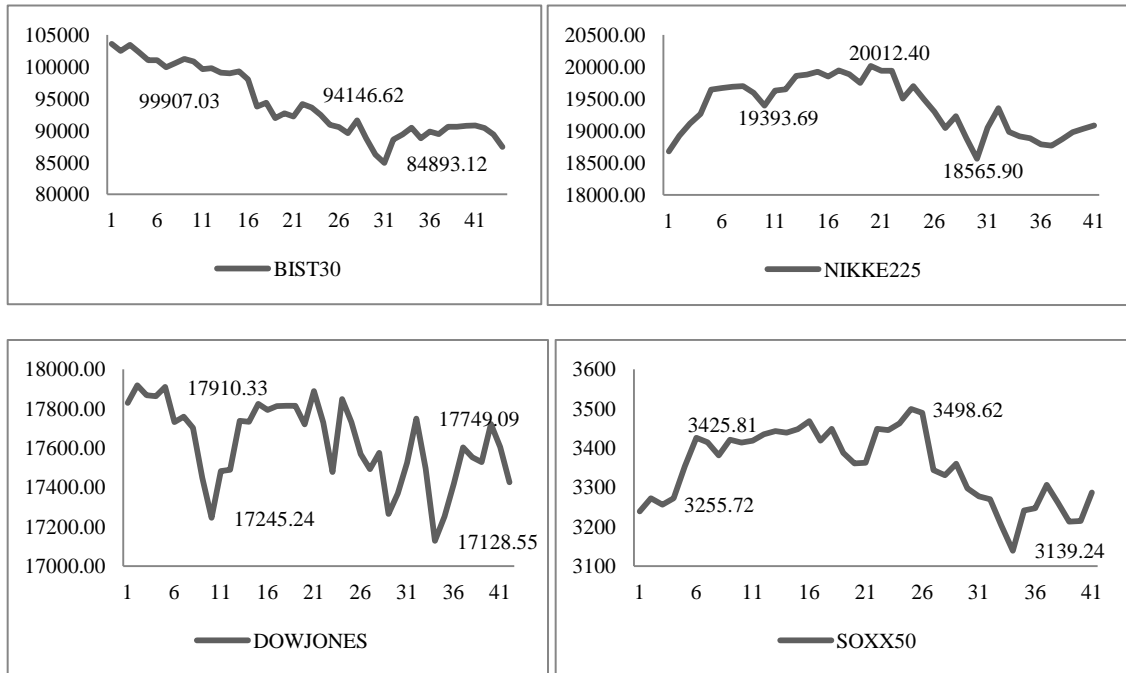


Figure 3.1: November-December 2015 Closing Values of Four indexes

We can see the general price movement of the four indexes over a period of time in figure 3.1. In general, they have unique price movements except one new low which is seen in all figures between the dates of the 31st to the 36th. This shows us that every country's indexes are like families because everybody lives their own life but they are all affected by each others' bad and good news. In addition to seeing the main structure of the four markets, the descriptive statistics of four markets can be seen in Appendix Table A.1 and A.2.

Table 3.1: Correlation Coefficient

	BIST30	SOXX50	NIKKEI225	DOW JONES
BIST30	1			
SOXX50	-0.3031	1		
NIKKEI225	-0.7100	0.7127	1	
DOW JONES	-0.8496	0.5308	0.8565	1

We check the daily closing price movements to see the existence of asymmetric correlation. The results of the asymmetric correlation between BIST30, SOXX50, NIKKEI225, and DOW JONES can be seen in Table 3.1.

From Table 3.1, one can easily figure out the negative correlation between BIST30 and the other indexes. Negative correlation means one variable increases as the other decreases, and vice versa. For example, the correlation co-efficiency between NIKKEI225 and BIST30 is -0.71. This means if one of them increases one point, the other one decreases 0.71 point. No one can conclude that one of them affects the other by the help of correlation analysis. We can only conclude that the positive correlation means that they move together, increasing or decreasing. The negative correlation means that they move in opposite directions.

The highest positive correlation is between Dow Jones and NIKKEI225. The correlation result is 0.8565, which is a very high value for two different country market correlation coefficients. Since the correlation coefficient matrix is symmetric, we did not write the symmetric values of coefficients. Up to now, the closing values of all indices, which are selected to measure the asymmetric information and error, were calculated currently for technical indicators.

From closing prices, we calculated EMA. EMA is a stock or index chart tool, which investors use to follow trends in the value of a stock or index. EMA works similar to simple MA, except the most recent values are given more weight in the average than the older values. This makes EMA more closely reflective of the changes in prices. In this

study, a standard EMA formula that uses the industry standard exponential function $2/(1+\text{number of periods in MA})$ has been used. We set the initial value of the EMA sequence equal to the close value on the same line because we have to "seed" the EMA calculation with a reasonable value. Figure 3.1 illustrates the EMA values of four indexes:

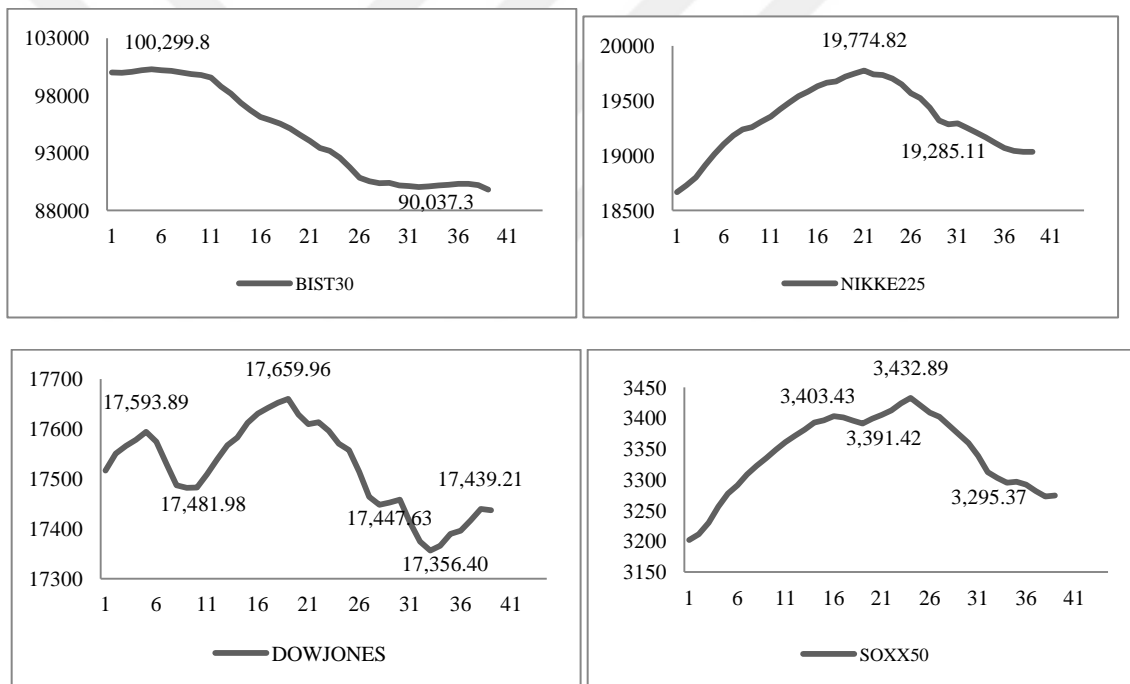


Figure 3.2: November-December 2015 EMA Values of Four indexes

In Figure 3.2 one can see that the four indexes move and follow the trends. Some indexes show strong upward or downward trends, in this case it's logical to trade from the long sides of EMA charts. Then, we calculated MACD for all these indexes. This indicator is a trend following indicator, which tracks the difference between two exponential moving averages. This difference is referred to as the "MACD line," and there is another shorter time-frame exponential moving average of the MACD line, which is called the "signal line," as explained in chapter 2.1.2. To calculate MACD, we

have to construct four data-series, which are named as fast EMA, short EMA, the MACD line, and the signal line. The basis for the calculation of MACD will be the close price values and for this indicator, 9, 12, and 26 have been set as parameter values. For the first step, EMA is calculated with a length parameter value of 12 and 26. These new series are respectively named as EMA12 and EMA26. For the second step, the difference between EMA12 and EMA26 is calculated. This new series is named as MACD. Therefore, the “MACD Signal” line is an EMA of the MACD values. Figure 3.3 illustrates MACD and MACD signal values for all indexes that were examined in this study.

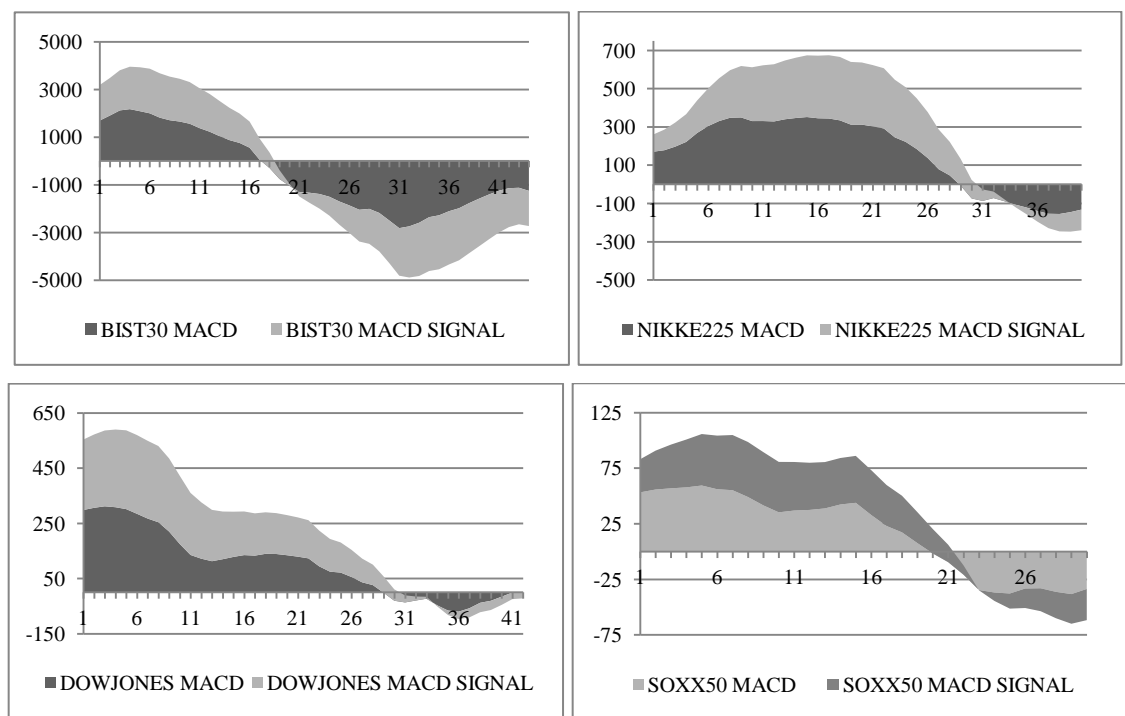


Figure 3.3: November-December 2015 MACD and MACD Signal Values of Four Indexes

One can see signal line crossovers in Figure 3.3, a bearish crossover occurred in all 4 indexes which means MACD goes down and crosses below the signal line. A bullish move can be seen in one of the indexes above.

RSI is a momentum oscillator which calculates velocity and strength of a financial instrument value movement. RSI evaluates whether the market is currently overbought or oversold. If the value of RSI is greater and/or equal to 70, generally, technical analysts assume that the market condition is overbought. They can assume this condition according to their expert opinion. If the value of RSI is below and/or equal to 30, they generally assume the market condition is oversold. If the value of RSI is between 30 and 70, this indicator is not solid for the knowledge based “buy” or “sell” decisions. To calculate the value of RSI, the first step is to calculate the daily differences from closing values. According to the negative or positive differences, we split them into two subgroups as positive and negative ones. The positive/negative ones are named as Gains/Losses. For the second step, 14 daily average Gains/Losses are calculated. The ratio of them is named as RS (Relative Strength). The aim of the last step is to take the value of RS between 0 and 100 which helps the investor to make the decision of buy, sell, or maybe do nothing. One can use the following formula to calculate the value of RSI:

$$RSI = 100 - 100 / (1 + RS)$$

where, $RS = \text{Average Gain} / \text{Average Loss}$.

One can found RSI graphs as a sample in Appendix Figure A.7, A.10, A.13, and A.17.

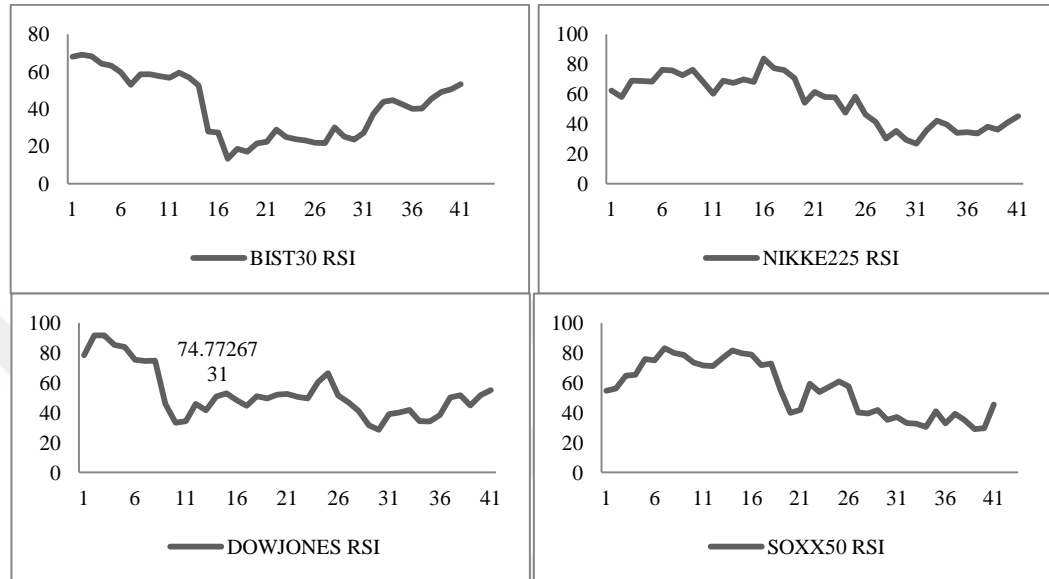


Figure 3.4: November-December 2015 RSI Values of Four Indexes

In Figure 3.4, traders can follow the buy and sell signals. Strong buy and sell signals can be detected easily from the same graph. Another movement pointed out in these indexes is that no buy-sell signal periods are more than buy and sell signal periods.

By the help of these EMA, MACD, and RSI technical indicators, one can make trade decisions, such as buy, sell, or do nothing. We decide to only use buy and sell decisions for the indicators EMA and MACD. For the RSI indicator, it is not common to make decisions between values 30 and 70, therefore, for these values we set a decision as do nothing. Table 3.2 illustrates Buy-Sell decisions for the EMA indicator:

Table 3.2: EMA Results (Buy-Sell Decisions)

EMA	Sell	Buy
BIST30	904 (45.27%)	1093 (54.73%)
NIKKE225	852 (43.43%)	1110 (56.57%)
Dow Jones	776 (38.74%)	1227 (61.26%)
SOXX50	912 (45.17%)	1107 (54.83%)

In the sample for all indexes, the percentage of the sell decision is greater than the buy decision. The minimum percentage for the buy decision is from the Dow Jones index. For the other three indexes, the percentages are approximately close. Table 3.3 illustrates buy-sell decisions for the MACD indicator:

Table 3.3: MACD Results (Buy-Sell Decisions)

MACD	Sell	Buy
BIST30	944 (47.27%)	1053 (52.73%)
NIKKE225	868 (44.24%)	1094 (55.76%)
Dow Jones	728 (36.35%)	1275 (63.65%)
SOXX50	907 (45.92%)	1112 (55.08%)

The MACD decision results are approximately similar to the results of the EMA indicator. The minimum percentage for the buy decision is again from the Dow Jones index and all sell decisions are greater than buy decisions. Table 3.4 illustrates buy-sell-do nothing decisions for the RSI indicator. When we only mention the results of the MACD indicator, we can conclude the structure of the indexes, which are representatives of different markets, follow the same trend.

Table 3.4: RSI Results (Buy-Sell-Do Nothing Decisions)

RSI	Buy	Sell	Do Nothing
BIST30	388 (19.43%)	201 (10.07%)	1408 (70.51%)
NIKKE225	160 (8.15%)	330 (16.82%)	1472 (75.03%)
Dow Jones	213 (10.63%)	406 (20.27%)	1384 (69.10%)
SOXX50	176 (8.72%)	258 (12.78%)	1585 (78.50%)

The percentage of do nothing decisions is greater than the percentage of both the buy and sell decisions. In addition, the percentage of do nothing decisions is greater than the total percentage of the buy and sell decisions. For this indicator, the percentage of the do

nothing decision for all four indexes are between the range of 69% and 79%, and the percentage of buy for all four indexes are between 8% and 20%.

Now, we want to check if these technical indicators give the same buy and sell signals at the same time. Our main question is that we want to answer if these technical analyses generate different or same buy or sell signals at the same time and which technical indicators' signals support the other technical analysis signal. Also, we will be able to compare the results of each index to other indexes' results to check for similarities. The do nothing decision of RSI is shared between the buy and sell decision equally to make it similar to the EMA and MACD decision. Tables 3.5 illustrate the percentage of buy and sell decisions for all combinations of technical indicators for all indices:

Table 3.5: Indicator Buy and Sell Signals (%)

	Buy	Sell
BIST30 EMA-MACD	268 (13.62)	238 (11.42)
BIST30 EMA-RSI	916 (45.87)	754 (37.76)
BIST30 MACD-RSI	215 (10.77)	202 (10.12)
BIST30 EMA-MACD-RSI	146 (7.31)	147 (7.36)
NIKKE225 EMA-MACD	613 (31.24)	855 (43.58)
NIKKE225 EMA-RSI	143 (7.29)	159 (8.10)
NIKKE225 MACD-RSI	203 (10.35)	203 (10.35)
NIKKE225 EMA-MACD-RSI	58 (2.96)	49 (2.50)
Dow Jones EMA-MACD	503 (25.18)	1002 (50.17)
Dow Jones EMA-RSI	145 (7.26)	157 (7.86)
Dow Jones MACD-RSI	181 (9.06)	241 (12.07)
Dow Jones EMA-MACD-RSI	46 (2.30)	67 (3.36)
SOXX50 EMA-MACD	647 (32.40)	847 (42.41)
SOXX50 EMA-RSI	151 (7.56)	169 (8.46)
SOXX50 MACD-RSI	193 (9.66)	216 (10.82)
SOXX50 EMA-MACD-RSI	48 (2.40)	54 (2.70)

The first row of Table 3.5 shows that the EMA and MACD indicators gave buy (sell) signals at the same time with a 13.62% (11.42%). From Table 3.4, one can also analyze that for BIST30 index, EMA and RSI technical indicators move in unison, generating buy signals at the same time with a 45.87%. However, for Dow Jones, EMA and RSI technical indicators give buy signals at the same time with a 7.56%. EMA, MACD, and RSI technical indicators give buy or sell signals at the same time between 2% to 3% in the NIKKEI225, Dow Jones, and SOXX50 indexes. In the BIST30 index, the percentage increases to 7.31 for the buy signal and 7.36 for the sell signal.

For NIKKEI225, Dow Jones, and SOXX50, the indexes give the highest same time signal percentages for EMA and MACD technical indicators, second for MACD and RSI technical indicators, third for EMA and RSI technical indicators, and least for EMA, MACD, and RSI technical indicators, as we mentioned above. Also, Table 3.1 is supporting Table 3.5 as BIST30's result distribution is different from the other indexes' result distribution. Choosing technical indicators that are not similar is better for traders, rather than giving the same signal's technical indicators.

Since the decision results of the EMA, MACD, and RSI are most of the time not giving strong buy, sell, and do nothing decisions, we decide to construct different and more accurate strategies. Another reason why we decide to construct new strategies is because the previous strategies are not well-defined. For instance, when the given decision is buy, the security is not well-defined of how many shares of this security you are willing to buy or if it is a short buy or long buy. First of all, we increase the number of strategies or decisions to four. In previous strategies, the number of strategies changed according to the indicators. Only RSI has three strategies, the other two indicators have two. The new strategies which are more sensitive than buy-sell and do nothing strategies are defined in Table 3.6:

Table 3.6: Strategies and Meanings

Notation	Name of Strategy	Strategy
BB	Buy- Buy Strategy	Strong buy, keep it until it makes profit
SB	Sell-Buy Strategy	Sell it, but buy in a short time period
BS	Buy-Sell Strategy	Buy it, but sell in a short time period
SS	Sell- Sell Strategy	Strong sell, sell it in any position

We construct a system to check the sensitivity of buy and sell signals to see and decide how many shares the traders are willing to buy or sell. In other words, clustering the patterns from class, new subclasses were created such as Buy-Buy, Buy-Sell, Sell-Buy, and Sell-Sell. Instead of using a single model for each indicator, multiple models based on four subclasses are used. After deciding the four new strategies which are also decisions, we calculate the percentage of decision results for all indices that are created from the three most commonly used indicators. Table 3.7 illustrates the percentage of these decision results. From the second row of Table 3.7, the percentage of BB decision calculated, by the help of EMA for BIST30, is 26.48.

Table 3.7: Decision Results of BB-BS-SB and SS (%)

		BB	BS	SB	SS
BIST30	EMA	36.45	17.98	15.29	30.28
	MACD	3.84	45.24	47.14	3.79
	RSI	19.43	36.55	33.95	10.07
NIKKE225	EMA	37.30	18.96	15.26	28.48
	MACD	3.75	44.37	48.12	3.75
	RSI	16.82	36.09	38.94	8.15
Dow Jones	EMA	46.57	27.61	6.51	19.31
	MACD	3.92	46.94	45.22	3.92
	RSI	20.27	39.64	29.46	10.63
SOXX50	EMA	34.38	20.15	15.47	30.00
	MACD	4.04	46.08	45.84	4/04
	RSI	12.78	37.35	41.16	8.72

To check the accuracy of the decision techniques that we constructed in this study, we decided to check the profit and loss conditions of these decisions daily. To check these profit and loss conditions, we constructed a daily control group based on the closing prices. The percentages of correct decisions implied by the model are shown in Table 3.8. To check these conditions, we also define a variable called E-M-R which denotes the same decisions of three technical indicators.

Table 3.8: Control Percentages of Financial Markets based on EMA-MACD and RSI

	EMA	MACD	RSI	E-M-R
BIST30-Control	443 (22.18)	687 (34.40)	586 (29.34)	15 (34.09)
NIKKE225-Control	475 (23.60)	414 (20.57)	475 (23.60)	9 (22.5)
Dow Jones-Control	363 (18.03)	677 (33.63)	514 (25.53)	18 (22.5)
SOXX50-Control	616 (30.60)	84 (4.17)	193 (9.59)	3 (13.63)

From Table 3.8, one can easily figure out that technical indicators in the E-M-R have same time decisions with a success rate of 13% to 34%. EMA can be considered as the leading indicator from Table 3.8. The MACD value of BIST30 has the highest success rate with 34.40%. The average success rate is 22.94% (E-M-R signal is not included). Technical analysis and technical indicators do work, however, success with this technical indicators is not remarkable.

3.2 Model of the Fuzzy Structure

Up to now, with the help of the technical indicators, we found some examples that explained different decisions at the same time. If one wants to trade with using only one of them, the main question will be which one he/she will choose. In addition, if you want to use more than one, and if they give different decisions, which one's decision will be accurate. To get beneficial answers on the investor side for those types of questions, we take the assistance of Fuzzy Logic. In this section the steps of the application of the Fuzzy Logic system is explained.

For the modeling system, we have chosen three basic technical indicators as inputs such as EMA, RSI, and MACD. They are also technical indicators that help us to predict the return of four indexes. Mamdani-type fuzzy structures present two main components

such as the fuzzy inference system, which implements the fuzzy reasoning process to be applied on the system input to get the system output and the fuzzy knowledge base, which represents the knowledge about the problem being solved.

In view of the latter, it can be clearly recognized that the Mamdani-type fuzzy structure demonstrates several interesting features. It also provides a natural framework to include expert knowledge in the form of linguistic fuzzy rules. This knowledge can be easily combined with rules which are automatically generated from data sets that describe the relation between system input and output. On the other hand, there are many different design issues for the fuzzy inference mechanism, making a full use of the power of fuzzy logic-based reasoning, opposite to Takagi-Sugeno-Kang's fuzzy rule based system which applies a single and simplified kind of fuzzy inference. Figure 3.5 shows the first step in the Fuzzy Logic Design tool.

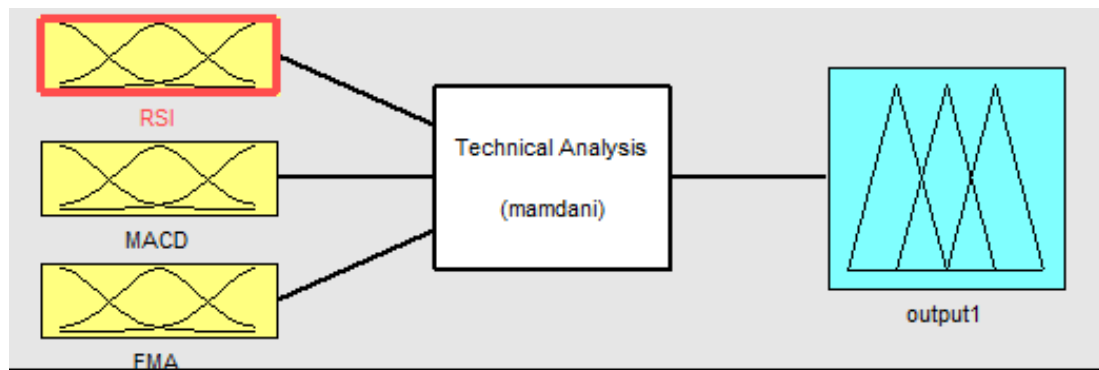


Figure 3.5: The Fuzzy Logic Designer

To measure the sensitivity of the signals, we have decided to use five membership functions such as Buy+, Buy, Do Nothing, Sell, and Sell+ for all input and output variables. Brief explanations are as follows:

Buy+ = In the market, it is known as strong buy. In addition, Buy+ is a recommendation to purchase.

Sell+ = In the market, it is known as strong sell and it's a recommendation to sell.

Do Nothing = In the market, it is known as hold. In general terms, hold recommendation is expected to perform in-line with the market.

Sell = Underperform: a recommendation that means a stock is expected to do slightly worse than the market return. Underperform can also be lumped in with "moderate sell," "weak hold," and "under-weight."

Buy = Outperform: also known as "moderate buy," "accumulate," and "over-weight." Outperform is an analyst recommendation meaning a stock is expected to do slightly better than the market return.

Below, Figure 3.6 illustrates membership functions of input EMA. When looking at the graph, there are two trapezoids and three triangles. For every other index, we define different parameter periods for all of the membership functions. These periods are chosen by the help of basic statistics.

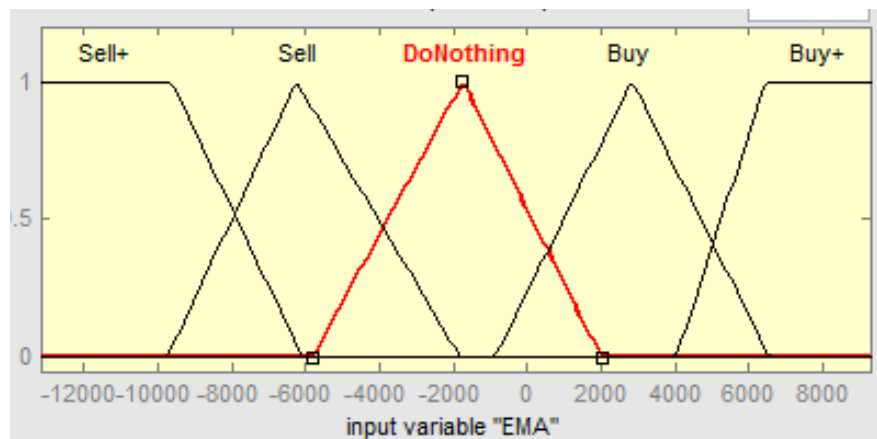


Figure 3.6 Membership function: EMA

Figure 3.7 illustrates membership functions of input MACD for BIST30 index and you can see the range of the functions easily:

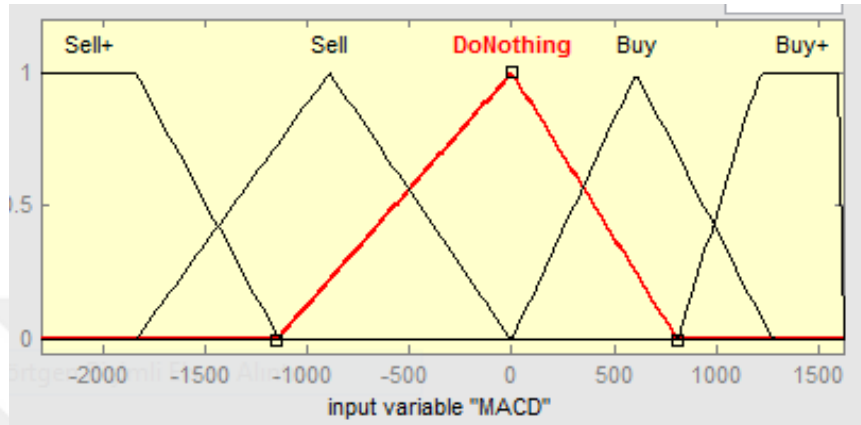


Figure 3.7 Membership function: MACD

Figure 3.8 illustrates membership functions of input RSI for BIST30 index:

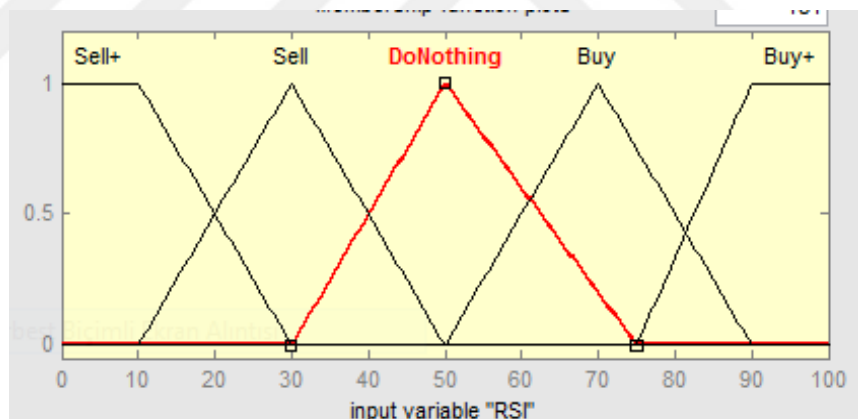


Figure 3.8 Membership function: RSI

Figure 3.9 illustrates membership functions of output variables. To make simpler conclusions for the results of the fuzzy system, we decided to use the same number of membership functions and construct the range between 0 and 50.

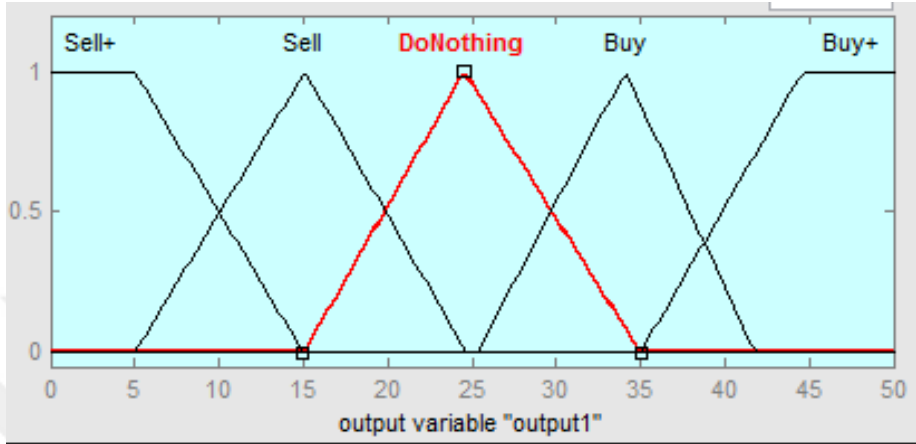


Figure 3.9 Membership function: Output

In other words, the border points of the each membership function has been chosen by calculating maximum, minimum, standard deviation, and the mean of the each input. By using these values and expert opinion, we decide the borders of the each membership functions as seen in Table 3.9 for the BIST30 index. One can find the borders of each membership functions for the other three markets in Appendix Table A.3, A.4, and A.5.

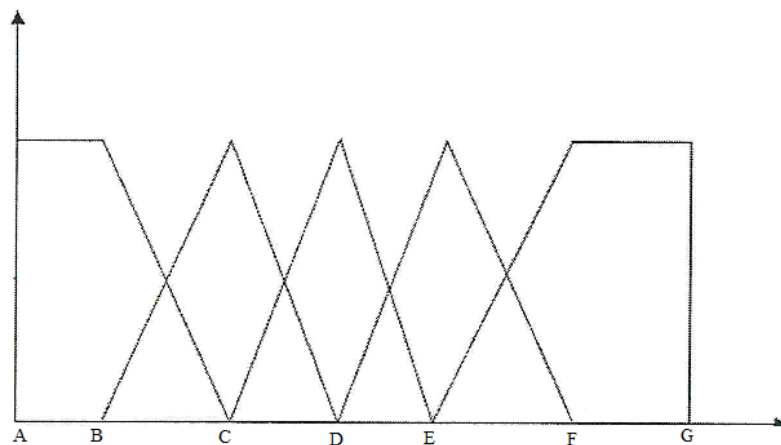


Figure 3.10: Borders of Membership Functions

As shown in Figure 3.10, A, B, and C are the borders of the trapezoid at the left side of the graph, B, C, and D are the borders of the first triangular. The borders of second

triangular are C, D, and E. The borders of third triangular are D, E, and F. The borders of trapezoids at the right side are E, F, and G. Head borders for triangular are B, C, and D and the rest are bottom borders. The A border point is shown under the minimum and the G border point is shown under the maximum in Table 3.9. (See Appendix A.3, A.4, and A.5 to see the range of variables of other financial markets).

Table 3.9: Range of Variables: BIST30

BIST30	Max (G)	Min (A)	Mean	St. Dev	B	C	D	E	F
EMA	0.1163	-0.1633	0.0010	0.0326	-0.130	-0.065	0	0.0465	0.0930
MACD	3186.38	-4674.1	84.36	-1451.3	-3739	-1869	0	1274	2549
RSI	96.6475	5.12472	52.7346	17.59	14.28	32.58	50.89	69.19	87.50

The next step is creating membership function rules. The total number of rules should be 125, with three variables with five membership functions for each (5x5x5). In this study, we constructed the rules with the following assumptions:

- If all technical indicators give the same signals, the output should be the same signal.
For example: IF RSI is Sell and MACD is Sell and EMA is Sell, then output is Sell.
- If two of them give the same signals, the output should be the same signal with two of them.
For example: IF RSI is Sell and MACD is Sell and EMA is Buy, then output is Sell.

Table 3.10 Results of the Optimization

BIST30	RSI	MACD	EMA	Output1
1	8.27	-1876.41	-0.05	24.95
2	32.82	-3148.85	-0.08	16.32
3	75.49	417.47	0.06	34.16
4	26.73	-1256.00	-0.11	6.97
5	84.11	2675.77	0.05	40.50
6	57.17	1680.78	0.01	27.68
7	18.47	-840.72	-0.12	6.04

Table 3.10's concept is context of multi-signal analysis. As seen in Table 3.9, indicators have close signals or totally different signals in some lines. Fuzzification is an effective way to overcome this problem as seen in this table's Output1 section. Output1 can serve as an effective stand point on its own. For example, if we compare line two and line six in Table 3.9, we can see that Output1 signal in the middle signal section refers to the Do Nothing (24.95 and 27.68) signal, even though indicators as inputs are in totally different directions. As seen in line two, MACD and EMA values are negative to the Sell signal (-3148.85--0.08) while line six is positive and refers to Buy signal (1680.78-0.01). Although they are both different, their outputs are positive. One can also see that there is a big difference between line two and line six in the RSI readings (24.65).

The EMA-MACD and the output surface graph for this thesis fuzzy inference system is shown in Figure 3.11:

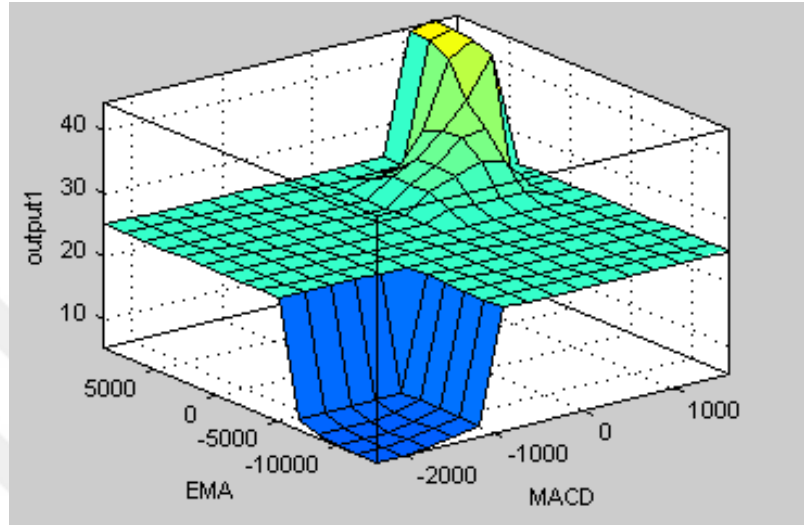


Figure 3-11: EMA-MACD and Output relationship map

The EMA-RSI and output surface graph for this thesis fuzzy inference system is shown in Figure 3.12:

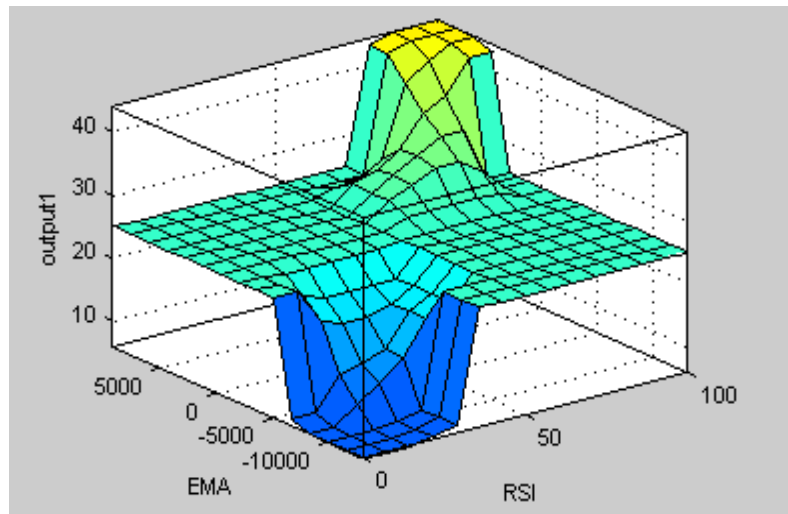


Figure 3.12: EMA-RSI and Output relationship map

The MACD-RSI and output surface graph for this thesis fuzzy inference system is shown in Figure 3.13:

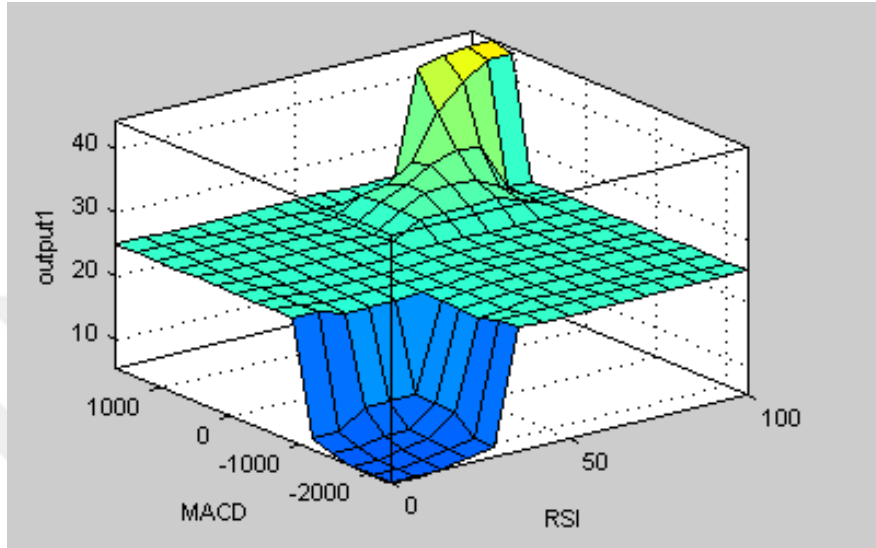


Figure 3.13: MACD-RSI and Output relationship map

3.3 Testing the Model

Utilizing this thesis theorem and extension principles of Fuzzy Logic can be obtained in stock markets. The outcome of Fuzzy Logic is useful to support decisions on the choice of a market position. From the simulated trading options, it turns out that the method tends to produce profit. The results of the thesis strategy are reported in Table 3.11:

Table 3.11 RIGHT DECISION PERCENTAGES

	EMA	MACD	RSI	E-M-R	Fuzzy Logic
BIST30-Control	22.18	34.40	29.34	34.09	33.55
NIKKE225-Control	23.60	20.57	23.60	22.5	21.66
Dow Jones-Control	18.03	33.63	25.53	22.5	34.95
SOXX50-Control	30.60	4.17	9.59	13.63	1.63

As explained in chapter 3.1, E-M-R denotes the correct percentage of decisions when three technical indicators generate the same signal. Although we were expecting these percentages greater than values, approximately our expectation for these percentages is greater than 70. Our expectation is that because in this case, three indicators give the same decisions at the same time. In addition, the percentage that they give the same decision is very low.

As mentioned in step ten of the modeling section of this thesis, we conducted an experiment which involved the use of the American dollar. Starting out with a value of \$100,000, we observed that at the end of seven years, this value was able to rise to an amount of \$700,000. Through this experiment, it is easy to conclude the high success rate of the thesis that has been proposed, examined, and studied.

4. CONCLUSION

Shortly, this thesis examines three widely used oscillators, the EMA, MACD, and RSI to predict the future price of the financial markets. To show the existence or utility of the technical analysis, we need to measure the power of their capabilities in order to predict correctly. To do this, we need some samples and since we need to generalize the subject, four big financial market indices are chosen, those of which are BIST30, NIKKEI225, Dow Jones, and SOXX50. At the same time, the relationship between these markets were checked and we discovered that the Turkish Stock Market's index is negatively correlated with the others in the years between 2008 and 2015. For a future study, the reasons of the negative correlation can be analyzed and checked if the negative correlation existed before 2008.

One of the main questions that this study tried to answer is which technical indicator can be used to predict future prices or their changes, and whether this technical indicator is accurate for all financial markets or if it is accurate for the markets that are positively correlated. In order to be able to accurately answer the questions stated above, we used the three most popular technical indicators – EMA, RSI, and MACD – and we calculated all the decisions that were found by the help of these indicators for four financial markets. The outputs of the three given oscillators were different from each other most of the time for a given period. Therefore, we decided to use the Fuzzy Set Theorem.

Fuzzification creates better forecasting and decision-making ability in signaling the timing of stock market entry and exit. All results compared and found that the Fuzzification signals are under expected levels. However, there was an apparent positive return success noted.

APPENDIX

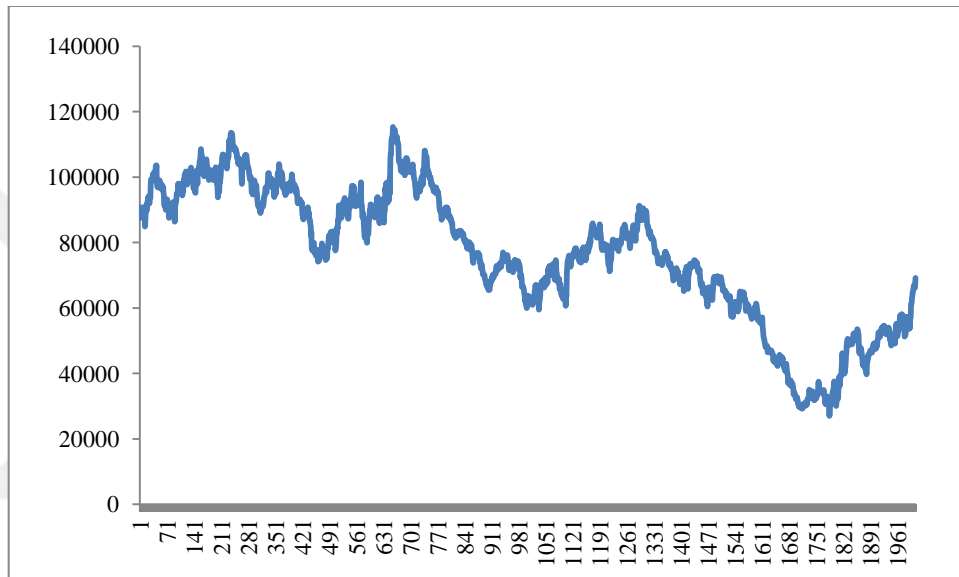


Figure A.1: Closing Price of BIST30: 2008-2015

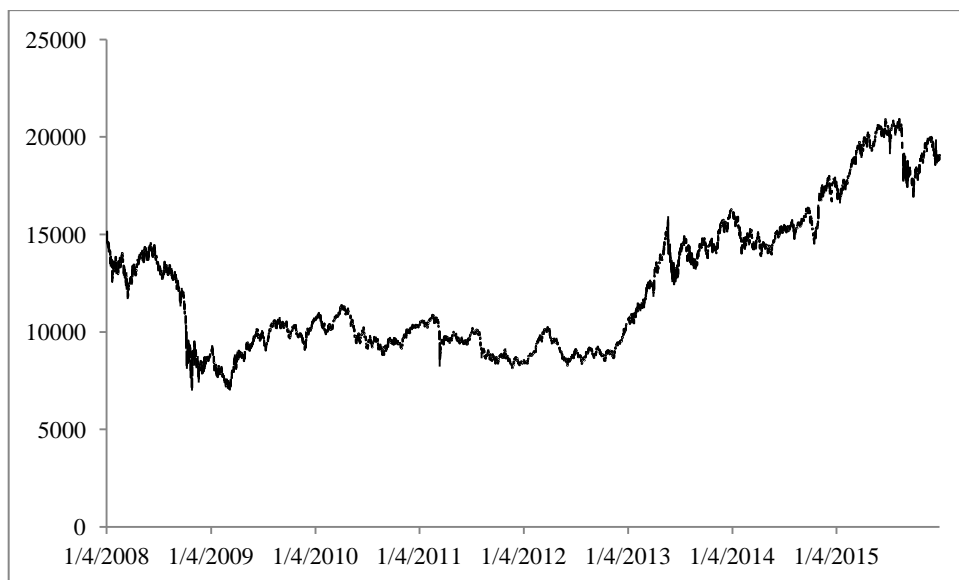


Figure A.2: Closing Price of NIKKEI225: 2008-2015



Figure A.3: Closing Price of Dow Jones: 2008-2015

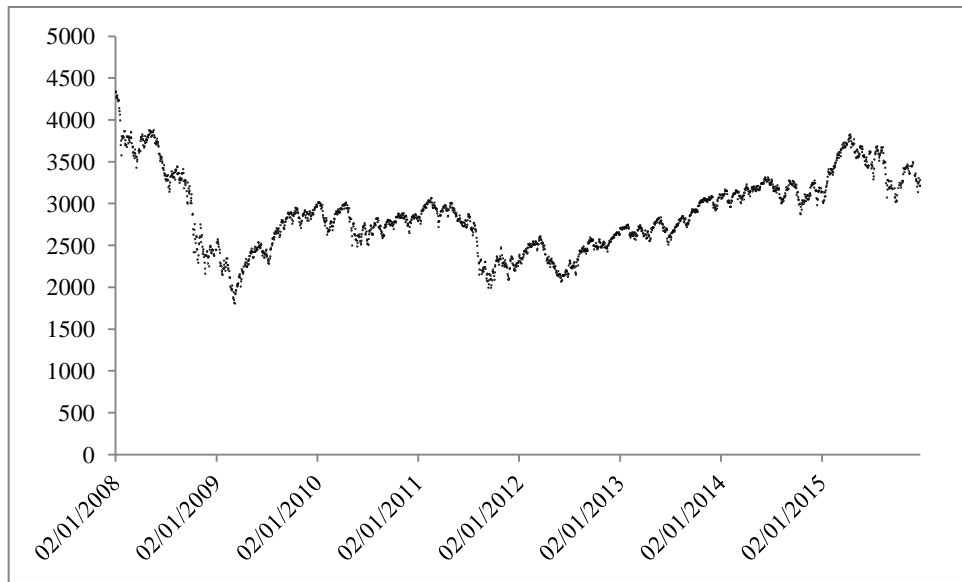


Figure A.4: Closing Price of SOXX50: 2008-2015

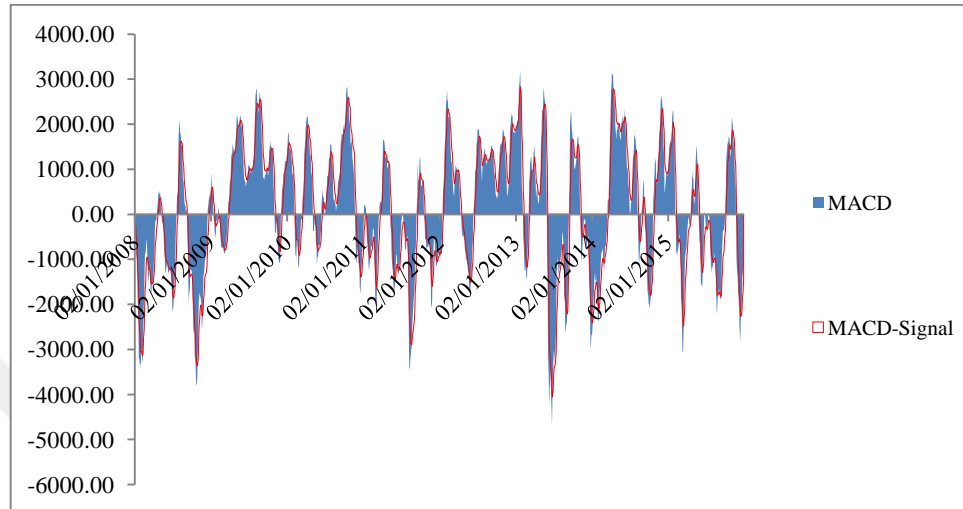


Figure A.5: MACD Values of BIST30: 2008-2015

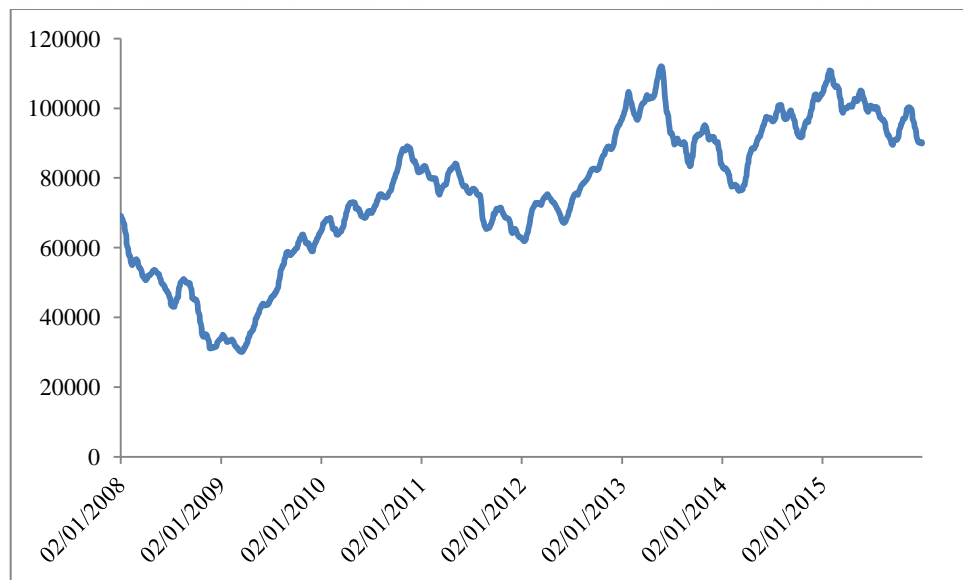


Figure A.6: EMA Values of BIST30: 2008-2015

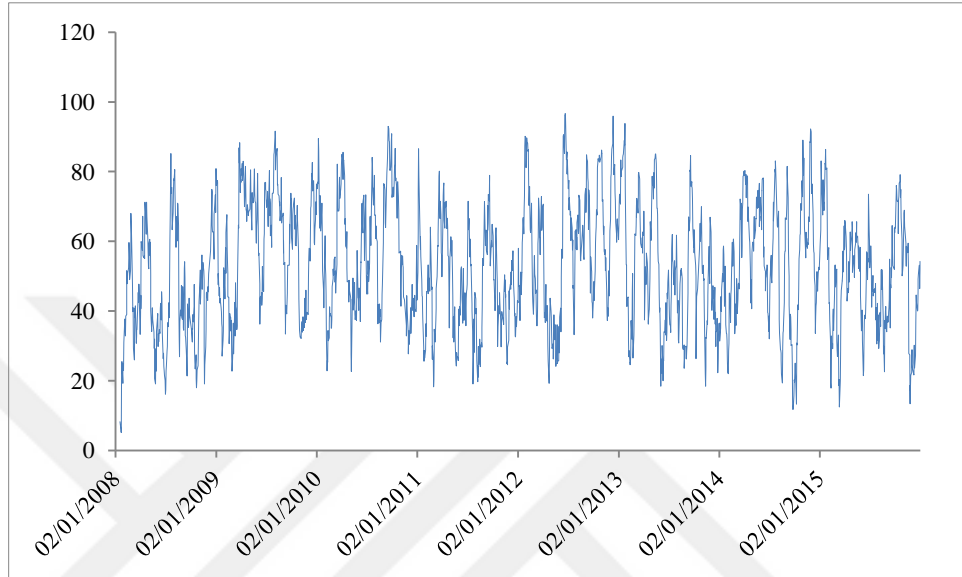


Figure A.7: RSI Values of BIST30: 2008-2015

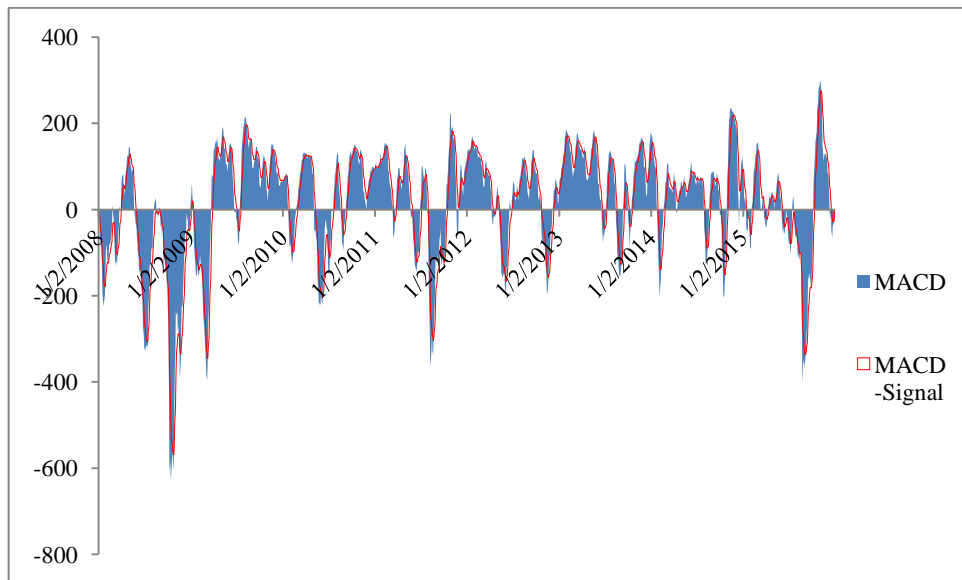


Figure A.8: MACD Values of Dow Jones: 2008-2015

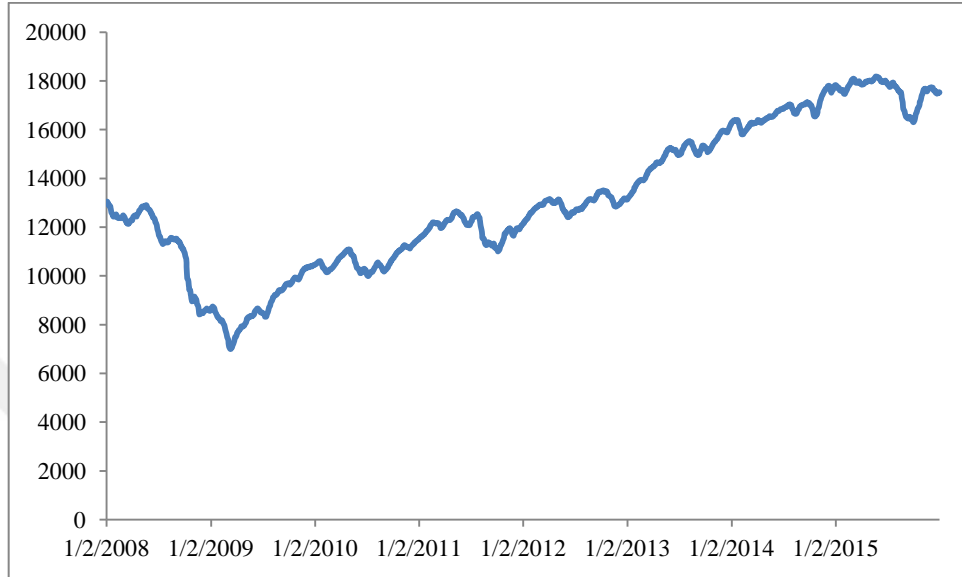


Figure A.9: EMA Values of Dow Jones: 2008-2015

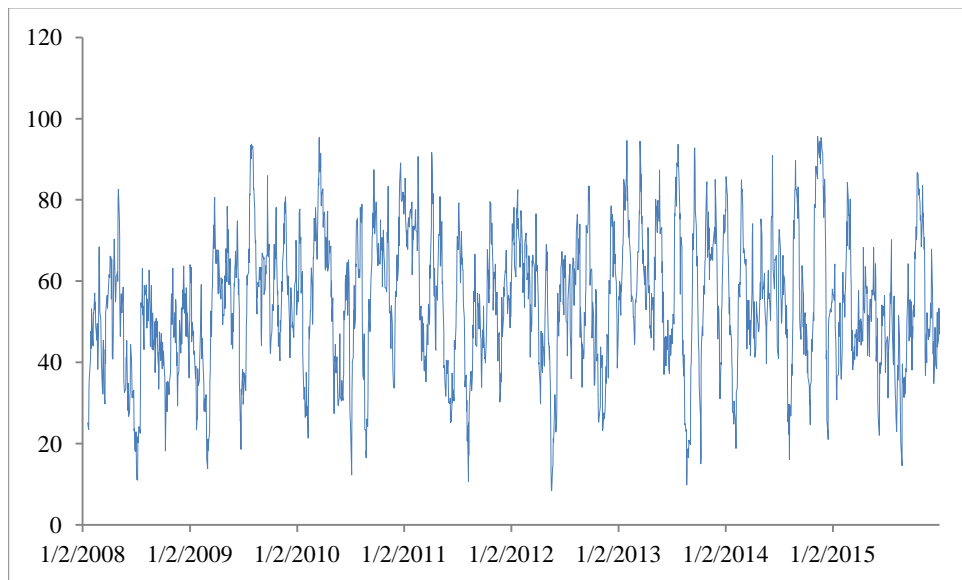


Figure A.10: RSI Values of Dow Jones: 2008-2015

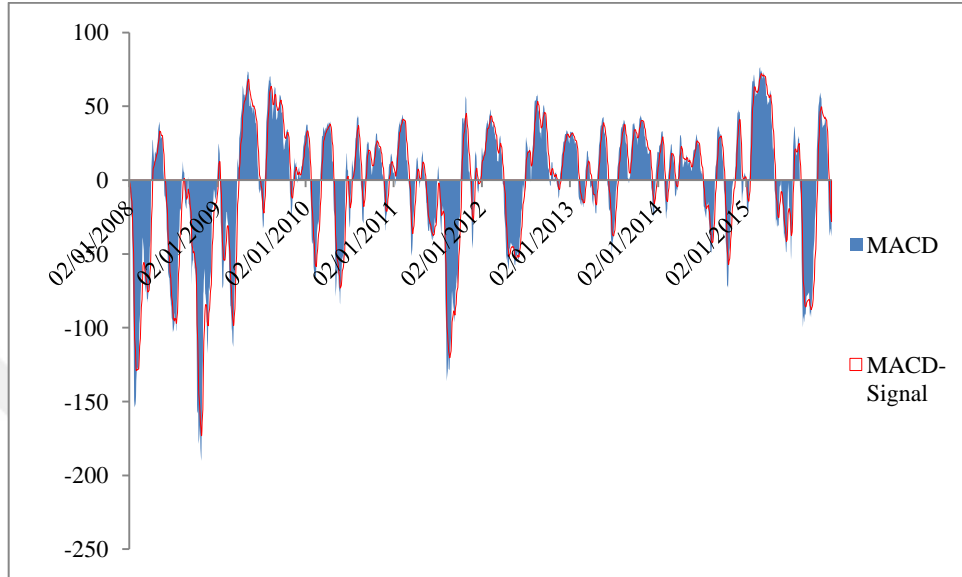


Figure A.11: MACD Values of SOXX50: 2008-2015

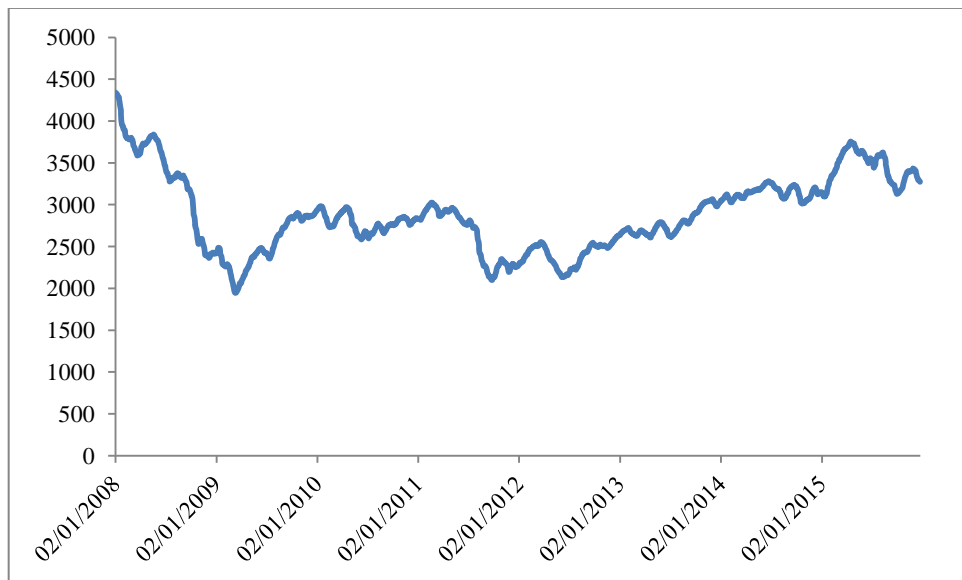


Figure A.12: EMA Values of SOXX50: 2008-2015

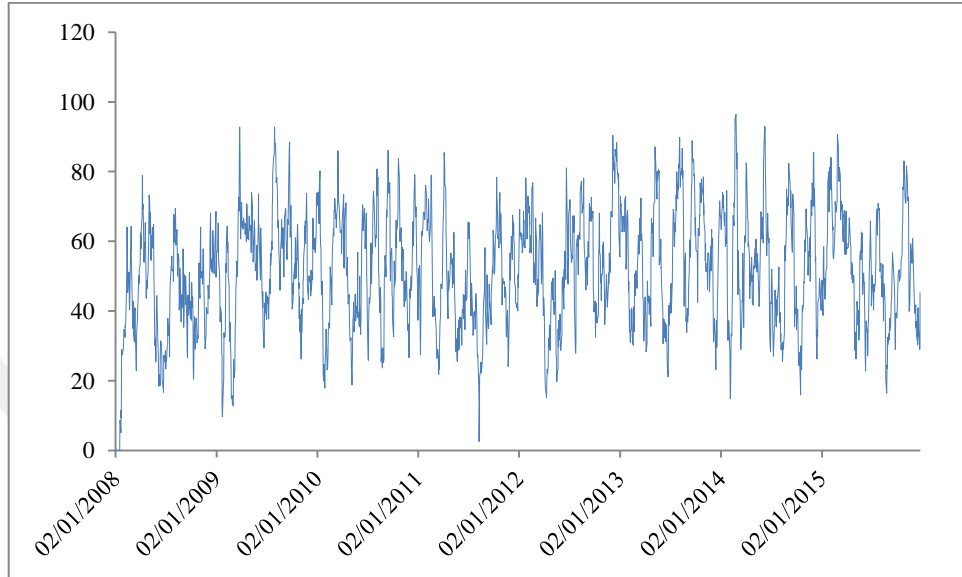


Figure A.13: RSI Values of SOXX50: 2008-2015

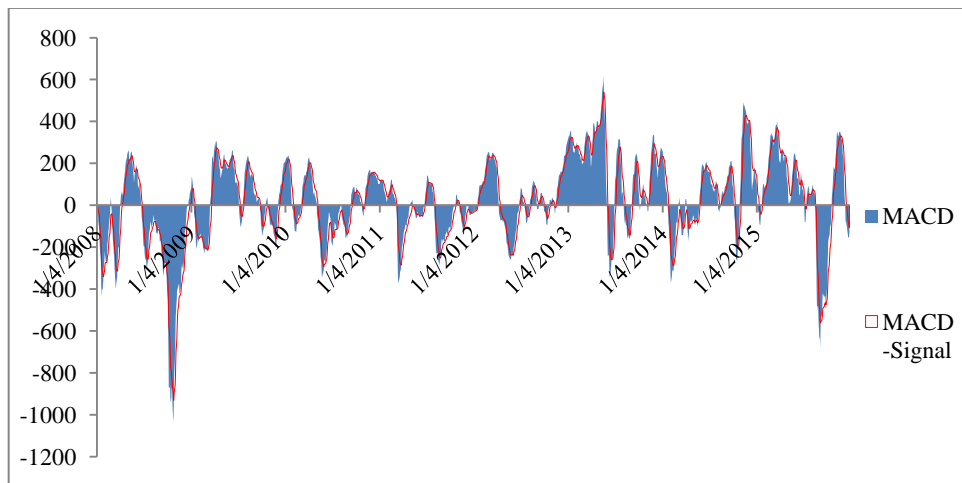


Figure A.14: MACD Values of NIKKEI225: 2008-2015

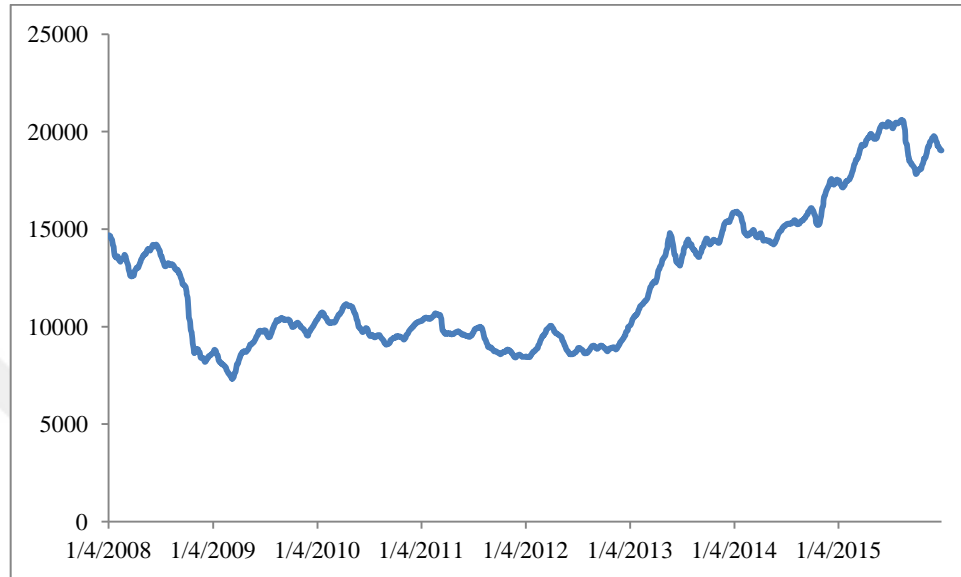


Figure A.15: EMA Values of NIKKEI225 2008-2015

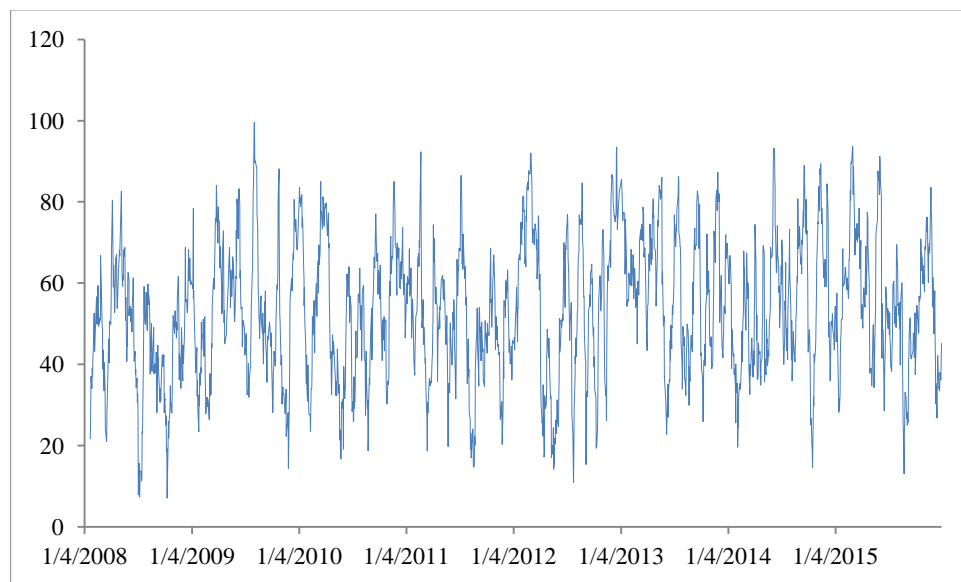


Figure A.16: RSI Values of NIKKEI225 2008-2015

Table A.1: Descriptive Statistics of Dow Jones and NIKKEI225

Dow Jones		NIKKEI225	
Mean	13136.17	Mean	12308.00
Standard Error	66.32	Standard Error	80.67
Median	12650.36	Median	10638.88
Mode	9509.28	Mode	17450.77
Standard Deviation	2977.07	Standard Deviation	3584.34
Sample Variance	8862963.79	Sample Variance	12847472.10
Kurtosis	-1.02	Kurtosis	-0.56
Skewness	0.10	Skewness	0.76
Range	11765.34	Range	13813.05
Minimum	6547.05	Minimum	7054.98
Maximum	18312.39	Maximum	20868.03
Sum	26469375.94	Sum	24296000.64
Count	2015.00	Count	1974.00
Largest(5)	18285.40	Largest(5)	20771.40
Smallest(5)	6763.29	Smallest(5)	7198.25
Confidence Level (95.0%)	130.07	Confidence Level (95.0%)	158.22

Table A.2: Descriptive Statistics of SOXX50 and BIST30

SOXX50		BIST30	
Mean	2873.18	Mean	76065.97
Standard Error	9.97	Standard Error	461.56
Median	2831.88	Median	77512.88
Mode	2648.53	Mode	#N/A
Standard Deviation	449.43	Standard Deviation	20688.13
Sample Variance	201985.05	Sample Variance	427998796.06
Kurtosis	-0.27	Kurtosis	-0.61
Skewness	0.37	Skewness	-0.46
Range	2529.25	Range	88279.09
Minimum	1809.98	Minimum	27062.22
Maximum	4339.23	Maximum	115341.31
Sum	5835423.74	Sum	152816527.65
Count	2031.00	Count	2009.00
Largest(5)	4270.53	Largest(5)	113614.87
Smallest(5)	1882.79	Smallest(5)	29289.15
Confidence Level (95.0%)	19.56	Confidence Level (95.0%)	905.19

Table A.3 Dow Jones Range of Variables

DOWJONES	Max(G)	Min(A)	Mean	St. Dev	B	C	D	E	F
RSI	98.68	4.57	54.21	18.64	13.98	32.80	51.62	70.44	89.26
MACD	311.76	-699.42	16.01	137.59	-559.54	-279.77	0.00	124.70	249.41
EMA	0.0928	-0.1418	0.0085	0.0193	-0.1134	-0.0567	0.0000	0.0371	0.0742

Table A.4 NIKKEI225 Range of Variables

NIKKEI225	Max(G)	Min(A)	Mean	St. Dev	B	C	D	E	F
RSI	99.56	7.12	53.01	16.75	16.36	34.85	53.34	71.83	90.32
MACD	616.29	-1031.35	17.03	208.18	-825.08	-412.54	0.00	246.51	493.03
EMA	0.0899	-0.2083	0.0010	0.0268	-0.1667	-0.0833	0.0000	0.0360	0.0719

Table A.5 SOXX50 Range of Variables

SOXX50	Max(G)	Min(A)	Mean	St. Dev	B	C	D	E	F
RSI	96.39	2.58	51.87	16.02	11.96	30.72	49.49	68.25	87.01
MACD	76.58	-190.19	-3.39	44.32	-152.15	-76.08	0.00	30.63	61.26
EMA	0.0697	-0.1605	-0.0009	0.0249	-0.1284	-0.0642	0.0000	0.0279	0.0558

REFERENCES

Adam H. Grimes, The Art and Science of Technical Analysis: Market Structure, Price Action and Trading Strategies oct 2009

Darrell R. Jobman, Handbook of Technical Analysis: A Comprehensive Guide to Analytical Methods, Trading Systems and Technical Indicators, McGraw-Hill, Nov 1994.

A technique for the optimization of the parameters of technical indicators with Multi-Objective Evolutionary Algorithms Evolutionary Computation (CEC), 2012 IEEE Congress on

Introduction to Fuzzy Logic using MATLAB OCT 2006

Technical Analysis from A to Z by Steven B. Achelis OCT 2000

The Three Secrets to Trading Momentum Indicators David Penn DEC 2009

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