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TESTING THE EFFICIENCY OF BORSA ISTANBUL,  
VIA AN ALGORITHMIC MODEL CREATED BY USING  
TECHNICAL ANALYSIS INDICATORS

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## Acceptance and Approval

This study titled as “TESTING THE EFFICIENCY OF BORSA ISTANBUL, VIA AN ALGORITHMIC MODEL CREATED BY USING TECHNICAL ANALYSIS INDICATORS” / “TEKNİK ANALİZ İNDİKATÖRLERİ İLE ALIM-SATIM SİSTEMİ OLUŞTURARAK, BORSA İSTANBUL’UN ETKİNLİĞİNİN TEST EDİLMESİ” and written by ÖMER FARUK TUNA is examined through online thesis defense platform and is successfully accepted as a Master’s Degree Thesis.

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I would like to thank to my dissertation supervisor Prof. Dr. Cenktan Ozyildirim for his continuous support and his feed-backs. He guided me in this study with contribution, patience and understanding. I could not ask for more.

I have been in trading business for almost 30 years. As my information accumulated over the years, making a detailed, academic level study in the field of my expertise has been in my agenda for long. With this paper, I am glad that I am able to attempt to demonstrate compliance of the reality in Borsa Istanbul with the long-known theories of technical analysis. The tool I have used with this purpose, the algorithmic model, form the basis of my study and I am happy that with this paper, I am able to open its validness to criticism of those who are passionately interested in this field like me.

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## **LIST OF ABBREVIATIONS**

m: million(s)

BIST-30: The index formed by top 30 stocks traded in Borsa Istanbul.

X30YVADE: Futures of BIST-30

\$: American Dollars



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## **ABSTRACT**

In this paper, the literature related to behavioral perspective of stock movements is briefly summarized with the purpose of providing the basis for a proposed mathematical model. A formula using technical analysis indicators is introduced. Using this formula and methodology, performance tests are applied and results are discussed. Due to the success of the algorithmic system in Borsa Istanbul, it may be deduced that Borsa Istanbul is not an efficient market.

Literature about stock markets and investor behavior is examined. In order to evaluate the algorithmic system tools used in the formula, principles and main instruments of technical analysis are explained. Later, the distinctive properties and formation of the algorithmic model is described together with its test on real data from Borsa Istanbul Futures and Options Market. The data for the first 5 years of the futures market in Borsa Istanbul is used for the creation of the system; testing and fine-tuning. The results indicate that, as forecasted, the model is highly successful in those time intervals, where there is a clear trend of appreciation or depreciation in the stock market. On the other hand, results in sideways markets are hardly adequate.

## ÖZET

Bu çalışma ile borsalardaki yatırımcı davranış şekillerini inceleyen araştırmalar irdelenmiş; bu davranışları temel alan teknik analiz göstergeleri kullanılarak, matematiksel bir modele dayanan bir algoritmik sistem formülü tanıtılmıştır. Bu metodoloji ve formülasyon kullanılmak suretiyle, Borsa İstanbul Vadeli İşlemler Pazarı'nda performans testleri yapılmış; çıkan sonuçlar tartışılmıştır. Sistemin başarılı sonuçlar vermiş olması nedeniyle, Borsa İstanbul'un verimli bir pazar olmadığı gözlemlenmiştir.

Formülasyonda kullanılan algoritmik sistem enstrümanlarını tanıtabilmek için, teknik analizin dayandığı prensipler ve sık kullanılan göstergelerden bahsedilmiştir. Bilahare, algoritmik modelin formülasyonu detaylıca anlatılmıştır. Borsa İstanbul Vadeli İşlemler ve Opsiyon Piyasası'nın açıldığı 5 Şubat 2005 tarihini takip eden ilk 5 senenin verileri, sistem formülasyonun oluşturulması, test edilmesi ve optimizasyonu için kullanılmış olup, 4 değişik zaman diliminde daha modelin testleri gerçekleştirilerek, performans analizi yapılmıştır. Beklendiği gibi sonuçlar, yükselme veya düşüş yönünde olması fark etmeksizin, trend olan dönemlerde, algoritmik sistemin çok başarılı performans sergilediğini göstermiş; öte yandan, trendin olmadığı yönsüz dönemlerde, ancak endeksten biraz daha başarılı olabildiği anlaşılmıştır.

## **SECTION ONE**

### **INTRODUCTION**

In stock exchanges, the investors follow the price movements and conduct certain analyses, make rational economic and political conclusions and try to identify the current trend; with all these, they try to derive a profit out of their investments. In the heads of the market players, there is always the question whether the future price of stock or forward investment tool can be estimated or not. In this study it is aimed to understand whether, using an algorithmic model based on the perspective of behavioral finance, it is possible to generate excess returns provided that the markets are inefficient, i.e. lack of rational investors. Before we proceed then, we must first define the rational investors in the context of this research.

Observations on stock markets showed us that fairly simple and understandable picture of reality drawn in the paragraph above is actually wrong. The first main observation on the equity premium puzzle; is that stock returns are higher than they should be given risk borne by investors in stock markets. The second observation is the formation of bubbles. It is shown that, at certain times markets get very far out of line with fundamentals. Caginalp, Porter, and Smith (1998, 2000a, 2000b, 2001) has shown that the price bubbles are inflated when cash is injected in the market and as the ratio of available cash to available shares increases. Third observation is the excess volatility observation. It means the stock returns are more volatile than they should be given that stock prices are present values of future expected cash flows. All these observations are examples that contradict with the big assumption of the investors' being rational. For this reason, behavioral finance approached this problem of rationality assumption from two main headers as "psychological factors" in the forms of beliefs and preferences and "limits to arbitrage".

In case of psychological factors, the investor rationality is primarily composed of two assumptions. First, according to the Bayes' Law, which says based on prior

knowledge of conditions that might be related to the event, one can determine the probability that the event may repeat in the future. As new information arrives at the markets, investors update their prior knowledge database with this new information and establish a new perception about the future (update of beliefs) and then take new positions accordingly. Second component of investor rationality, Subjective Expected Utility, states that under risky conditions, investors make choices by following these steps:

- 1) Figure out the probability of impact of new information
- 2) Figure out the utility they would get from each outcome
- 3) Calculate an expected utility for each decision they make based on the new information
- 4) Proceed with the decision that imply the highest utility.

Here again a bunch of assumptions are that, the investors have the ability to rank alternatives, they choose the dominant (with the highest payoff) alternative, they ignore the irrelevant alternatives, they consistently and continuously rank outcomes and they take into consideration the outcomes/payoffs, probabilities of the outcomes and how the alternatives are bundled (Plous 1993, p81).

Given these fair and acceptable assumptions, one may be inclined to expect that the price of a stock is primarily determined by rational investor decisions. However, in case of limits to arbitrage, there are solid examples on the contrary, as in the case of addition of stock to an index. Harris and Gurel (1986) and Shleifer (1986) showed that when a stock is added to the index, it jumps in price by an average of 3.5 percent, and much of this jump is permanent. Similarly, in the year of 1907, Royal Dutch and Shell Transport agreed to merge on a 60:40 basis. The combined entity analyzed by Froot and Dabora (1999) had the ratio of Royal Dutch equity value to Shell equity value relative to the efficient markets benchmark of 1.5. This difference between the merger ratio and market value of equity provides still another example where mathematics does not fully reflect the basis for investor decisions. Furthermore, there are controlled experiments showing that people do

not always make the decision that is mathematically correct (i.e. providing the highest return). As in one specific example, in the study by Allais 1953 or Hirshleifer 1992 (pp.36-9), people are asked to select between Gamble A which offers \$1m for sure and Gamble B which offers 10% chance of getting \$5m, 89% chance of getting \$1m and 1% of getting nothing. Although the expected value of Game A is:  $1 \times \$1\text{m} = \$1\text{m}$

and expected value of

Game B is:  $(0.1 \times \$5\text{m}) + (0.89 \times \$1\text{m}) + (0.01 \times 0) = \$1.39\text{m}$ ,

most of the subjects choose Gamble A over Gamble B.

In order to explain the irrational realities of financial markets some of which are described in the final section of the paragraph above, a theoretical framework other than the traditional paradigm was required, and one such attempt came from Eugene Fama. In his 1970 dated hypothesis, Nobel prize winner American economist Eugene Fama suggested that, in an efficient market, all of the information is within the price of the stock, that the prices of the stocks reflect their real value and accordingly, for the investors, it is not possible to generate returns that exceed the index average.

In today's world where technology and communication has developed very much, professional traders are completely leaving the initiative of buy and sell orders to the computers, use algorithmic systems that send orders within time intervals of less than a fraction of a second; in this way, they are able to generate earnings far beyond what ordinary investors are able to generate. It is generally accepted that, the success of these algorithmic systems stems not only from the logical system that they are built up on but also from their privilege to send orders in time intervals that are far beyond the human reaction time.

The purpose here is to reveal an evidence regarding the impact of behavioral finance and market efficiency on the returns of an algorithmic system. It is expected to exploit opportunities by following the trends in the prices of stock indexes. In this

study, in line with the conclusions of behavioral finance, for the period starting from February 5th 2005 (when the derivatives exchange was initiated in Istanbul Stock Exchange) until March 2020, the performance of a new algorithmic system that is developed by combining some indicators, based on the ordinary technical analysis instruments such as “Moving Average”, “Price Rate of Change”, “Standard Deviation” is tested. The benchmark of comparison is the X30YVADE instrument, which represents the nearest future price of BIST-30 index; that is traded at futures and options market of Borsa Istanbul.

Since the algorithmic system used in this study gave sell or purchase orders on the closing price that occur at the end of the trading day of the stock exchange, computer aided or labor-intensive stock trade is not in required. Moreover, since the algorithmic system is based on the principle of trend catching, it is expected that the number of transactions is considerably low.

In this thesis, it was attempted to put forth the benefits of technical analysis. Meanwhile, by the use of the algorithmic system, it is presented that the investor may obtain high returns that very much exceed what he/she would get if he only purchased the index and held it for long period of time. In addition to this, it was also attempted to show that Borsa Istanbul is not an efficient market.

## **SECTION TWO**

### **LITERATURE REVIEW**

The fundamental value of a company stock equals to the sum of discounted future expected cash flows that will be generated by the company. Fundamental analysis starts from the economic conditions in the world and continues with examining the economy of the country, the sector and finally takes into consideration the financial statements of the company respectively with the objective of identifying the favorable stocks in the sector. In literature, fundamental analysis has always been ahead of technical analysis. Moreover, before 60's, apart from the work of Cowles (1933) who conducted the first academic study and stated that only 55% of the estimates based on the Dow theory of William Peter Hamilton between the years of 1904 and 1929 were correct, it is difficult to find any significant research on the subject of technical analysis (Zhu and Zhou, 2009, pages 519-544).

In his article "Random Walks in Stock Market Prices" (1965), Eugene Fama for the first time described the concept of market efficiency and showed that technical analysis did not produce better results than purchasing and holding a stock.

The "Efficient Markets Hypothesis" which was published in the year of 1970 (Fama) assumes that the prices established in the market cover all available information; for this reason, it argues that, based on the historic prices and other market data, it is not possible to get returns above average. Fama (1970) talks about three different levels of market efficiency:

**Weak Efficient Form:** Here, the dominant idea is that it is not possible to get above market returns, prices develop randomly and on the other hand, fundamental analysis may, to certain extend, provide advantage.

**Medium Efficient Form:** In such markets, it is argued that the current prices cover all of the information including the financial statements, which can be accessed by



everyone, and in the event of arrival of new information to the markets, this new information will also be quickly incorporated into the prices. According to this view, an advantage is only possible with “insider trading”.

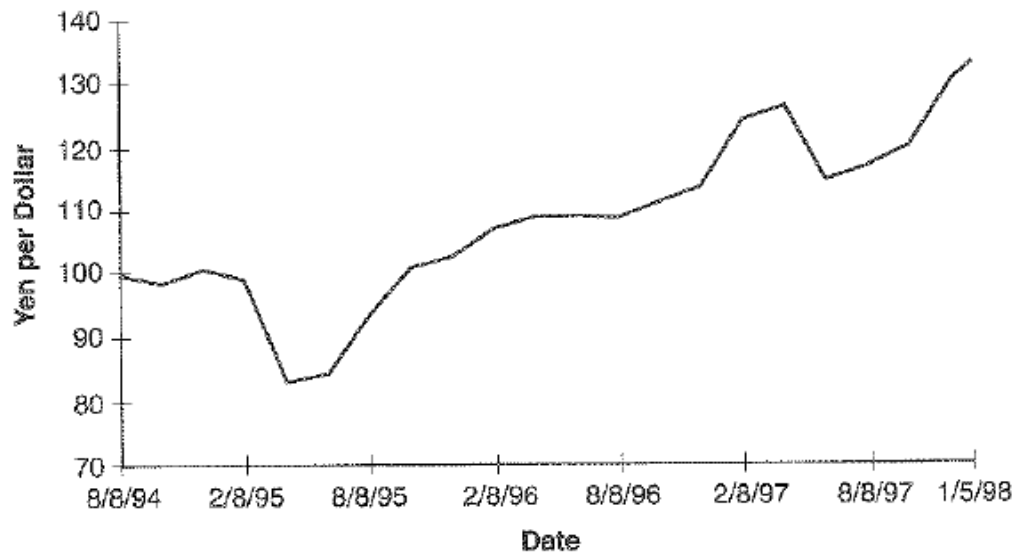
**Strong Efficient Form:** The current prices reflect not only all of the information that is made public but also the private information about the company. Accordingly, in this form, no investor may generate above market returns because the market price is at the real value that it should be.

According to BSV (Barberis, Shleifer and Vishny, Journal of Financial Economics page 49 (1998) 307–343), earnings follow a random walk in the sense that changes in earnings are  $+y$  or  $-y$  with equal probability. However, investors believe that they switch between two regimes, namely, “Earnings mean-reverting” and “Earnings are persistent”. In a mean-reverting earnings regime, the investors assume that when a positive/negative earnings change event takes place, there is a low probability of another positive/negative earnings event to take place in the following period. Similar to that, in a regime where earnings are persistent, the investors assume that if a positive/negative earnings change takes place today, there is a high probability of another positive/negative earnings change in the following period. Consecutively, investors’ perception with respect to the regime that they are in, affects the prices as follows:

- When investors think they are in a mean-reverting earnings regime, they underreact to earnings changes because they consider this as a one-time event.
- When investors think they are in an earnings persistent regime, they overreact to earnings changes because they think more will follow.

An inefficient market can form due to heuristic driven bias of the executives, analysts and investors or due to frame dependence. As a clear observation of the heuristic bias, one can point out the excessive speculation by traders on the foreign-exchange which are affected both by fundamental economic factors and sentiment.

**Graph 2. 1:** Yen/Dollar Parity For the Period of 1994-1998

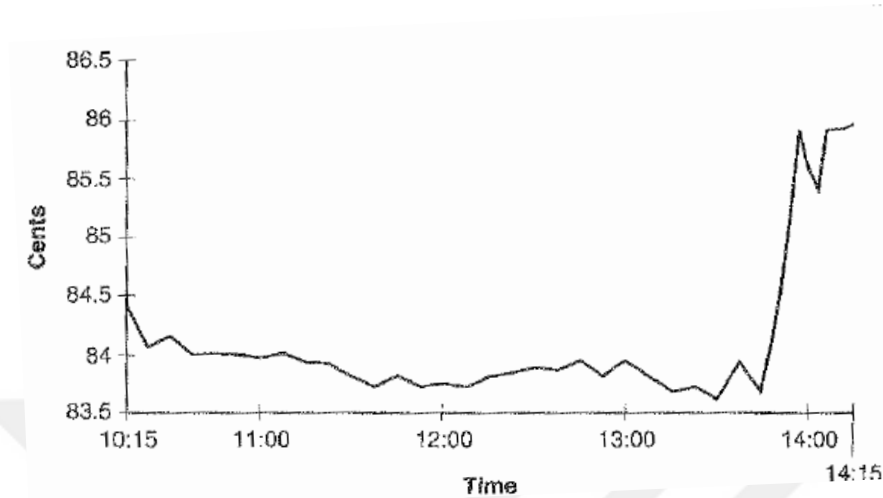


Source: Beyond Greed&Fear, H. Shefrin, Ch21, Exc. Speculation in FX Markets

When the graph of yen/dollar parity presented above is examined, clearly, by just using the fundamental analysis, it is not possible to explain the fluctuation of yen per dollar observed during the August 1995-May 1998 period.

Meanwhile, in inefficient markets, investors react to news based on their perception of their impact and moreover, in order to get a response from the investors, it is not required to have any news at all. Regarding the investor sentiment, the price fluctuation of orange juice that took place on December 4<sup>th</sup> 1997 is a striking example. U.S. orange juice concentrate is a well-studied commodity and under normal circumstances, the price of it depends on the weather conditions in Florida and the supply of oranges from Brazil. Normally, a major change in one of these parameters has immediate effect on the prices of orange juice futures. On that particular day of December 1997, the price of March 1998 contract has jumped enormously as shown in the graph below:

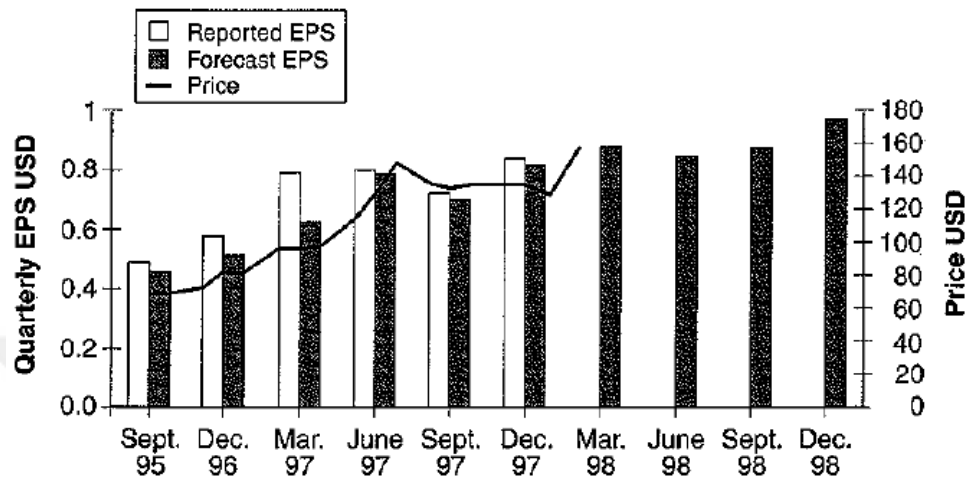
**Graph 2. 2:** U.S. Orange Juice Futures Price On December 4<sup>th</sup> 1997



Source: Beyond Greed&Fear, H. Shefrin, Ch20, Exc. Speculation in FX Markets

On that specific date, there was literally not a single news in media with respect to prices of orange juice futures. There was no clear reason for the traders' reaction other than the idea that they were actually reacting to each other's trades. Also, as in the case of Chellam-Prudential relationship in 1994, companies may give their banking business to an institution in return for favorable stock recommendations issued by the research arm of the same institution. Similarly, work of Roni Michaely and Kent Womack (1999) has demonstrated that analysts of the underwriter company of a stock issued 50% more "buy" recommendations than the non-affiliated analysts. Furthermore, they have revealed that, while the prices of the stocks recommended by the non-affiliated analysts went up by 4.1% when following the buy recommendation of these underwriter company analysts, the stock prices of the subject companies actually went down by 2.4% on average. Clearly, if the markets had been efficient, such performance differences would not have occurred.

**Graph 2. 3:** Reported And Forecasted Earnings Per Share Of Microsoft Stock For The Period Of 1995-1998



Source: Beyond Greed&Fear, H. Shefrin, Ch18, Exc. Speculation in FX Markets

In an inefficient market, the information may not be accessible simultaneously by everyone and therefore reflected on the stock price. Microsoft manages to beat the consensus expectations almost every quarter, as seen in the graph above.

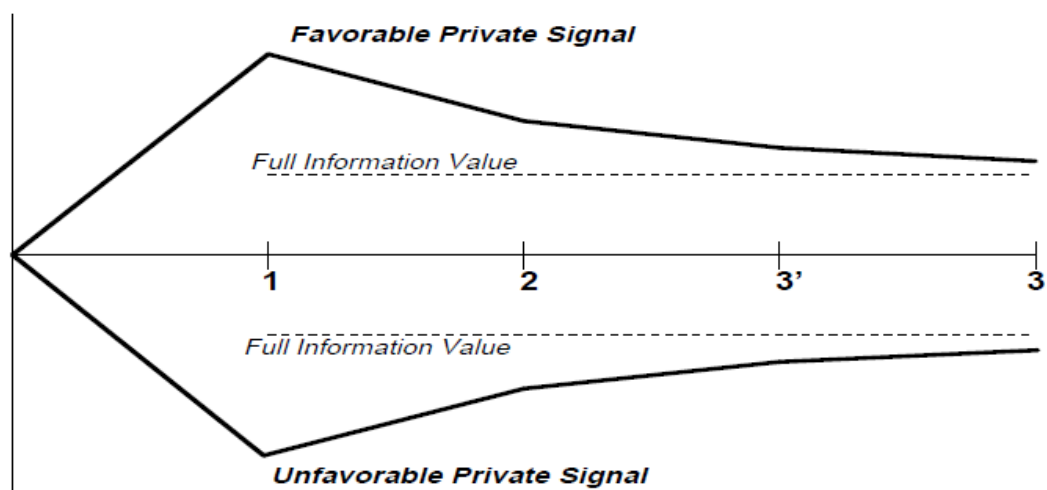
If a market is efficient, one can expect that security prices respond to new information relatively quickly and accurately. Similarly, in such a market, if the risks and costs of transaction and analysis are taken into consideration, professional investors will not be able to outperform the market.

Finally, in an efficient market, all simulated trading strategies should fail, as they will either be not statistically significant, consistent across different periods or be a mere result of careful data mining.

Apart from the structure of the market, individual behavior may also be the source of inefficiency in the markets. As Kent Daniel, David Hirshleifer and Avanidhar Subrahmanyam put it, some security price anomalies are due to investor overconfidence and variations in overconfidence arising from biased self-

attribution. Their theory is based on observations on human behavior collected in cognitive psychological experiments and surveys. Accordingly, people overestimate their ability to evaluate stocks. They perceive their private information signals (information that they receive before the other people) as more precise than they really are. As a result, they overreact to such information while relatively ignoring the information coming from a publicly available source and it is empirically observed in the stock prices. The graph presented below summarizes the extra value attributed due to biased self-attribution.

**Graph 2. 4:** Value Attributed To Signals Due To Self-attribution Bias



Source: A Theory of Overconfidence (Daniel, Hirshleifer, Subrahmanyam, 1997)

The erroneous pricing of overconfident investors may persist for many periods, which makes it difficult for arbitrage based on fundamental analysis to exploit the value in the mispricing. From technical analysis perspective, there is just a decline trend to follow.

Although technical analysis comfortably functions in such controversial situations as described above and it is seen in the literature, many of the pioneering academic works that examine technical analysis reveal that technical analysis is not that

successful (Alexander (1961), page 7; Alexander (1964), page 372; Fama and Blume (1966), page 226; Jensen and Bennington (1970), page 482; Ball (1978), page 17), however, starting from 80's, the academic studies conducted have revealed the positive returns of purchase and sell systems (Pruitt and White (1988), page 58; Fakhry (1989), page 29). The studies that claim that based on the historic returns, it is possible to make forecast for the future (French and Roll (1986); Lo and MacKinlay (1988); Jegadeesh and Titman (1993)), in a sense gave direction to the studies that put the technical analysis on the focus.

In that framework, Murphy, 1986, page 518; Fakhry, 1989, page 29; Neftci, 1991, page 571; Brock, Lakonishok and LeBaron, 1992, page 1764; Mills, 1997, page 331; Neely, Weller and Dittmar, 1997, page 426; Lo, Mamaysky and Wang, 2000, page 1705; Gunasekarage and Power, 2001; Kwon and Kish, 2002, page 653; Wong, Manzur and Chew, 2003, page 551; Chaitanya and Rajendra, 2005; Gehrig and Menkhoff, 2006; Zhu and Zhou, 2009; Teixeira and Oliveira, 2010; Mitra, 2011, page 206, have revealed that for several markets and time intervals, compared to buy and hold strategies, simple moving averages and their technical analysis implementations are more rewarding.

While J.F. Ehlers (2001 and 2002), by looking at the financial markets from the perspective of finance and phase, has shown how various indicators may be utilized for benefit, on the other side Chong and Wing-Kam (2008), in their studies based on simulation on the FTSE100 index have proved that, Relative Strength Index (RSI) and Moving Average Convergence Divergence Index (MACD) indicators are in fact useful.

In the studies conducted about the efficiency of Borsa Istanbul, it is stated that our stock exchange is a weak-efficient exchange (Ceylan (1998), page 411).

In literature, there are other significant studies such as;

- “Ability to Forecast Stock Prices with K- Nearest Neighbour (k-NN) Algorithm: Sample Application from Borsa Istanbul” (Ilarslan (2016), pages 375-392) which aims to forecast the future prices of stocks traded in Borsa Istanbul,
- “Development of Indicators that will help Trend Analysis in Financial Markets” (Cetiner and Erdem, 2011) which aims to identify the trends formed by stock prices, and,
- “Establishment of Buy-Sell System in Technical Analysis: Test of the System with Respect to Past” (Ozturk (2016), pages 469-493) as a study which simulates a system created using exponential moving averages on Borsa Istanbul.

## **SECTION THREE**

### **TECHNICAL ANALYSIS**

Technical Analysis which forms the basis of the subject study, can be defined as follows (Perseme (2001), 1, Page 26): It is the examination of the market movements with the purpose of forecasting the price direction in the future, essentially by using the price graphs. As there are rational and irrational investors in the market, arbitrage process eliminates those decisions that are not in compliance with Baye's law and/or that do not maximize the expected utility. Yet, there is significant amount of data that shows, although arbitrage exists, irrationality may persist to exist for significant amount of time. Technical analysis is considered as one of those methods to describe the dynamics of such periods.

#### **3.1 DOW THEORY**

A reporter Charles H. Dow who was not even a high-school graduate, is the founder of Dow Jones Industrial Index which is currently in use. He is also recognized as the person who has made the highest contribution to investment analysis (Market Technicians Association). Deceased at the age of 52, he managed to leave behind three major works:

- Dow Jones Industrial Index
- Milestone of Financial Reporting: Wall Street Journal newspaper
- Dow Theory

In 1903, one year after his death, S.A. Nelson edited his articles, which were published in the Wall Street Journal newspaper founded by himself, in the book named "ABC of Stock Speculation".

After his death, William Peter Hamilton who, with his articles published at Wall Street Journal, has further developed the Dow theory and has presented the



principles of the theory in categorized form with his book titled "Barometer of Stock Market" published in 1922. In the year of 1932, by analyzing the 252 editorial letters written by Charles Dow during the period of 1900-1902 and W.P. Hamilton during the period of 1902-1929, Robert Rhea has published the book "The Dow Theory". As the most comprehensive book written on the subject of Dow Theory, one can cite George Bishop's book titled "Charles H. Dow and Dow Theory" dated 1960.

Even though more than one hundred years have passed over its first introduction, when the Dow Theory is examined carefully, it is seen that today the markets behave in a similar way compared to how they behaved in the past. At the basis of the Dow Theory, which guides price movements and technical analysis, lies the psychology of the market.

A generally accepted fact is that the theory of technical analysis has somehow came out in response to Dow Theory (Murphy (1986), page 25). Dow Theory is the milestone even for the new and arguably better indicators that are developed with the support of complex and complicated computer technologies of today's world (Murphy (1999), page 23).

The six principles that form the basis of Dow Theory are as follows:

1- Averages discount everything.

What is meant with this principle is the stock exchange index. The index, which reflects the average price of the market, at the same time, reflects the total combination of the expectations, hopes and fears of the market participants. Within this price, there is past information, there is information with respect to events that are currently taking place and there is expectation for the future, in summary all of the available information.

2- There are three different types of price movements in the markets.

According to the Dow Theory, three types of trends exist in the markets: Main trend, secondary trend and daily fluctuations. The main trend may last between a couple of seasons up to a couple of years and it reflects the main tendency dominant in the market. The secondary trends are measured in weeks or months and they are responsive movements that move in opposite direction of the main trend. Daily fluctuations meanwhile are independent of the main trend and they may move in the same or opposite direction, they may last hours or days and even extend to a couple of weeks.

3 - There are three stages of the main trends.

The most determining Dow Theory principle is probably this one. According to this, there are three stages of the main trends: "Accumulation", "Movement" and "Extremism":

- i. In the "Accumulation" stage, which is the first stage, the market has finished a very heavy drop trend; the prices no longer arrive at new bottom levels. However, general pessimism in the market persists. The transaction volume is low and media publishes news about bad status of the market and the desperateness of the situation. At this level, only a few number of skilled and foresighted investors collect stock from the market. Warren Buffet describes these times when the market value falls below the real and intrinsic value, as historic purchase opportunities (Hagstrom, 2000).
- ii. In the "Movement" stage which is the second stage, with the signs and news with respect to improvement in the economic conditions, first with the purchases of professionals and afterwards with the purchases of the investors who are close to the market and who work scientifically in a disciplined manner, very important levels of resistance are broken, the prices start to rise quickly, relative optimism starts to spread in the market. Technical analysts, investors who follow the trend, will at this stage start to join.

iii. In the "Extremism" stage, which is the final stage, with the impact of general optimism and good news coming one after the other, the purchases in the market, extend to the public; the media starts to broadcast news that talk about how good the stock exchange has generated returns and how good the economy of the country is. With the joining of the public, at this stage the transaction volume increases very much; increasing prices result in much wider section of the public becoming investors in the stock exchange. At this stage with everything looking excellent, those skilled and foresighted investors who invested at the first stage "Accumulation", start to sell their stock while everyone is running to the stock markets (distribution).

#### 4 - Averages must confirm each other.

With this principle, Dow pointed out at the Industrial and Transportation indexes (we have already stated in the first principle that, with the averages, the indexes are meant). According to this, in order to be able to talk about the start of a main trend it is required that both of the two indexes exceed their second-degree peaks and produce the same signal. In the event that one of the indexes exceed its second degree peak and create a signal that implies start of a main trend, if the other index does not also produce the same signal, it is not possible to talk about the start of a main trend; and this is called "dissonance". In such situation, the old trend will be assumed to persist.

#### 5- Transaction volume must confirm the trend.

Dow has shown that for the confirmation of the signals that are composed of the price graphs, transaction volume is a secondary but a very important factor. In order to be able to talk about confirmation of trend, it is required to observe that, the transaction volume which represents the participation to the market, supports the direction of trend. In Dow Theory, while the purchase and sale signals are determined completely according to closing prices, the transaction volume is used as a second-degree indicator.

6 - Unless there are definite signals indicating its return, a trend will continue.

According to this principle, rather than assuming that a trend which is basic component of the Dow Theory is about to end and try to open the most perfect position either from the top or from the bottom, the financial investor should assume that the trend will continue and utilize the price movements that are on the opposite direction with the trend as opportunities to open positions in the direction of the trend. In case of any suspicion about the trend, one should take position on the side of the main trend at all times.

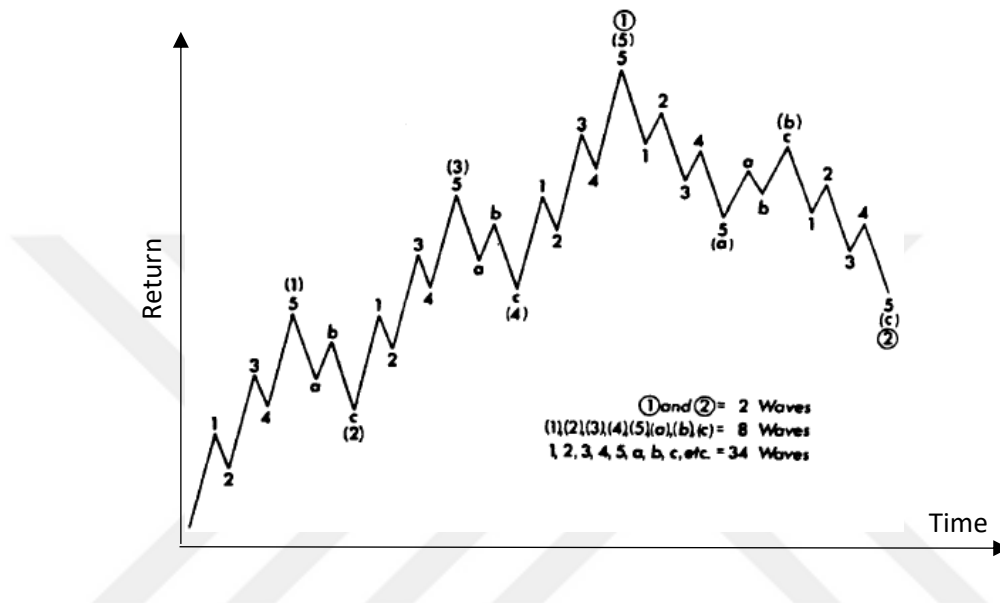
One thing we should note in evaluating these trend stages is that, they are valid at micro-level (i.e. on a transaction basis) as well. Depending on the common business sentiment and depending on the managements attitude (especially in acquisitions), from time to time, the market values are in fact very subjectively determined. As pointed out by Richard Roll (1993), in corporate takeovers, referring to possible synergies that may result out of the acquisition, the management of the acquiring firm usually overestimates the true market value and overpay for the target. Analysis conducted on British data by Michale Firth (1980) have found strong evidence that the value of the acquiring firm declines, value of the target firm increases and the combined value of the two remains the same. Because of hubris or for some other reason, the value lost because of these inaccurate transactions also provides the basis for the transition to turn down the trend.

### **3.2 WAVE PRINCIPLE**

Seen as a complement of the Dow Theory by its founder Ralph Nelson Elliott, the wave principle published in 1938, builds on three aspects; pattern, ratio and time, in order of respective importance. According to the simplest form of the theory, wave patterns of the stock market have the form of five times advance and three times decline, which makes 8 waves per cycle. Furthermore, Elliot argued that the magnitude of the waves ranges from 200 years to a few hours but the 8-wave pattern cycle appears in all magnitudes. The graph shown below helps us visually

understand the repetitive nature of the cycles at small and large scales at the same time.

**Graph 3.2. 1:** Repetitive Nature of Elliott Cycles



Source: <http://www.rutherfordjournal.org/article020104.html>

As it is seen in the graph (Frost and Prechter, page 21, 1978), the large scale observed in (1), (2), (3), (4) and (5) are repeated at small scale with 1, 2, 3, 4, 5, a, b and c.

### 3.3 BASIC PRINCIPLES THAT FORM THE BASIS OF TECHNICAL ANALYSIS

Almost all modern technical analysis literature piece suggests the three propositions stated below as the basic principles of technical analysis (Murphy, 1986; Murphy, 1999):

- i) Market movement discounts all sorts of information.
- ii) The prices move in trends.
- iii) History repeats itself.

"Market action discounts all sorts of information" which is the most important proposition that makes the technical analysis usable and logical, relies on the principle that the current price symbolizes a momentary consensus and even though positive or negative elements have an impact on the direction of buy or sell, they will find a counterpart in the current price. In summary, this proposition tells that if things are fine with a company and/or good news are expected, the ones who somehow accessed to this information before everyone else will affect the stock price in the buy direction, thus the new price will be established at a higher level. When that is the situation, thanks to technical analysis, the entry of fresh money (new investment) into a stock can be observed by examining the graph of the stock.

The second principle is "movement of the prices in trends". The priority of the technical analyst is to identify the trend in its preliminary stage and to invest in the direction of the trend. The great majority of the technical analysis studies aims to carry an investment along a trend.

"Repetition of history" which is the third proposition forecasts that some formations that have established on the price graphs will today and in the future evolve in the same way as they did in the past and result in price movements of similar direction and magnitude. Even behind this foresight, there lies the assumption that, under similar conditions, individual and public psychologies always give similar responses. By recognition of price movements observed in similar situations in the past, whether the current trend will continue or not or whether the end of a trend has been reached or not, offers an opportunity for investment.

### **3.4 INSTRUMENTS THAT ARE UTILIZED IN TECHNICAL ANALYSIS**

Eight instruments that are used in technical analysis studies are as follows:

- i) Price Graphs
- ii) Supports and Resistance
- iii) Trends
- iv) Levels of Correction and Retrieval
- v) Formations
- vi) Moving Averages
- vii) Indicators
- viii) Time Cycles

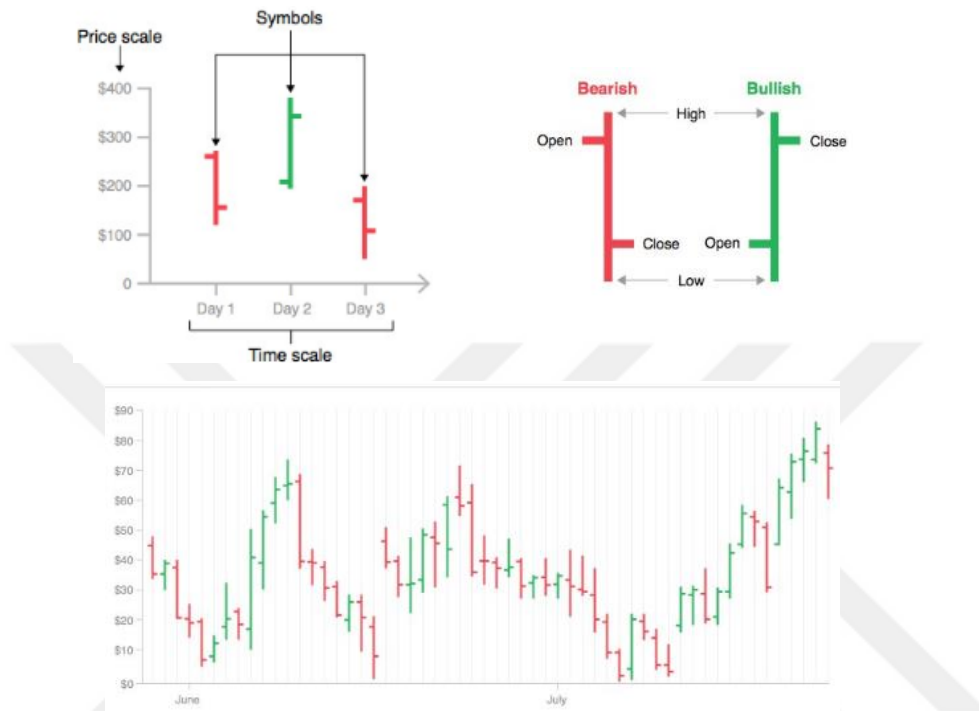
#### **3.4.1 Price Graphs**

Price graphs that help monitoring the price movements of a financial instrument over time, show the history and what is taking place currently. According to the needs, they may be formed in several ways. The most common types are line and bar graphs. In addition to these, candle graphs first used by the Japanese in rice trade in the 17th century, then became popular in the western world in the 20th century. Also, zero/cross graphs also allow follow up of price movements, although they are not popular nowadays.

In the formation of the graphs, arithmetic price scale is generally used; whereas, especially in the long-term analysis, use of logarithmic scale is preferred.

### Graph 3.4.1. 1: How To Read A Bar Chart

#### BAR CHART



Source: [https://datavizcatalogue.com/methods/OHLC\\_chart.html](https://datavizcatalogue.com/methods/OHLC_chart.html)

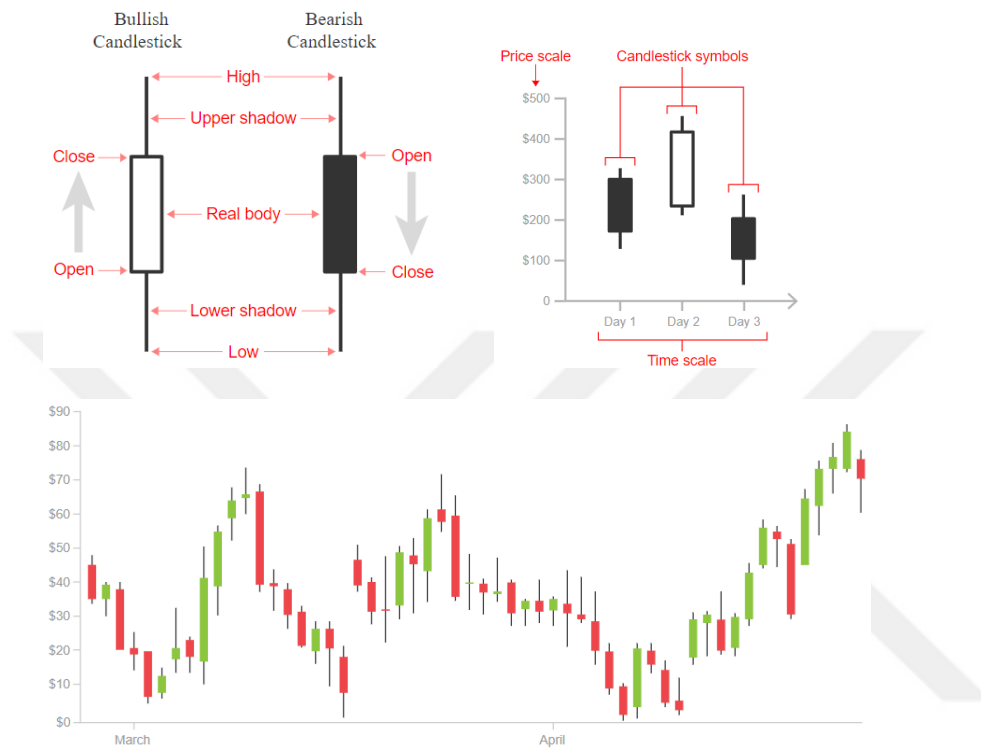
In the graph above, most common used bar chart formation is briefly explained.

Historically, in 1700s in Japan, it was first realized that there was a link between the emotions of the traders and price moves of rice. In order to reflect that information on graph, they have invented the candlestick graph. In Japanese candlestick graphs, the body (thick part) of the graph represents the price range between the opening and closing.



**Graph 3.4.1. 2: How To Read A Japanese Candlesticks Chart**

### JAPANESE CANDLESTICKS

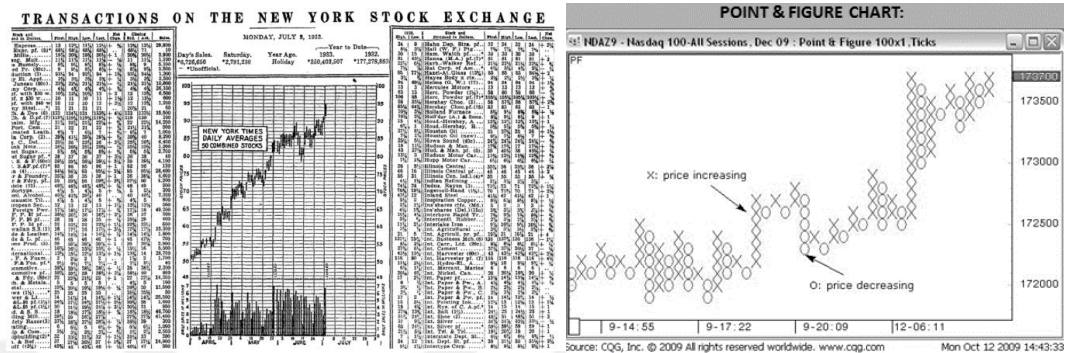


Source: [https://datavizcatalogue.com/methods/candlestick\\_chart.html](https://datavizcatalogue.com/methods/candlestick_chart.html)

The modern statistical chart was invented by the Scottish political economist William Playfair at the end of the 18th Century but became popular after 1930's.

**Graph 3.4.1. 3: First Example of Point & Figure Chart**

### POINT AND FIGURE CHART



Source: New York Times, 1933

Point and figure charts are rarely used nowadays.

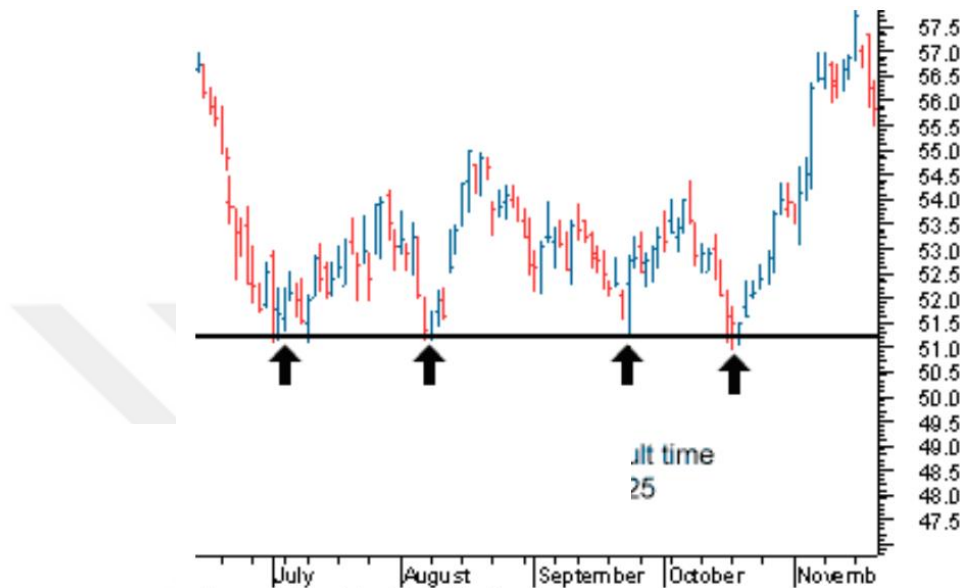
### 3.4.2 Supports And Resistances

Support and resistance levels are of great importance in technical analysis and are widely used by all technicians.

Support is the price level where the prices resist the pressure to drop and the market has enough of the purchase orders. An example of a support level is presented below:

**Graph 3.4.2. 1:** Example of A Support Level

**SUPPORT IS A LEVEL THAT DOES NOT LET THE PRICE GO LOWER.**



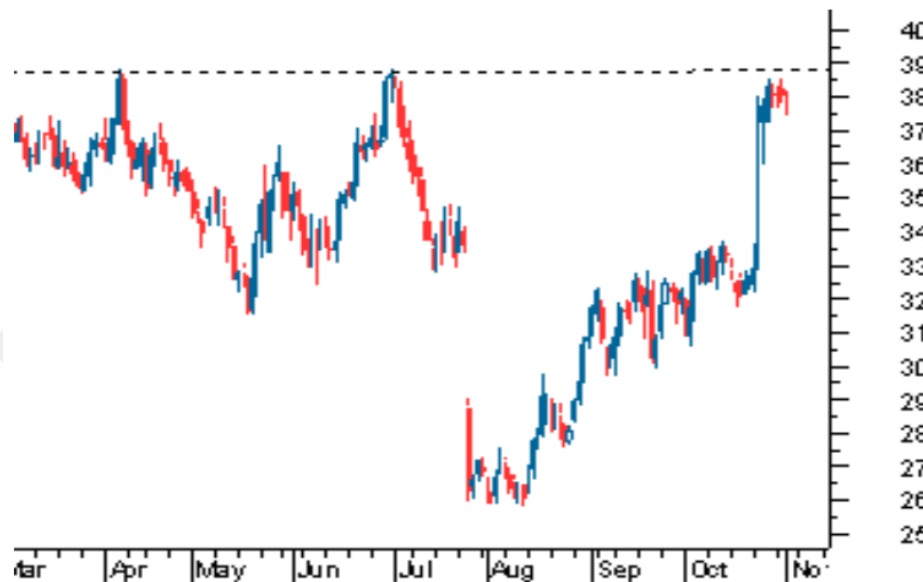
Source: <https://www.investopedia.com/trading/support-and-resistance-basics/>

Support levels do not have to be always in a horizontal form. An uptrend line will act as support, every time prices test the upward sloped trendline.

Resistance on the other hand is the area where the prices face a selling pressure and are not able to increase any more. An example of a resistance level is presented below:

**Graph 3.4.2. 2:** Example of A Resistance Level

RESISTANCE IS A LEVEL THAT DOES NOT LET THE PRICE GO HIGHER.



Source: <https://www.investopedia.com/trading/support-and-resistance-basics/>

Once again, resistance levels do not have to be always in a horizontal form. A downtrend line will act as resistance, every time prices test the downward sloped trendline.

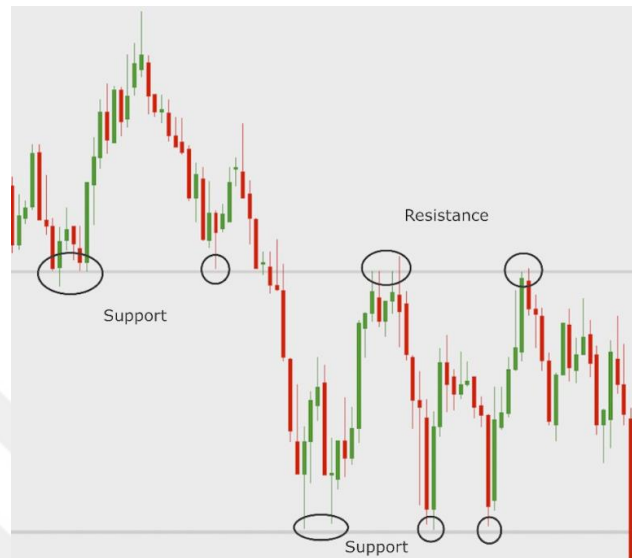
In the price graphics, the support and resistance levels are identified by determining the highs and lows of pivots and upper-lower limits of the concentration areas.

One important point that needs to be discussed here is that, once they are broken, the support and resistance levels exchange roles. In other words, while the broken support turns into a resistance, the broken resistance becomes a support.

An example is presented in the Graph 3.4.2. 3 below:

**Graph 3.4.2. 3:** Example of A Broken Support Turning To Resistance

**A SUPPORT WOULD ACT LIKE A RESISTANCE, ONCE BROKEN:**



Source: <https://www.binance.vision/glossary/support>

The power of a support or resistance can be understood by looking at three formations:

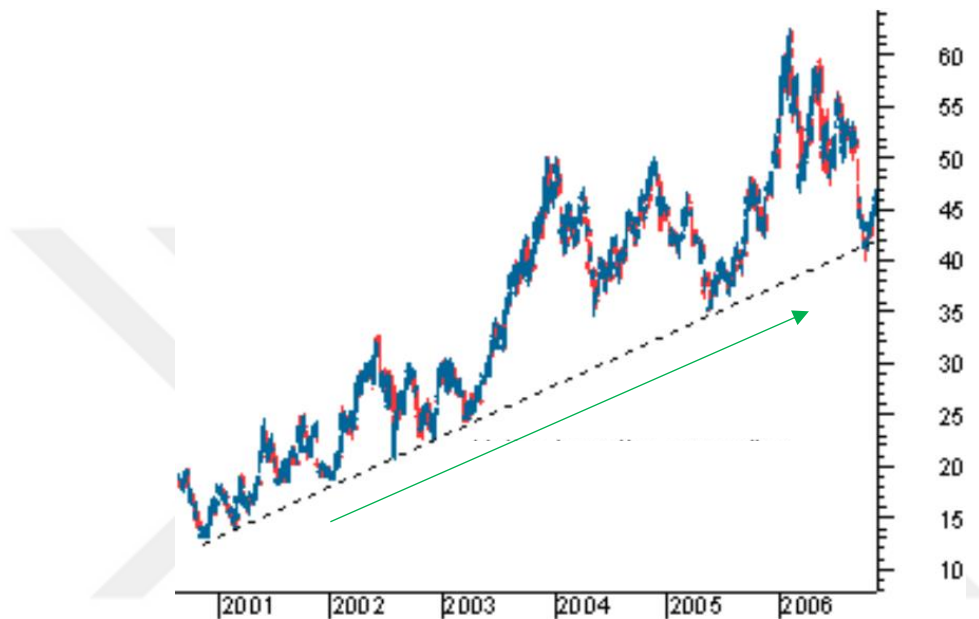
- The longer the period of time that a support or resistance level stays valid without breaking, the stronger that level will be.
- The higher the transaction volume that constitutes a support or resistance level, the stronger that level will be.
- A support or resistance level that was established in a sooner past will be stronger than a support or resistance level that was formed in the further past.

Although the probability of breaking of a strong support or resistance level is low, if it is broken in a way, the price movement following the break will be intense.

### 3.4.3 Trends

**Graph 3.4.3. 1:** Example of A Trend Line

**TRENDLINES ARE THE GENERAL DIRECTION OF THE PRICE**



Source: <https://www.investopedia.com/trading/support-and-resistance-basics/>

In simplest terms, trend can be described as the direction in which the market is moving. In an increase trend, there will be elevating tops and bottoms that follow each other while in a decrease trend, the consecutive tops and bottoms decrease. In those periods where there is no increase and decrease trend and where the market tries to identify itself a direction, sideways movements will be observed. Under the Dow Theory title, we have discussed that, according to the Dow Theory there are three types of trends in the markets: Main trend, secondary trend and daily fluctuations.

The technical analysts aim to identify the horizontal periods where the market is unable to determine a direction as early as possible and if possible, stay away from the market and/or get out of it with the minimum possible loss.

**Graph 3.4.3. 2:** Example of A Macro Trend

**SMALL UP AND DOWN TRENDS INSIDE THE SAME BIG UPTREND**



Source: <https://www.quora.com/What-is-the-current-stock-market-trend-in-India>

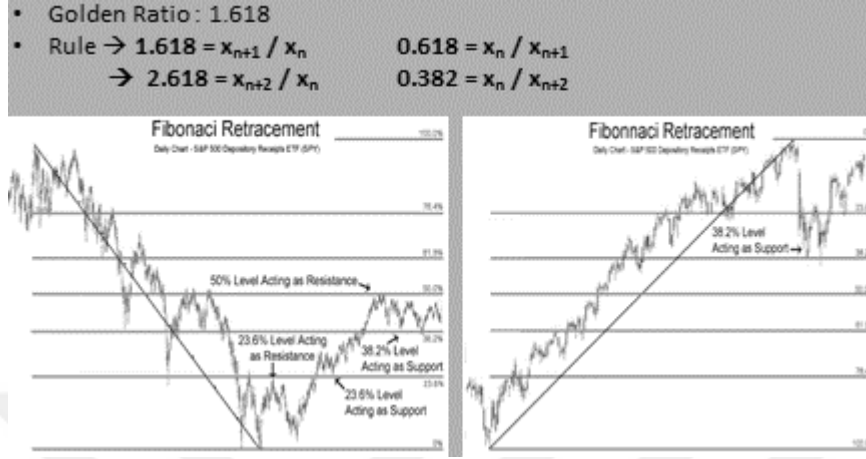
During the decrease or increase trend periods on the other hand, they want to become investors by taking position in the direction of the trend and by making the least number of transactions possible, stay in the position until the time of a trend change signal.

#### 3.4.4 Levels Of Correction And Retrieval

In the beginning of the 13th century, Italian mathematician Leonardo Fibonacci presented to the world of mathematics the Fibonacci numbers series, which continue as follows:

1,1,2,3,5,8,13,21,34,55,89,144,233,377,610,987,1597,2584,4181,6765,...

**Graph 3.4.4. 1:** Relationship of Support And Resistance Levels With Golden Ratio



Source: Mergen, A. (1997). Fibonacci Teknik Analiz Yöntemi. Istanbul: Sogut Ofset

Here, each number is the sum of two numbers before it. As the numbers get bigger, the ratio of the two consecutive numbers approaches to 1.618, which is called the “Golden Ratio”. In proportioning conducted by skipping one number, the number 2.618 will be reached. While these numbers are used in future projections, 0.618 and 0.382, which are the minus first powers of them, are utilized as strong supports in the form of correction targets. In proportioning conducted by skipping two numbers, it is seen that 4.236 emerges where 0.236 is the minus first power and it never changes.

The Golden Ratio is observed at many places in the nature such as leaves of a plant, crown leaves of a daisy, cones of pine trees, horns Nautilus Spiral, typhoon formations, ratios of the human body, seashells and Gizza pyramid in Egypt.

In the examinations of society and herd psychology also, it is observed that Fibonacci correction levels have significant importance. For this reason, in identification of the supports and resistances, using the Fibonacci ratios, the users of the technical analysis have arrived at successful results (Frost and Prechter, 1978; Mergen, 1997; Sengoz, 2002).



### 3.4.5 Formations

In the time graphics that are drawn as a time series, if it gives a projection for the future, the look created by the price groups following each other is called a graphical formation.

The price formations, which are based on the assumption that history repeats itself, are the leading indicators of new price movements about to start. Graphical formations that are slowly edited and named over the history of the technical analysis are primarily examined under two headings:

1. "Continuation Formations" that imply the current trend will continue, and
2. "Return Formations" that indicate the ending of the current trend (Edwards and Magee, 1991; Curtis, 1993).

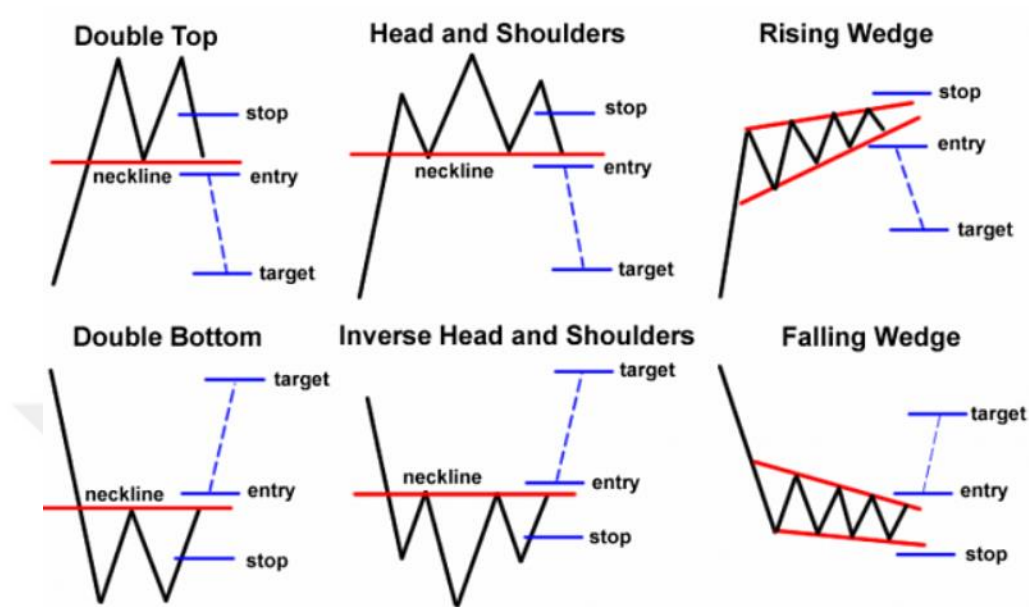
Formations are grouped under two main categories; namely, reversal formations and continuation formations.

#### Reversal Formations

- Head and shoulders
- Double tops and bottoms
- Triple tops and bottoms
- Diamond
- Expanding formations
- V tops and bottoms
- Plate formations
- Days of return

Below, graphical representations of general structure of reversal formations are presented.

**Graph 3.4.5. 1:** Examples of Reversal Formations



Source: <https://www.forexfactory.com/showthread.php?t=789233>

A bunch of reversal formations is presented in in Graph 3.4.5. 1 above.

A real life observations of head and shoulders type reversal formation is presented below in Graph 3.4.5. 2:

**Graph 3.4.5. 2:** Example of A Head And Shoulders Type Reversal Formation



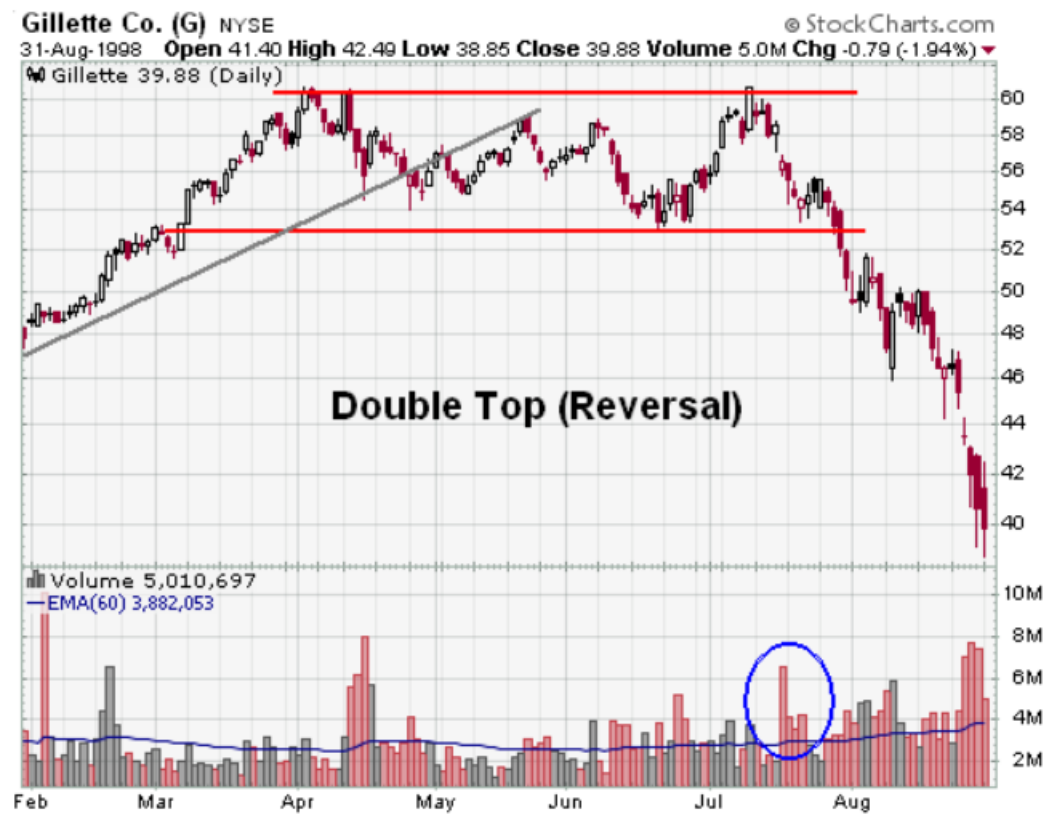
Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:head\\_and\\_shoulders\\_top\\_reversal](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:head_and_shoulders_top_reversal)

In addition to these, one can easily identify several real-life examples of double top, triple top, double bottom and triple bottom type reversal formations as well, as shown below.

**Graph 3.4.5. 3:** Various Types of Reversal Formations – Double Top

**DOUBLE TOP**



Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:double\\_top\\_reversal](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:double_top_reversal)

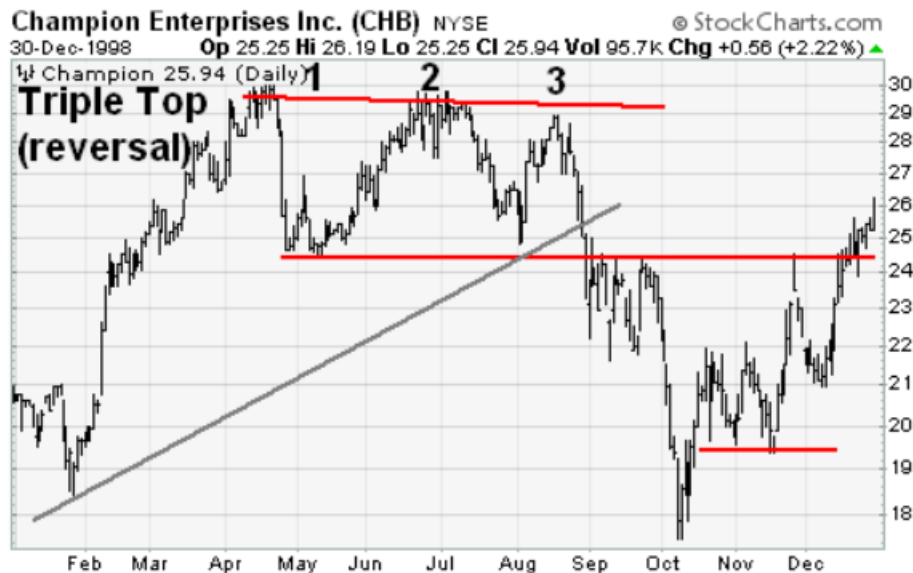
**Graph 3.4.5. 4: Various Types of Reversal Formations – Double Bottom**

### DOUBLE BOTTOM



Source: <http://www.dstockmarket.com/double-bottom.html>

**Graph 3.4.5. 5: Various Types of Reversal Formations – Triple Top**



Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:triple\\_top\\_reversal](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:triple_top_reversal)

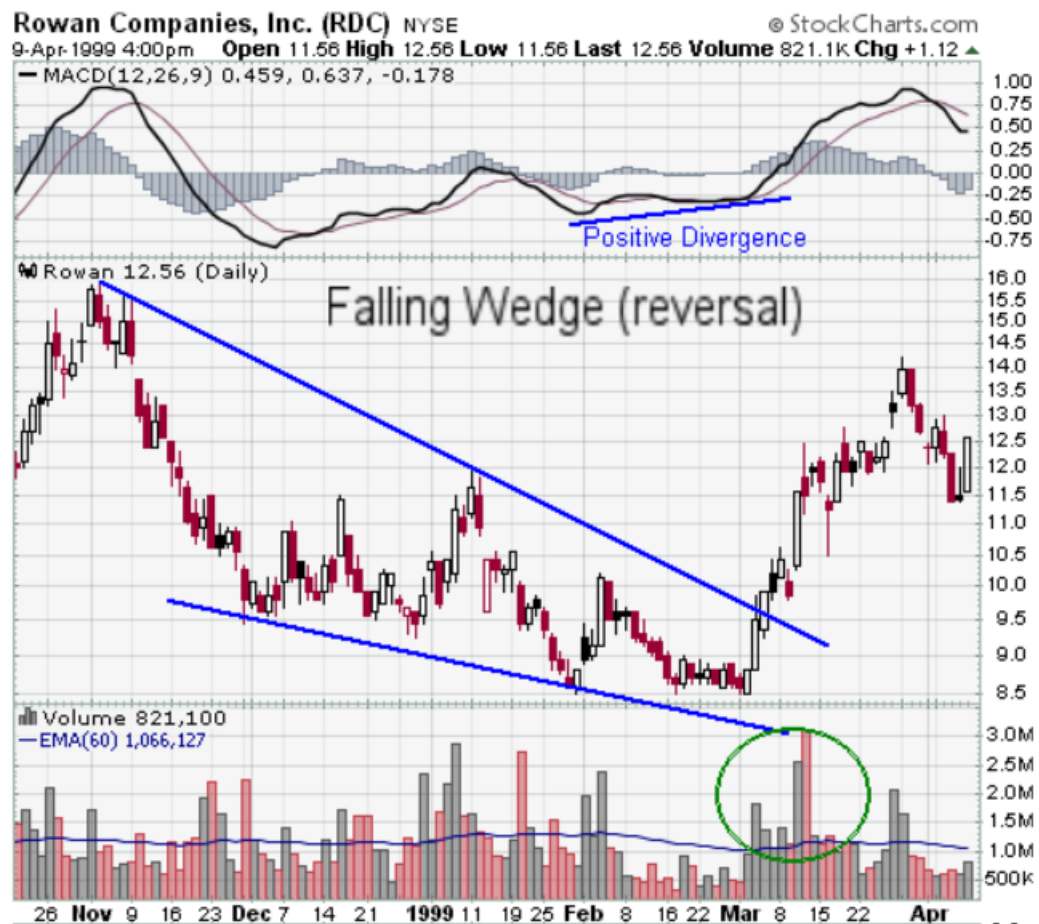
**Graph 3.4.5. 6:** Various Types of Reversal Formations – Triple Bottom



Source: <https://capital.com/how-to-trade-a-triple-bottom-reversal>

Below, examples of other reversal patterns such as wedge, v-reversal, saucer and rounding bottom are presented.

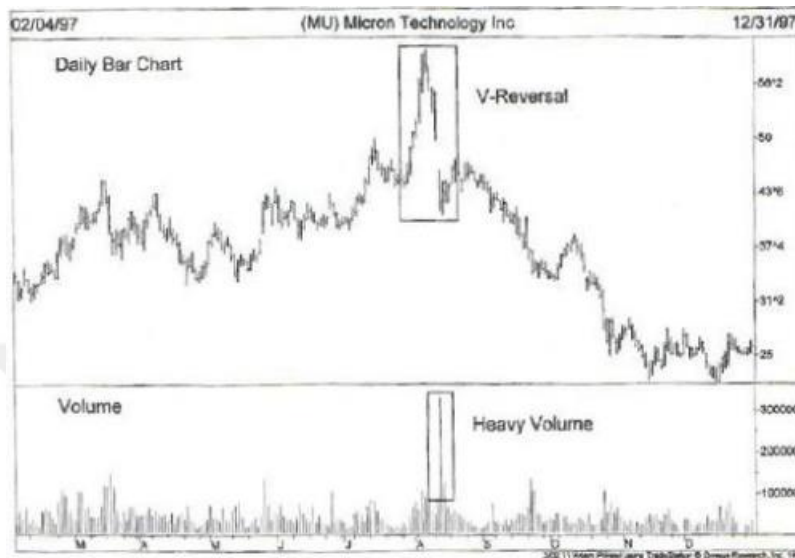
**Graph 3.4.5. 7: Various Types of Reversal Formations – Wedge**



Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:falling\\_wedge\\_reversal](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:falling_wedge_reversal)

**Graph 3.4.5. 8:** Various Types of Reversal Formations – V Reversal  
**V REVERSAL**



Source: <https://slideplayer.com/slide/14819605/>

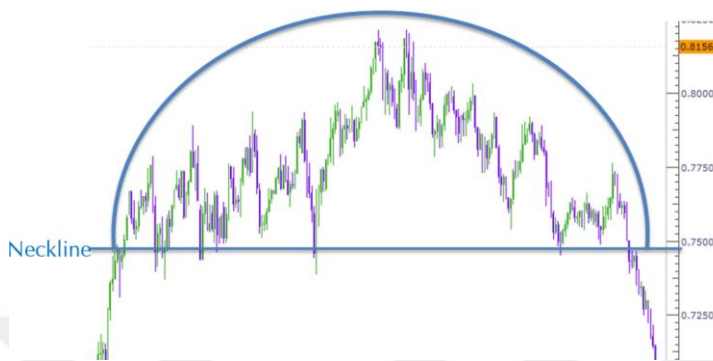
**Graph 3.4.5. 9:** Various Types of Reversal Formations – Saucer  
**SAUCER BOTTOM**



Source: [https://www.kotaksecurities.com/maile/Horizon\\_01092010/newsletter4.html](https://www.kotaksecurities.com/maile/Horizon_01092010/newsletter4.html)



**Graph 3.4.5. 10:** Various Types of Reversal Formations – Rounding Top  
**ROUNDING TOP**



Source: <https://www.investdiva.com/investing-guide/saucers/>

When evaluated together with other financial instruments available in the market, inconsistencies with the general market, the related indicators and the price formations, the Return Formations create meaningful financial results. Top formations emerge in relatively shorter time intervals compared to bottom formations.

#### Continuation Formations

- Triangles
- Rectangles
- Flags and streamers
- Wedges
- Reverse shoulder head shoulder formations

Interpreting a formation is only possible by simultaneously taking into consideration other market conditions such as transaction volume and volatility. When defining the formations with respect to continuation of a trend, it is required to pay attention whether other related financial products and current indicators are in harmony or not.

Some examples of triangle form of continuation formations are presented below.

**Graph 3.4.5. 11:** Continuation Formations – Symmetric Triangle  
**SYMMETRICAL TRIANGLE**



Source: <https://tradingstrategyguides.com/symmetrical-triangle-trading-strategy/>

**Graph 3.4.5. 12:** Continuation Formations – Flag



Source: <https://www.mysmartrend.com/technical-analysis-chart-patterns/flag-and-pennant>

**Graph 3.4.5. 13:** Continuation Formations – Ascending Triangle



Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:ascending\\_triangle\\_continuation](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:ascending_triangle_continuation)

**Graph 3.4.5. 14:** Continuation Formations – Descending Triangle



Source: [https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:descending\\_triangle\\_continuation](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:descending_triangle_continuation)

**Graph 3.4.5. 15:** Continuation Formations – Diamond



Source: <https://www.e-futures.com/futures-trading-chart-patterns.php>

**Graph 3.4.5. 16: Continuation Formations – Pennant**



Source:

[https://school.stockcharts.com/doku.php?id=chart\\_analysis:chart\\_patterns:flag\\_pennant\\_continuation](https://school.stockcharts.com/doku.php?id=chart_analysis:chart_patterns:flag_pennant_continuation)

**Graph 3.4.5. 17: Continuation Formations – Channel**



Source: <https://www.investopedia.com/terms/a/ascendingchannel.asp>

**Graph 3.4.5. 18:** Continuation Formations – Head and Shoulders



Source: <https://www.financialsense.com/contributors/ryan-puplava/head-shoulders-not-always-reversal-patterns>

In order to obtain the most successful results, it will be helpful to examine the formations according to their terms. In other words, opening the position when the short, medium and long-term formations meet in the same direction, is the secure way.

### 3.4.6 Moving Averages

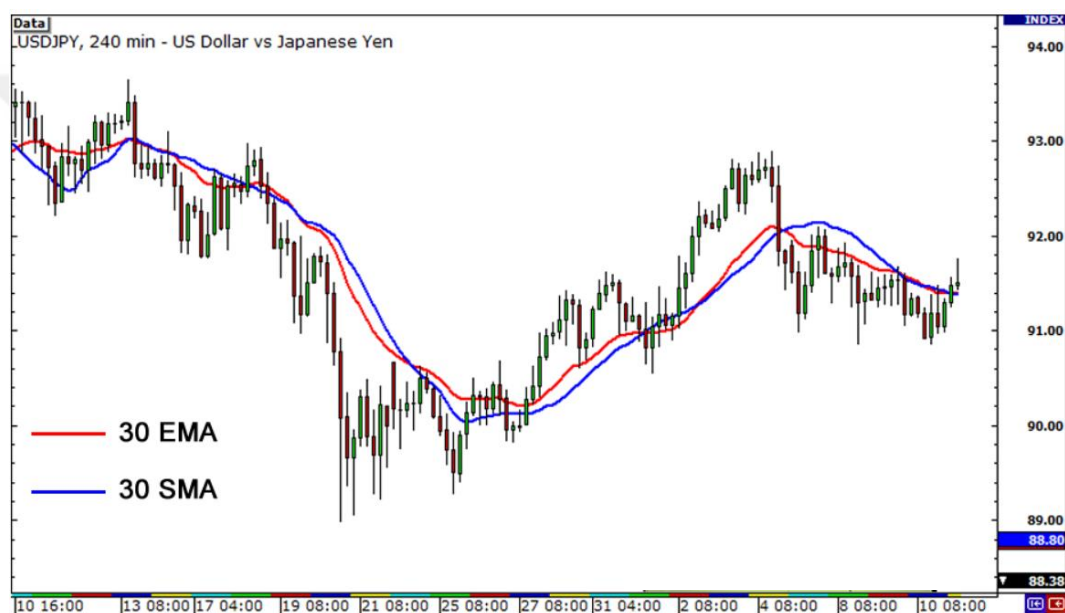
Moving averages, being the most widely used but the most primitive of the family of indicators, follow the trend. In general, moving averages work according to the main principles of “Cut the loss short, carry the profitable position for a long time” and “Get in to a position that is in the same direction with the trend”.

For this reason, even though they are very successful in those markets where there is trend, in those horizontal markets where there is no trend, they are unsuccessful and result in loss of investor's money.

In the discipline of technical analysis, moving averages are not only applied to the prices but also to the indicators as well and with various applications, the variety of the indicators have increased. Some examples of use of moving averages are presented below.

**Graph 3.4.6. 1:** Simple and Exponential Moving Averages

#### MOVING AVERAGES



Source: <https://www.babypips.com/learn/forex/exponential-moving-average>

The common application is in the way of opening position at the intersection of the moving averages that are obtained by using two or three different terms. The buy signal of such an intersection is called a "Golden Intersection" and sell signal of such an intersection is called a "Death Intersection" (Patel, 1980).



**Graph 3.4.6. 2:** Example of A Golden Cross

### GOLDEN CROSS



Source: <https://azcoinnews.com/what-is-the-golden-cross.html>

**Graph 3.4.6. 3:** Example of A Death Cross

### DEATH CROSS



Source: <https://www.yatirimkredi.com/death-cross-nedir-nasil-yorumlanir.html>



As the moving averages, which are in essence a type of indicator, on their own have a very common use and have an important place in establishment of different indicators, they are examined under a different technical analysis instrument title. The types of moving averages will be explained later under the heading of “Components of the Algorithmic System that will be Used for Test”.

### 3.4.7 Indicators

With the access of public to computers and use of technology becoming widespread, a new era in use of technical analysis has started. Thanks to the computers that are able to conduct millions of multiplications, divisions, to take derivatives-integrals and to make other transactions within seconds and to store this information, indicators took their place in the world of technical analysis as a new alternative in efforts to establish a strategy.

Most of the indicators can be examined under two main categories:

- Indicators that aim to follow the trend
- Extreme purchase/Extreme sale indicators

While the indicators that aim to follow the trend lead to successful results in those trending markets, extreme buy-extreme sell indicators on the other hand are successful in those horizontal markets where there is no trend, in those concentration areas or in those markets with low levels of slope and relatively weak trend channels. Maybe most important of all, these extreme buy-extreme sell indicators are successfully utilized as leading indicators in those times when a trend is about to end and there is a certain probability that another trend in the opposite direction is about to start.

Here, it is required to talk about a side effect. The trend-following indicators, when utilized in the horizontal markets, create several unnecessary wrong signals; for this reason, they result in both position loss and high level of buy-sell commission

charges. Similarly, when the extreme buy-extreme sell indicators are utilized in strong trend market by an inexperienced technical analyst, it may result in early sales in rising markets and early purchase in declining markets. In order to overcome this, it is advised that one tries to obtain confirmation by using different indicators that are accepted to exist under different headers, simultaneously.

In calculation of the indicators, various variables, in other words, parameters are used. In general, these parameters are "Data Variables" and "Duration Variables".

Data Variables show us based on which market data the indicator makes calculation. The big majority of the indicators, use "Price data" such as \*Opening price, \*Highest Price, \*Lowest Price and most important of all \*Closing price and "Transaction Volume Amount". Apart from these, calculated based on advanced level and complex mathematical and statistical concepts, various other successful but not popular indicators are created like Fourier Analysis (Bloomfield, 2000; Kammler, 2000), ARIMA (Autoregressive Integrated Moving Average (Kaufman, 1998), Regression Analysis (Schwager, 1984; McCormick and Katz, 2000), Spectral Analysis (Stoica and Moses, 1997), Box-Jenkins Model (Box, Jenkins and Reinsel, 1994) and Maximum Entropy Method (Sivia, 1996; Golan, 1996).

Indicators analyze the historic and current price movements and present forecasts with respect to expectations about the future. The parameter that has the most significant impact on the establishment of this forecast is the time parameter. The time parameter determines, in calculation of that indicator, retrospectively, how many transaction rods (periods) will be taken into consideration. As the time interval selected narrows, the indicator generates more buy-sell orders; this is called a fast indicator. A fast indicator catches the peaks and bottoms without delay but it has a disadvantage of creating too many orders that result in high commission payment. Furthermore, it has a higher risk of creating erroneous signals. On the other hand, the long-term indicators that are described as slow create a smaller number of signals and enable staying within the trend as much as possible. By this

way, they reduce the cost of commissions and by minimizing the number of buys and sells, they prevent losing of position. As a disadvantage on the other hand, it can be said that the peaks and bottoms will be identified relatively late.

In summary, technical analysts do not base their strategies on a single indicator. By using a bunch of indicators of different types, they expect them to confirm each other. It is required that one takes into consideration indicators that are based on different strategies, such as, trend following, extreme buy-extreme sell or price formations, and uses them together in order to achieve “at the right time with the right indicator” principle.

#### 3.4.8 Time Cycles

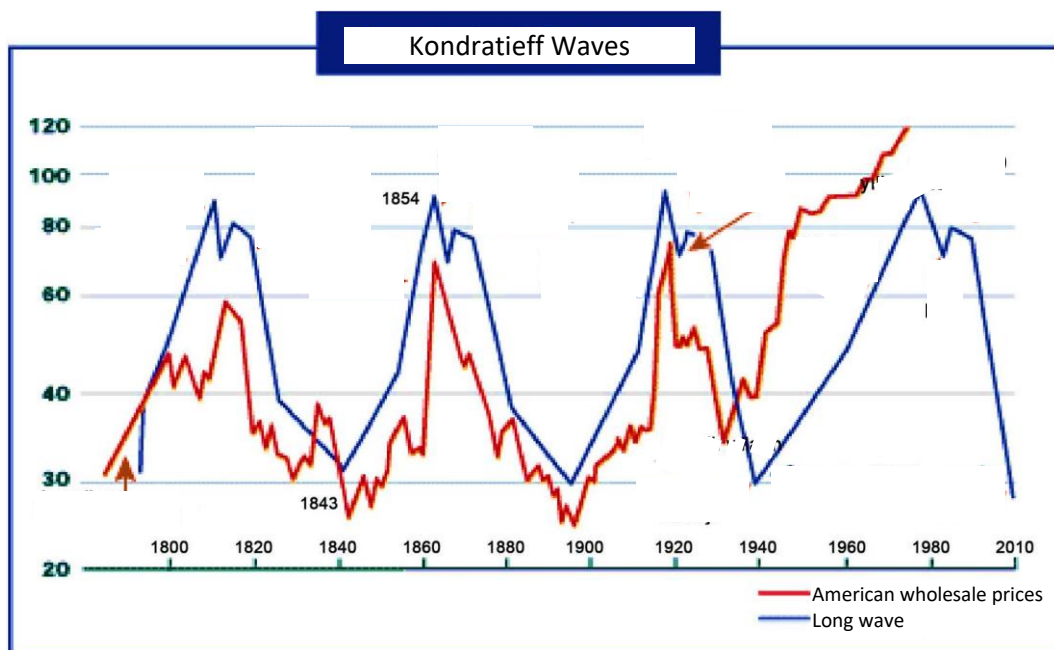
The time that takes for earth's one cycle around itself makes one day, the moon's one cycle around the earth makes one month and earth's one cycle around the sun makes one year. The tilting of the earth's axis results in formation of the seasons and this leads to migration of the animals. It can be said that cycles have a great importance in our lives. Since very long time, the periodicity of the markets has been researched and studies on this subject have been conducted. Although everybody knows that the markets show periodicity to a certain extent, the valuable thing for the market players is whether it is regular and predictable or not and whether as a tool of investment, it is useful or not.

Firstly, the concept of periodicity in the markets was introduced in the book of William Stanley Jevons named “Researches on the Money and Finance” (1884). Considering the fact that a series of commercial crisis and collapses in the 19<sup>th</sup> century took place in 11-year intervals, it is stated that these crises are in parallel with the cycles of the sun spots. The biggest contribution to this subject was provided by Nikolai D. Kondratieff who lived between the years of 1892-1930 and worked at Moscow Agriculture Academy and Commercial Research Institute and conducted research on the economies of United States, Germany, France and

England. In these economies, Kondratieff analyzed the worker salaries, external trade, interest, manufacturing levels of the industries and consumption and after adjusting these numbers with the population increase and using a moving average of 9 years, proved the existence of 54 year long cycles.

According to Kondratieff, the main lines of a 54-year cycle is as follows: The cycle starts with an increase wave that lasts 25-30 years where the economy grows, and as a result, the stock and commodity prices slowly increase. At the end of this stage, at a point where the inflation has risen significantly, a recession period comes at a scale that shakes the economy. The prices relax and markets depress. This period will be followed by 2nd plateau period where the economy relatively recovers and prices are balanced and this period lasts approximately ten years. At a point where it is thought that everything will be fine, this unhealthy and non-general relative growth period turns into a panic with a sudden shock; the markets start to collapse, the second recession period of the economy starts. In this period, economic recession, deflation and crisis will be dominant.

**Graph 3.4.8. 1: Kondratieff Waves**



Source: Charles Hugh Smith, January 19, 2006

After Kondratieff, studies on shorter wave series were conducted. In his study in which he examined the interest rates and prices, French economist and statistician Clement Juglar (1819-1905), found the cycle composed of 4 periods, namely wealth, crisis, recommendation and stagnation.

Harvard University economist Simon Kuznets has revealed that the real estate in United States has cycles that last 16.5-18 years; and for this study, he has received 1971 Nobel Prize. On the other hand, using the statistics of United States and United Kingdom for the period between 1890 and 1922, English statistician and businessperson Joseph Kitchin has identified a short cycle that lasts 40 months. Today, the cycle of Kitchin which takes the changes in stock levels as basis, is used as 4 years.

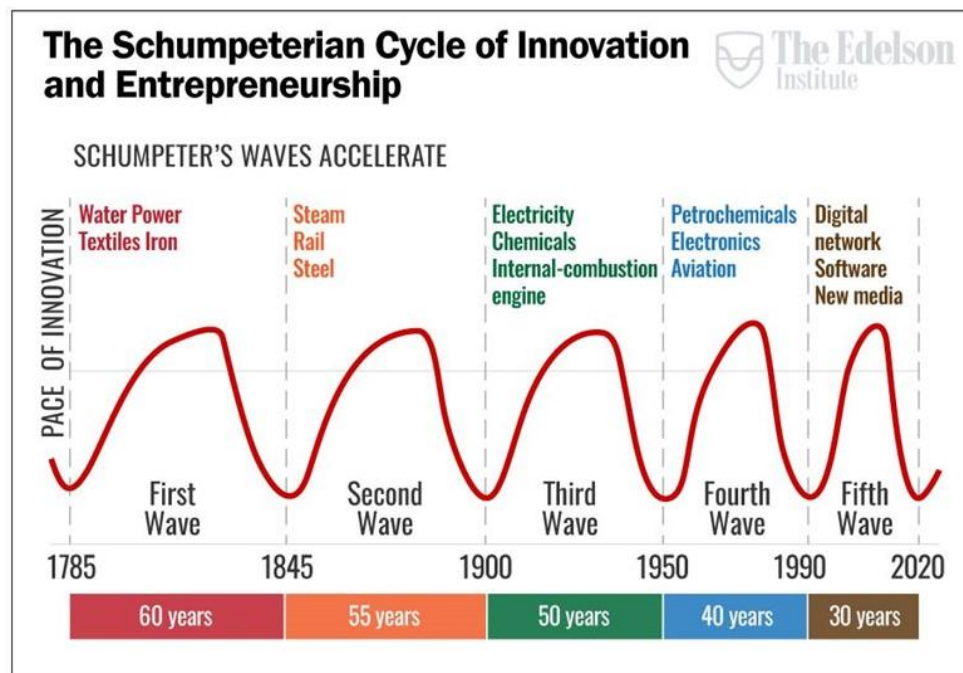
When talking about the Dow Theory, we have stated that "daily movements" are the ones that last for a couple of hours up to 3 weeks, secondary trends are the ones that last for 3 weeks to 3 months and main trends are the ones that last for more than 3 years.

According to the cycle theoreticians, these short, medium and long-term cycles actually do not move independent from each other and in fact, the lower level cycles combine and form the long cycle. The person who first brought forward this idea was economist Joseph Alois Schumpeter (1883-1950). In his book named "Business cycles: Theoretical, Historical and Statistical Analysis of the Capitalist Process" dated 1939 Schumpeter has revealed that, 3 Kitchin cycles (3-5 years) is 1 Juglar cycle, 6 Juglar cycles (7-11 years) correspond to 1 Kondratieff cycle (54 years). Similarly, while 2 or 3 Juglar cycles make 1 Kuznets cycle (15-25 years); 3 Kuznets cycles again make 1 Kondratieff cycle.

Schumpeter argued that innovation was the driving force of economic progress in general. From his perspective economic development's main features are circular flow, role of entrepreneur, business cycle and end of capitalism. In circular flow the

economy is in perfect competitive equilibrium as the supply and demand are in equilibrium and static. When technical or another form of innovation as in discovery of new source of raw materials, a new product offering or a new method of production takes place, it marks the beginning of a technology cycle that creates development which disturbs this equilibrium state and the economy becomes dynamic. This increases the level of investment in the economy which will be fueled by bank credits, that eventually results in acceleration of money incomes, increase in prices and therefore a cumulative growth in the economy. Following that, as new products replace the old ones, old firms start to sell at lower prices, firms start to make losses and as profits decline, pessimism spreads in the economy which is then followed by crisis. In world history what corresponds to technological cycles can be labeled as follows: Industrial Revolution (1771), Age of Steam and Railways (1829), Age of Steel and Heavy Engineering (1875), Age of Oil, Electricity, the Automobile and Mass Production (1908) and Age of Information and Telecommunications (1971).

**Graph 3.4.8. 2:** The Schumpeterian Cycle of Innovation And Entrepreneurship



Source: Schumpeter 1883 – 1950

As summarized in the graph above, first Schumpeterian cycle lasted 60 years and ended in 1845. On the other hand, the fifth wave which is summarized as “Digital Network, Software and Media” is expected to finish in 2020 and therefore last only 30 years.

The basis of the Cycle Theory relies on four main principles as “wholeness”, “harmony”, “concurrency” and “proportionality”. In order of duration length, the cycle analysis is conducted according to the terms as follows: “dominant cycle (2-11 years)”, “seasonal cycle”, “main cycle (9-22 weeks)”, “transaction cycle (3-8 weeks)”, “Alpha and Beta Cycles (short and very short period)”. It offers a usable time series and in each dominant cycle and around it, it enables price projections on a continuous basis.

Even though external factors are also supposed to have an effect on the loops, it is claimed that the reasons behind the economic fluctuations emerge from the very nature of the economy itself. Namely; economies expand, with the enthusiasm of growth, a balloon forms; subsequently, this balloon bursts, and the periods of panic, shrinkage and crisis will be followed by recession. During this period, the basis of a new growth wave will be established and again, a growth period will start. Throughout history, this loop repeats itself moreover on a regular basis.

It is not always possible to trace fundamental data behind short-term fluctuations. Most of the time, behind these types of fluctuations, lies the investor psychology. As the current trend extends, some of the investors realize their profit, some fall in love with their positions and the trend and decide to sit and wait and yet another group prefers to open positions in the opposite direction with the trend. Here the general investment psychology will unite to produce periodic responses. According to the cycle theoreticians, these psychological powers will comply with an approximate time formation. While the herd psychology reveals itself in the price graphs in the form of waves, in historic examination of these waves, some clear and repeating structures catch the eye. The cycle theoreticians, who take this as the basis, try to identify the peak or the bottom of the next cycle as time and price level.

Expecting the start and the end of a cycle at a fully theoretical date is accepted as realistic. According to the cycle theoreticians, a tolerance level of plus/minus 15% is appropriate. Because the tolerance bands are long, it is not appropriate to use the cycle analysis as a stand-alone tool but it may be useful under the circumstances described below:

- i) Knowing the existence and direction of the long-term trend and not acting in the opposite direction to the trend as much as possible,
- ii) Being cautious for the time when a trend will face a correction,
- iii) Confirming the time cycle with technical analysis indicators.

Cycle analysis greatly resembles the fundamental analysis. Both of them say that in a determined time the market should move in a given direction. However, since both of these analysis types face difficulty in correct timing, they would better be supported by technical analysis indicators.



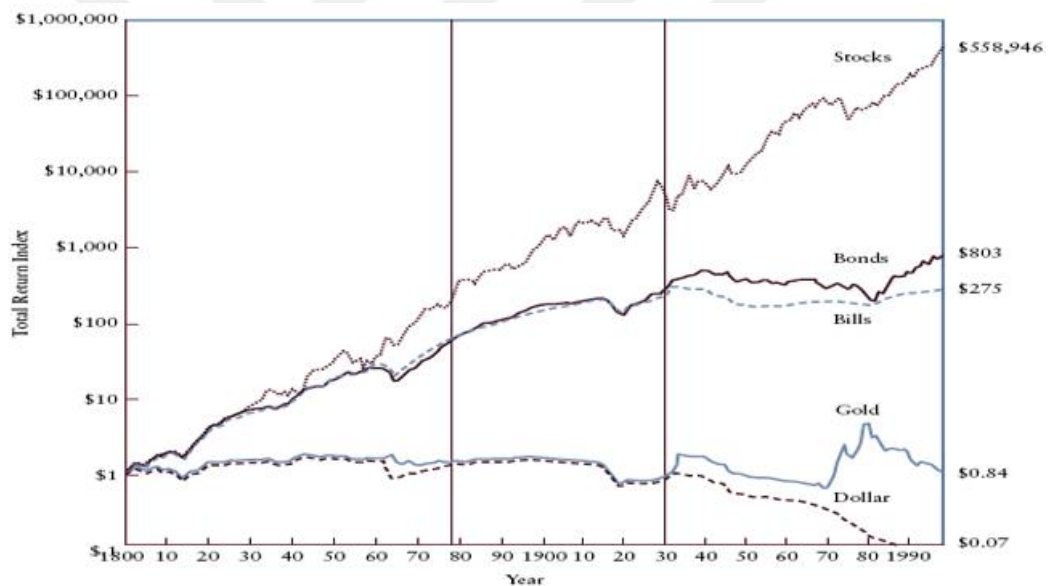
## SECTION FOUR

### DATA SET AND FORMULA PARAMETERS

#### 4.1 DATA SET AND THE METHODOLOGY UTILIZED

Investments made in the stock exchange during 1802-1997 period proved that, a strategy in the form of buy and hold beats the performance of the other asset classes to a significant extend.

**Graph 4.1. 1:** Total Return On Indexes (1802-1997)



Source: Siegel JJ., "The Future Value of an 1802 Dollar Invested in Different Asset Classes, 1998

In this study, it is claimed that, via better positioning within the stock exchange, the returns can yet be enhanced. The data from Bloomberg and Matriks, Borsa Istanbul-100 Index, Borsa Istanbul-30 Index and X30YVADE transaction prices, which show the nearest-term transaction price of Borsa Istanbul -30 Index is used and analyzed in this study. An algorithmic buy and sell system is attempted to be created by using the "Oracle" application, which is offered by the Matriks data provider; by

running a simulation of this system on the Istanbul Stock Exchange starting from the date of February 4th 2005 when the futures transactions initiated, until today and performance analysis will be conducted. In that sense, ““Kahin”” of the Matriks enables the parameter optimization of the system.

Simulation is a decision-making technique, quickly developed with the progress in the information technologies. It is the modelling of a real theoretical or physical system in the computer environment. With this model, it is aimed to understand the behavior of the system and conduct of tests to evaluate different strategies. With the help of simulation, the properties and the behavior of the system are evaluated by computers. The simulation allows us to observe how the system performance changes according to several factors. With simulation, alternative scenarios can be studied and by reducing the risk factor to a minimum, it is possible to conduct feasibility studies.

With the algorithmic system that will be utilized in this study, it is aimed to catch up with the trend and therefore maximize profits on the X30YVADE instrument which is traded on the Futures and Options Market futures market (the price of Istanbul Stock Exchange-30 Index with the nearest term), by executing purchase and sell orders with the most appropriate timing, it is aimed to catch up with the trend and therefore maximize the profits.

## **4.2 COMPONENTS OF THE ALGORITHMIC SYSTEM USED FOR TESTS**

### **4.2.1 Weighted And Exponential Moving Averages**

In simple terms the moving average is the average value of the prices formed within a defined period of time. Because it is easy to calculate and test it, in technical analysis, it is regarded as the basis of the systems that follow the trend and it is the most frequently used.

Simple Moving Average is calculated as the arithmetic average of the closing values of the price movements of a financial instrument within a determined period.

Weighted Moving Average is formed by giving higher weight to those price movements that took place more recently in taking the average of the price movements of a financial instrument within a determined period.

As for the calculation of the exponential moving average, not only the more recent price movements are given higher weight but also, all historic data that were not included in the moving average calculation are taken into consideration and a moving average is obtained. Thanks to this method, compared to simple moving average, a moving average with a smaller lag will be obtained.

#### 4.2.2 Price Rate Of Change Indicator

Price Rate of Change indicator reveals the momentum of the financial instrument on which the technical analysis is conducted, measuring the percentage increase or decrease in price over a given period of time.

For the calculation of this indicator, the subtraction of the current price of the financial instrument from the price N periods ago will be divided with the price of the past date and will be multiplied by 100. In this way, the percent change of today's price with respect to historic price will be calculated. Its formula is as follows:

Price Rate of Change Indicator =  $(\text{Last Closing Price} - \text{Closing Price of N Days Ago}) \times 100 / \text{Closing Price of N Days Ago}$

As it can be understood from the formula, the indicator oscillates around the zero line. In its general meaning, the values above the level of zero, point out to a trend in the upwards direction, namely buying pressure; while the negative values

indicate a trend going downwards, namely selling pressure. Increasing momentum in the direction of the trend is indicated when the values calculated by the indicator in either direction increase. Similarly, moves back toward zero line indicate waning momentum.

#### **4.2.3 Standard Deviation And Variance**

Variance can be defined as the expectation of the squared deviation of a random variable from its mean and standard deviation is the square root of the variance.

As one of the measures of distribution, standard deviation gives an idea with respect to the way the distribution has taken place.

### **4.3 ALGORITHMIC SYSTEM FORMULA AND THE PARAMETERS**

Some technical analysis indicators; namely, Exponential Moving Averages, Price Rate of Change, Standard Deviation and Variance are used in order to obtain an algorithmic system formula. The tool used is the “Oracle” application on Matriks, which is a real-time data and news service provider. Matriks has a “Kahin” application, by which the user can create trading formulas using technical analysis instruments.

Although different formulas are utilized for buy and sell trades, they are mainly the same in nature, only with different directions. By using the formulas, the investor is almost always carrying a position either short or long. One exception to that is when a take-profit order is realized. The system closes a profitable position whenever a certain level of profit margin is achieved.

#### **4.4 FORMULA TO BE USED FOR BUY AND SELL ORDERS**

In the formulas described below, the following definitions are used:

PROC: Price Rate of Change,

SDEV: Standard Deviation,

MOV: Moving Average,

C: Close, (in other words price at closing),

E: Exponential,

W: Weighted,

Cross: Intersection of the indicator values.

##### **4.4.1 Buy Order**

Cross (PROC (2), SDEV (MOV(C,9,E), 9)\*2)

##### **4.4.2 Sell Order**

Cross (SDEV (MOV(C,9,W),9)\*-2, PROC(2))

#### **4.5 EXPLANATION OF THE FORMULA**

The formulas are given in Matriks formulation style above.

Therefore, formulas stated at section 4.4 are explained in this section.

##### **4.5.1 Price Rate Of Change Value**

In the formula PROC (2) means, use 2 days prior day close value in calculation. If the prices are in uptrend, since today's day close will be larger in value, a positive percentage will be obtained. Likewise, in downtrends, negative percentage values will be seen.

#### 4.5.2 Moving Average Value

In one of the formulas,  $MOV(C,9,E)$  is used, meaning that exponential moving average of the last 9 days' close prices is to be calculated.

For the Sell order formula,  $MOV(C,9,W)$  is used. This time it means: calculate 9 days weighted average of last 9 days' close values.

#### 4.5.3 Standart Deviation Value

Standart Deviation used in buy order formula is as follows:

$SDEV(MOV(C,9,E),9)$

As explained in section 3.5.2, a moving average value is obtained.

In this formula, 9 days standart deviation of this calculated 9 days moving average is calculated as a percentage. The formula can be written as follows:

$SDEV(9 \text{ days exponential moving average}, 9 \text{ periods})$

In the buying formula, the value obtained from standart deviation is multiplied by 2. This value is obtained by optimization studies.

Likewise, for sell order  $SDEV(MOV(C,9,W),9)$  is used. The formula can be written as follows:

$SDEV(9 \text{ days weighted moving average}, 9 \text{ periods})$

In the selling formula, the value obtained from standart deviation is multiplied by - 2 this time. It is multiplied by a negative value but the same magnitude because in the selling circumstances, as the prices are declining day by day, negative values are coming from Price Rate of Change indicator and a cross is sought for. Cross will be explained in section 4.5.4.

#### 4.5.4 Explanation Of Cross

In the formulas a cross is necessary for a transaction order to occur. That is to say, a buy order takes place, when a percentage value obtained from price rate of change indicator, intersects and crosses over the line which is calculated by multiplying the standart deviation value explained in section 4.5.3 by 2. Buying formula can be written as follows:

Cross

(Price Rate of Change (2 periods)

And

2 times Standart Deviation of 9 periods of Exponential Moving Average of last 9 periods)

Likewise, selling formula is as follows:

Cross

(-2 times Standart Deviation of 9 periods of Weighted Moving Average of last 9 periods

And

(Price Rate of Change (2 periods))

#### 4.6 OTHER LIMITING PARAMETERS

As a result of the optimization studies conducted, the optimization levels described below are achieved by trial and error.

##### 4.6.1 Take - Profit Level

The optimization studies conducted on the algorithmic system has revealed that, if at any position it is reached to 22.3% profit level, exiting by realizing the profit creates better results instead of waiting the system to give an exit order. This feature

increases the profitability of the algorithmic system by a slight margin. Therefore, it may not be used at all.

#### 4.6.2 Optimization Levels

The values used in the algorithmic system formula created is put in to systematic test and optimization studies so as to achieve the highest level of returns. In this regard, hundreds of test trials are made for the period between 2005 and 2010. After this hard work, it is understood that best results are obtained by using following variables:

Price Rate of Change is run by 2 days.

Both moving Averages are calculated with 9 days. However, exponential average is used for buy orders; whereas, weighted moving average is used in calculation of sell orders.

Standart Deviation of Moving Averages are calculated by using 9 days as Period. It is the same number of days used in calculation of moving averages.

Finally, Standart Deviation Value is multiplied by 2 for buy orders and by -2 for sell orders. This coefficient is related to the number of orders to be created. As this number decreases, algorithmic system creates less orders and gives more leeway and as this number increases the system will be quicker, creating more transactions. The coefficient is chosen as 2 after a lot of test runs and trials.

All of these numbers used in the formulas are kept constant throughout the other tests for various time periods, mentioned at section 6. Results.



#### **4.6.3 Further Improvements To Be Made In The Future**

Although not used in the formulas in this study, a cut-loss level could be used in order to maximize profitability and minimize the drawdowns.

Cut-loss can be explained as follows:

If any position that is opened creates a certain percentage of loss since its opening, accepting the loss and closing the position might create better results than waiting for the system to give a close position order. A more sophisticated form of this is using moving cut-loss levels.

For this purpose, loss from the profit that may occur compared to the point at which the position was most profitable is calculated dynamically. When moving cut-loss is used, the loss compared to the point at which the position, reaches its most profitable level, while the algorithmic system carries a position, reaches a certain level of percentage, the system automatically closes the position. In this way, profit maximization is achieved. This instrument is also not used in the algorithmic system in this study.

### **4.7 EMPIRICAL FINDINGS**

When the algorithmic system formula, which took its final form with simulation studies, is applied on the X30YVADE index, it is seen that it reveals very profitable investment results. Namely; the X30YVADE index which was at the value of 37,000 on the date of February 4th 2005 has reached to the value of 103,000 and provided the investor a return of approximately 66,000 points whereas the algorithmic system which started with a value of 10,000 on that date, has reached to the value of 457,000; achieving a return of 447,000 and exceeded the performance of the stock exchange by 6 times.

In the graphs demonstrated at the Results part of the study, the performance of X30YVADE index and the algorithmic system are compared for various periods of time.

First 5 years is used for the creation of the formula, testing and optimization. The other different 4 results are obtained by keeping the formula same and not changing anything in it. Please see part 6. Results for findings.



## **SECTION FIVE**

### **DATA AND METHODOLOGY**

For the purpose of this study, the data related to market performance of X30YVADE Index is analyzed under 5 pieces of time intervals in order to obtain comparisons of the performance of the algorithmic system in different time periods and market conditions.

BIST-30 is the index that is composed of top 30 stocks of Borsa Istanbul.

X30YVADE is the futures of BIST-30. This instrument started being traded in February 2005.

As for the performance analysis, “KAHIN” feature of Matriks is chosen. Matriks is a real-time data provider from world stock and bond markets; specialized in Turkish stock exchange.

For the creation of the algorithmic system, by trial and error, technical analysis indicators are used in numerous orders, in many formulas seeking for meaningful, sustainable and profitable results. Criteria for a very successful algorithmic system is as follows:

- Obtain maximum profit
- Avoid drawdowns as much as possible
- Minimize number of trades, in order to:
  - i) avoid slippage factor; due to shallow markets and fast markets
  - ii) minimize transactions costs
  - iii) minimize human factor

For the sake of minimizing the number of trades, daily data is used.

It is observed that, when 5 minutes, 15 minutes or hourly charts are used, the systems create a lot of transaction orders. A lot of orders to be executed means a lot of commissions to be paid and it is also observed that the trader should monitor the market continuously and uninterruptedly; being alert, watching for the algorithmic system, which can create a buy or sell order any time. Besides, as the number of trades increases, risks arising from the trader also soar; where he/she can miss to execute the order totally, or miss the price to be executed due to a fast market, or volatility or depth issues etc...

When daily data is used, all of the issues mentioned are solved. As can be seen in the Results part, only 371 transactions are executed in more than 15 years. Besides, at day closing there is almost no concern for depth and volatility issues. The trader may watch the market for just a few minutes at the closing, checking whether an order to be executed exists or not.

For controlling purposes, weekly and monthly charts were run by the systems. As the charts with weekly/monthly data are very slow, these options are disregarded.

During my studies, a bunch of successful systems were obtained; whereas the number of unsuccessful systems were a lot more, as the criteria mentioned above are not easy to meet. Among a handful of successful systems, the algorithmic system described in this thesis is chosen, because of the above-mentioned criteria.

Subject periods of this analysis are 2005-2010, 2010-2015, 2005-2020, 2015-2019 and 2005-2017.

2005-2010 is the first 5 years of X30YVADE trading. The data in this period was used for the creation of the algorithmic system and also for optimization purposes. Optimisation studies concentrated on the values used in the formula. In order to achieve above mentioned criteria, various standard deviations or various number of days to be used in moving average and in Price Rate of Change calculations are checked numerous times. The formula and the components are derived mainly on trial and error basis.

In this period, worldwide 2008 crisis took place. It was promising to see the algorithmic system survived difficult times. It should also be noted that, performance in this period might not be trustworthy, as optimization was held according to this specific time period.

For this reason, performance analysis is made for different periods and market conditions in other sections of Results part.

2010-2015 was chosen for controlling purposes as a second 5-year period; first period out of the sampling data. The results were favorable again. It should also be noted that parameters are kept constant and no changes were made in the algorithmic system for optimization issues in order to maximize the profit. The third

period is the maximum time period available: from the start of futures market till today. The results show how the system worked brilliantly.

The fourth period is chosen in order to demonstrate how the algorithmic system performs during sideways market. In this regard, 2015-2019 period is selected. Theoretically, the system should suffer in markets where no premier trends exist. So indeed, this period of testing was the worst among others. As a matter of fact, even under these circumstances, the system outperformed BIST-30 index.

Finally, 2005-2017 period was cited in order to demonstrate that the trader should not give up sticking to the system and avoid quitting, even though there might be some intervals, during which trades are not performing so favorably. During the sideways market, the performance of the algorithmic system diminished. In this part of Results, it is shown that, although still very profitable, if the trader quitted the system on Jan 5, 2018, he/she would obtain 2,675% return. On the other hand, if he/she chose to continue trading until March 2020, a return of 4,476% would be capitalized.

## SECTION SIX

### RESULTS

#### 6.1. COMPARISON OF RETURNS FOR 2005-2010 INTERVAL

This is the interval where the algorithmic system was tested for the first time. The reason of this is, in the year of 2005, futures and options exchange was established and opened to trading.

As seen in the graph below, during the period under consideration, the system has performed very well (total return of 613%) and exceeded the performance of the benchmark index (70%).

**Graph 6.1. 1:** System Performance vs. Benchmark Index (2005-2010)



The algorithmic system's performance for the period of February 9<sup>th</sup> 2005 till February 9<sup>th</sup> 2010 was as follows:

Total return:	6,139.19
Total number of transactions:	101
Number of profitable transactions:	45
Number of loss-making transactions:	56
Average profit:	234
Average loss:	78
Average profit/Average loss:	2.98
Most profitable position:	20,070
Most loss-making position:	-13,130
The position with longest holding period and its result:	50 transaction days; +19,000 profit
The position with shortest holding period and its result:	2 transaction days; -3,180 loss
Total number of days without position:	152 transaction days

The report obtained from Matriks that summarizes the performance of the algorithmic system is presented below:

**Table 6.1. 1: System Performance vs. Benchmark Index (2005-2010)**

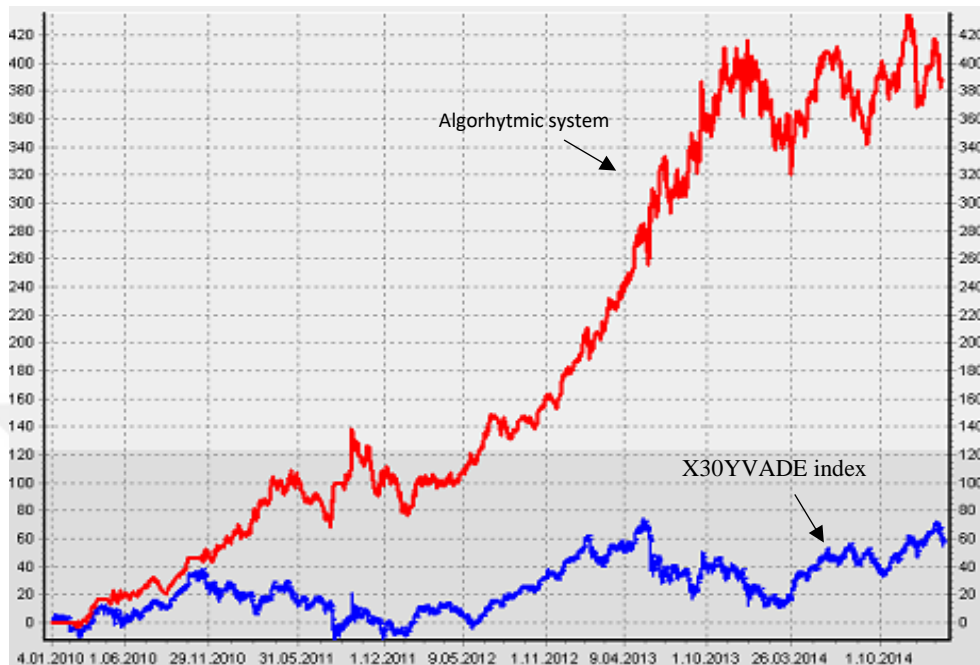
Summary					
Raket		XU030 Short Term / F_XU0301019			
18.10.2019 19:16		Between 9.02.2005 - 9.02.2010 - 1,258 bars - 1,826 days			
Performance					
Starting balance:	1,000		Final overall:	7,139,190	
Commission expenses:	0.00		Interest income:	0.00	
Return:	6,139,190		Percent return*:	613.92	
Transactions		101	Average Profit/Average Loss:		2.98
Profitable:	45	10,528,530	Loss making:	56	4,389,340
Long:	25	6,819,440	Long:	27	2,426,340
Short:	20	3,709,090	Short:	29	1,963,000
Average profit:	233,970		Average loss:	78.38	
Statistics					
Most profitable position:	Between 22.08.2005-4.10.2005 - 30 bars				20.07
Most loss making position:	Between 14.10.2008-16.10.2008 - 2 bars				-13.13
Longest position:	Between 30.07.2009-12.10.2009 - 50 bars				19.00
Shortest position:	Between 4.10.2005-6.10.2005 - 2 bar				-3.18
Period without transaction					
Longest time:	Between 9.02.2005-1.04.2005 - 38 bars				
Total time:	152 bars				
Final status			122,275		
Last transaction	Short sale	Feb. 3rd '10	68,825		
Cash		44.79			
Position		0			

## 6.2. COMPARISON OF RETURNS FOR SELECTED 2010-2015 INTERVAL

If the interval under consideration is selected somewhere between the beginning and ending dates of the indexes such that in this specially selected interval there are clear trends available, then, as it is a trend-tracking model, it is expected that the returns will be even higher. Similarly, for those intervals where trends are not clear, it is expected that returns are lower (or losses higher). With the purpose of testing this, the period of December 12<sup>th</sup> 2009 and February 9<sup>th</sup> 2015 is selected and the algorithmic system is run for this period. Please note that, compared to the first interval tested above, in this interval the market trends are not very clear and volatility is higher.



**Graph 6.2. 1:** System Performance vs. Benchmark Index (2010-2015)



The observations made regarding the performance are summarized below:

Total return:	38.899,84
Total number of transactions:	109
Number of profitable transactions:	55
Number of loss-making transactions:	54
Average profit:	1.401
Average loss:	707
Average profit/Average loss:	1.98
Most profitable position:	19.000
Most loss-making position:	-6.210

When the first 5-year-period's results are compared with the results of the selected 5-year-period presented above, it is seen total return has dropped from 614% to 389%. The model makes as many as 109 transactions to make use of available

opportunities in the market (previous case, 101) and average profit of these transactions barely doubles the average loss per transaction with a ratio of 1.98 (previous case was 2.98).

The report obtained from Matriks that summarizes the performance of the algorithmic system for the selected 5-year-period under consideration is presented below:

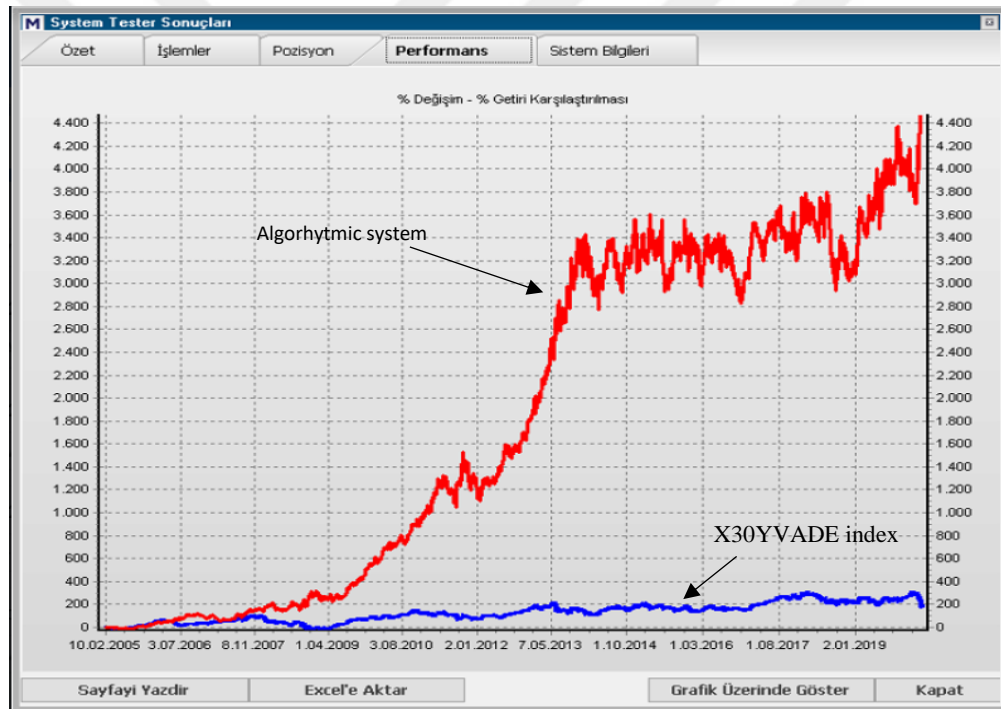
**Table 6.2. 1: System Performance vs. Benchmark Index (2010-2015)**

Summary				
Raket		XU030 Short Term / F_XU0301019		
18.10.2019 19:20		Between 31.12.2009 - 9.02.2015 - 1,285 bars - 1,866 days		
Performance				
Starting balance:	10,000	Final overall:	48,899,840	
Commission expenses:	0.00	Interest income:	0.00	
Return:	38,899,840	Percent return*:	389.00	
Transactions		109	Average Profit/Average Loss: 1.98	
Profitable:	55	77,091,840	Loss making:	54 38,192,020
Long:	28	46,301,680	Long:	28 20,491,900
Short:	27	30,790,160	Short:	26 17,700,120
Average profit:	1,401,670		Average loss:	707.26
Statistics				
Most profitable position:	Between 29.05.2013-24.06.2013 - 18 bars			19.00
Most loss making position:	Between 21.03.2014-26.03.2014 - 3 bars			-6.21
Longest position:	Between 2.10.2012-27.12.2012 - 59 bars			19.00
Shortest position:	Between 28.04.2010-29.04.2010 - 1 bar			-1.14
Period without transaction				
Longest time:	Between 31.12.2009-17.02.2010 - 34 bars			
Total time:	91 bars			
Final status			122,275	
Last transaction	Short sale	Feb. 4th '15	129,675	
Cash		67.82		
Position		0		

### 6.3. COMPARISON OF RETURNS FOR 2005-2020 INTERVAL (FROM DAY ONE TO MARCH 2020)

This is the third testing period examined and it is the largest interval in which the algorithmic system is tested, starting from the first day of futures market, till March 2020. As seen in the graph below, compared to the benchmark of X30YVADE index, the algorithmic system has generated much better results.

**Graph 6.3. 1:** System Performance vs. Benchmark Index (2005-2020)



The algorithmic system's performance for the period of February 9<sup>th</sup> 2005 till March 20<sup>th</sup> 2020 was as follows:

Total return:	457.650
Total number of transactions:	371
Number of profitable transactions:	165
Number of loss-making transactions:	206

Average profit:	7.219
Average loss:	3.609
Average profit/Average loss:	2.00
Most profitable position:	21.800
Most loss-making position:	-13.130
The position with longest holding period and its result:	62 transaction days; +19.500 profit
The position with shortest holding period and its result:	1 transaction day; -2.640 loss
Total number of days without position:	133 transaction days

As the system only makes transactions with the end-of-day closing value, it is expected that in the evening, at the closing time of the stock exchange, by sparing just five minutes a day, the investor should check if the algorithmic system has created an order and in case there is one, the transaction should be executed.

Again, as an interesting result, even though the number of profit-making transactions is less than the number of loss-making transactions (%44.5-%55.5), the system is still very profitable. The most important reason that lies behind this is the fact that the average profit is 2 times larger than the average loss.

The report obtained from Matriks that summarizes the performance of the algorithmic system is presented below:

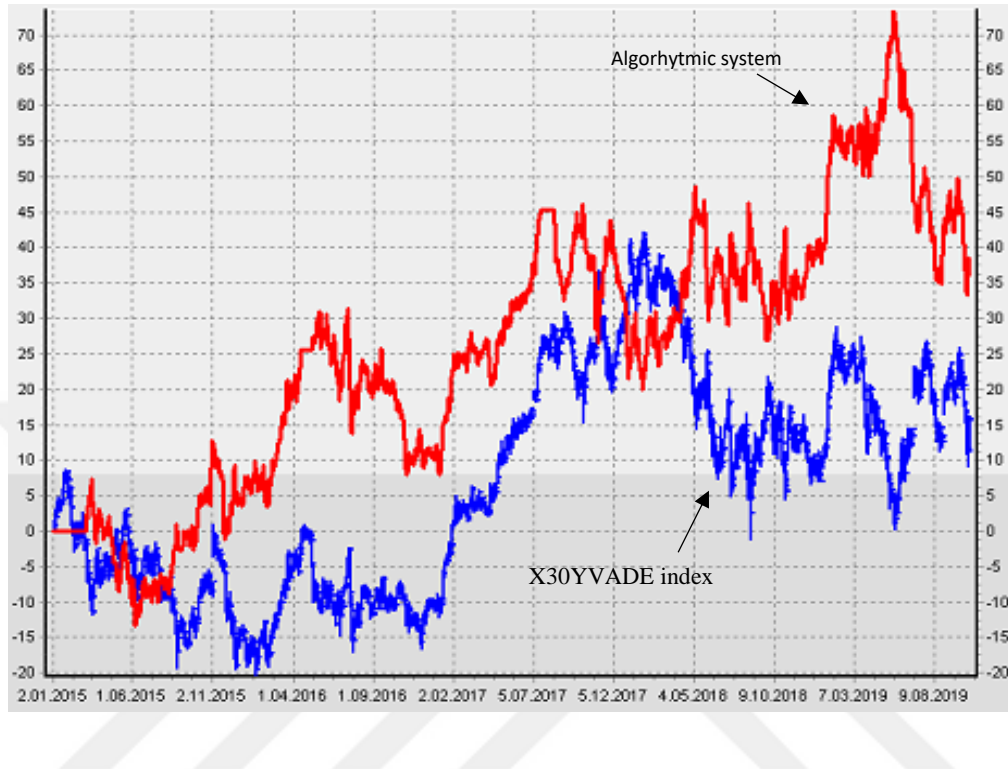
**Table 6.3. 1: System Performance vs. Benchmark Index (2005-2020)**

Summary				
Raket		XU030 Short Term / F_XU0300420		
20.03.2020 13:07		Between 09.02.2005 - 20.03.2020 - 3,802 bars - 5,518 days		
Performance				
Starting balance:	10,000	Final overall:	457,650,300	
Commission expenses:	0.00	Interest income:	0.00	
Return:	447,650,300	Percent return*:	4,476.5	
Transactions		371	Average Profit/Average Loss: 2.00	
Profitable:	165	554,650	Loss making:	206 743,498,900
Long:	87	325,780	Long:	102 388,584,900
Short:	78	228,860	Short:	104 354,913,900
Average profit:	7,219,090		Average loss:	3,609,220
Statistics				
Most profitable position:	Between 19.08.2005-04.10.2005 - 31 bars			21.80
Most loss making position:	Between 14.10.2008-16.10.2008 - 2 bars			-13.13
Longest position:	Between 02.10.2012-02.01.2013 - 62 bars			19.50
Shortest position:	Between 18.10.2005-19.10.2005 - 1 bar			-2.64
Period without transaction				
Longest time:	Between 09.02.2005-22.03.2005 - 30 bars			
Total time:	133 bars			
Final status			105,525	
Last transaction	Stop (Profit)	12.03.2020	116,134	
Cash	457,650.3			
Position	0			
*: It is calculated according to the first closing value (09.02.2005 - 37.15)				

#### 6.4. COMPARISON OF RETURNS FOR 2015-2019 (5 YEARS) INTERVAL (SIDEWAYS MARKET)

As the fourth example, the algorithmic system was tested on the 5-year interval of recent market period during which the market had no clear either up or down trends; whereas, sideways market movements were dominant.

**Graph 6.4. 1:** System Performance vs. Benchmark Index (2015-2019)



Similar to the period examined in case ii above, if the interval under consideration is reduced from the side where the volatilities of the indexes are higher (for our case, it is the older data section of the interval under consideration), in accordance with the working principles of the model, it is expected that the total returns generated would decrease. Indeed, when the interval is reduced by one year to take only the last five years into consideration, the period of December 31<sup>th</sup> 2014 till October 10<sup>th</sup> 2019 is examined, and the following observations are made:

Total return:	13.846
Total number of transactions:	26
Number of profitable transactions:	10
Number of loss-making transactions:	16
Average profit:	971
Average loss:	366
Average profit/Average loss:	2.65

Most profitable position:	19.000
Most loss-making position:	-6.130

Compared to the first 5-year interval studied in case i, here it is seen total return has dropped from 613% to just 38%. Total number of transactions has dropped because, as foreseen by the model, there are now less opportunities to utilize. Note that even in this environment, the model is able to generate positive returns but it is not good enough when compared to other 5-year periods previously tested. This shows that the algorithmic systems struggle in sideways markets, open unnecessary positions and lose time. This is one of the weak points of the system: When there is no clear trend, it will not be able to generate significant returns.

The report obtained from Matriks that summarizes the performance of the algorithmic system for the recent 5-year period under consideration is presented below:

**Table 6.4. 1: System Performance vs. Benchmark Index (2015-2019)**

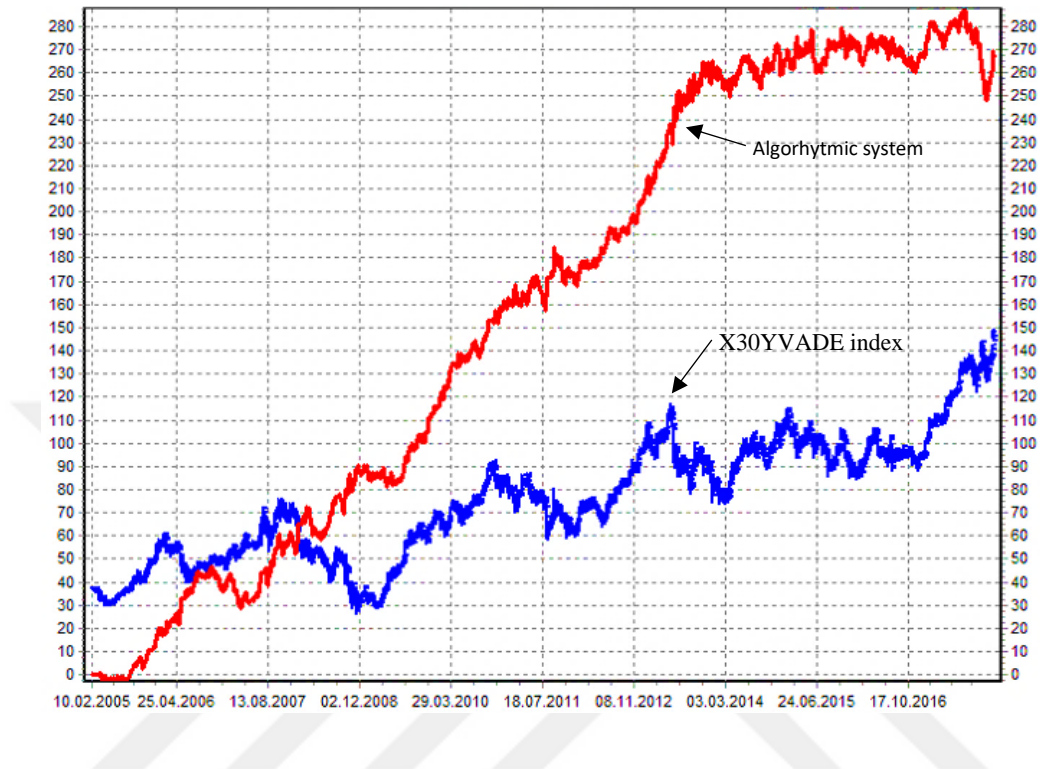
Summary				
Raket		XU030 Short Term / F_XU0301019		
18.10.2019 19:25		Between 31.12.2014 - 18.10.2019 - 1,207 bars - 1,752 days		
Performance				
Starting balance:	10,000	Final overall:	13,846,000	
Commission expenses:	0.00	Interest income:	0.00	
Return:	3,846,000	Percent return*:	38.46	
Transactions		26 Average Profit/Average Loss:		2.65
Profitable:	10 9,714,230	Loss making:	16	5,868,230
Long:	6 7,540,260	Long:	7	3,671,080
Short:	4 2,173,970	Short:	9	2,197,150
Average profit:	971,420	Average loss:	366,760	
Statistics				
Most profitable position:	Between 26.01.2016-14.04.2016 - 57 bars			19.00
Most loss making position:	Between 28.05.2018-31.05.2018 - 3 bars			-6.13
Longest position:	Between 16.08.2017-28.05.2018 - 197 bars			-0.06
Shortest position:	Between 11.08.2017-14.08.2017 - 1 bar			-2.67
Period without transaction				
Longest time:	Between 31.12.2013-4.03.2015 - 45 bars			
Total time:	76 bars			
Final status		122,275		
Last transaction	Buy	July 1st '19	129,675	
Cash		28.93		
Position		113		

## 6.5. COMPARISON OF RETURNS FOR THE FIRST 13 YEARS INTERVAL (EARLY EXIT)

In the first large period example described in item iii above, it was shown that the results are very significantly positive (4,234% return). In case an early exit decision was made, that should not have been the case and the example below is presented with the purpose of providing an evidence to this. If the decision to quit using the system was given two years before (beginning of 2018 rather than 2020), the investors would still be beating the index but with a much modest return rate of 2,675%. From the experience, it may well be deduced that, even though the markets may experience a long sideways market, the trader should stick to the algorithmic system and continue trading according to it.



**Graph 6.5. 1:** System Performance vs. Benchmark Index (2005-2017)



As a result of the performance analysis of the algorithmic system over the period of February 9<sup>th</sup> 2005 till January 5<sup>th</sup> 2018, the following findings are obtained:

Total return:	268.000
Total number of transactions:	314
Number of profitable transactions:	144
Number of loss-making transactions:	170
Average profit:	3.850
Average loss:	1.690
Average profit/Average loss:	2.28
Most profitable position:	21.800
Most loss-making position:	-13.130

The position with longest holding period and its result:	62 transaction days; +19.500 profit
The position with shortest holding period and its result:	1 transaction day; -2.640 loss
Total number of days without position:	170 transaction days

When the fact that the time interval in which the algorithmic system run was 13 years is taken into consideration, the occurrence of only 314 transactions is a significant data.

Again, similarly as shown in previous tests, even though the number of profit-making transactions is lower than the number of loss-making transactions (%46-%54), the system is consistently profitable. The main reason behind this outcome is the average profit is observed to be 2.28 times larger than the average loss, during this test period.

The report obtained from Matriks that summarizes the performance of the algorithmic system for this case is presented below:

**Table 6.5. 1: System Performance vs. Benchmark Index (2005-2017)**

Summary				
Raket2		XU030 Short Term / F_XU0300218		
04.11.2013 16:30		Between 09.02.2005 - 05.01.2018 - 2,197 bars - 4,713 days		
Performance				
Starting balance:	0	Final overall:	267,500	
Commission expenses:	0.00	Interest income:	0.00	
Return:	267,500	Percent return*:	2,675	
Transactions		314	Average Profit/Average Loss:	2.28
Profitable:	144	554,650	Loss making:	170 287,150
Long:	77	325,780	Long:	83 142,330
Short:	67	228,860	Short:	87 144,830
Average profit:	3,850		Average loss:	1,690
Statistics				
Most profitable position:	Between 19.08.2005-04.10.2005 - 31 bars			21.80
Most loss making position:	Between 14.10.2008-16.10.2008 - 2 bars			-13.13
Longest position:	Between 02.10.2012-02.01.2013 - 62 bars			19.50
Shortest position:	Between 18.10.2005-19.10.2005 - 1 bar			-2.64
Period without transaction				
Longest time:	Between 09.02.2005-22.03.2005 - 30 bars			
Total time:	170 bars			
Final status			146,175	
Last transaction	Buy	November 1st '17	141,475	
Cash	121.35			
Position	1			
*: It is calculated according to the first closing value (09.02.2005 - 37.15)				

## **SECTION SEVEN**

### **CONCLUSION**

Though having been applied in the financial markets over years, according to some academic authorities, technical analysis is a subject of discussion. In that sense, several academicians have opposed technical analysis stating that it has no theoretical basis.

In addition, effective markets hypothesis and random walk model (Fama, 1965) predict that technical analysis will not be able to generate returns above the market average (Philippatos, 1974, page 358). However, it is seen that the results of empirical tests being conducted on the efficient markets hypothesis and random walk model over many years are mixed and inconsistent.

On the other hand, several literature studies conducted, especially during the recent years, have revealed that, compared to buy and hold strategy, the methods of technical analysis, generate significantly superior returns in the markets. Details about the studies and the scientists were given in Literature Review part.

The algorithmic system that is developed in this thesis work, aims high returns by;

- identifying the trends at the early stage,
- using exponential and weighted moving averages,
- making minimum number of transactions and
- keeping the standard deviation low; hence, minimizing the risk of loss.

Besides, it is rather user friendly, when considered that, the investor should be ready for a possible trade only at the last 5 minutes of the trading day. Besides, the number of trades entered is only 371, as can be seen in part iii of the Results; in which a period starting from February 9, 2005 to March 20, 2020 is taken into consideration, namely 15 years. The results obtained reveals that, an algorithmic system that is developed by using the indicators of technical analysis very much exceeds the

performance of Borsa Istanbul-30 index, which is formed by the weighted average of the 30 blue chips of the Stock Exchange.

Due to very high performance obtained via technical analysis, the result that is obtained in this study rather proves the hypothesis that Borsa Istanbul does not have an efficient stock exchange structure.

In this regard, it is also shown that technical analysis can be a useful tool when used knowledgeably. For this specific algorithmic system, which was simulated on Futures and Options Market of Borsa Istanbul, to check its consistency about performance, an analysis can be conducted on individual stocks traded on Borsa Istanbul and as well as futures markets in Europe and North America.

In this study, supported by the literature work mentioned above in a way; with the help of an algorithmic system that is developed using the technical analysis instruments, it is shown that, in inefficient markets such as the Turkish one, compared to buy and hold strategy, superior returns can be obtained. However, it should be kept in mind that, it is not possible to claim that the aforementioned algorithmic model would successfully perform in each and every market. Each country and each market has its own dynamics, rules, regulations, investor base, financial players and tools. In efficient markets like Germany DAX and London FTSE, no meaningful and successful results are expected. Hence, the algorithmic system described in this thesis, would not be able to generate any excess returns. This issue can be analyzed by a further study on this subject.

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On Fri, May 15, 2020 at 8:15 PM Cenktan Ozyildirim <[cenktan.ozyildirim@bilgi.edu.tr](mailto:cenktan.ozyildirim@bilgi.edu.tr)> wrote:

Sayın Hocalarım,

15 Mayıs 2020 tarihinde Bankacılık ve Finans Programı öğrencisi Ömer Tuna'nın savunmasını başarılı bulduk. Prosedür gereği sizden kararınızı bu maili cevaplayarak teyit etmenizi rica ederim. İlginize tekrar teşekkür ederim.

Saygı ve sevgilerimle,

Cenktan Özyıldırım



Tarih:15.05.2020

Lisansüstü Programlar Enstitüsü'ne,

15.05.2020 tarihinde 116673012 numaralı Ömer Faruk Tuna adlı Bankacılık ve Finans Program öğrencisinin “Testing the Efficiency of Borsa Istanbul, via an Algorithmic Model Created by Using Technical Analysis Indicators” konulu tez savunmasında jüri üyesi olarak bulundum.

İlgili tezin **kabulünü** / ~~düzeltilmesini~~ / ~~reddini~~ uygun buluyorum.

Jüri Üyesinin Unvanı, Adı Soyadı : Prof. Dr. Cenktan Özyıldırım

Bağlı Bulunduğu Üniversite: İstanbul Bilgi Üniversitesi



FW: SAVUNMA KARAR FORMU - İleti (HTML)

DosyaİletiYardımNe yapmak istediğinizi söyleyin

Yoksay

Önemsiz

Sil

Arşivle

Yanıtla

Yanıtla Tümünü

İlet

Toplantı

Anlık İleti

Diğer

Taşı ?

Ekip E-postası

Yanıtla ve Sil

Yöneticiye

Bitti

Yeni Oluştur

Kurallar

OneNote

Eylemler

İlke Ata

Okunmadı

Kategorilere

İzle

Sil

Yanıtla

Hızlı Adımlar

Taşı

Etiketler

KB

22.05.2020 Cum 12:59

Kerim Balcı

FW: SAVUNMA KARAR FORMU

Kime ● Mine Genc

Bilgi ○ Demet Gurkan

İzle

Başlangıç tarihi: 22 Mayıs 2020 Cuma. Bitiş tarihi: 22 Mayıs 2020 Cuma.

Bu iletiyi 27.05.2020 15:46 tarihinde yanıtladınız.

gencofas\_savunmakarar.docx

51 KB

**From:** Genco Fas  
**Sent:** Friday, May 22, 2020 11:52 AM  
**To:** Cenktan Ozyildirim <[cenktan.ozyildirim@bilgi.edu.tr](mailto:cenktan.ozyildirim@bilgi.edu.tr)>  
**Subject:** Re: SAVUNMA KARAR FORMU

Cenktan Hocam, selamlar.

Dokuman ektedir. Ben de ogrencimiz Omer Faruk Tuna'nin tez savunmasini basarili buldum. Ogrencimize sagladiginiz yonlendirme icin tesekkur ederim.

Sevgilerimle.

Genco


Tarih:15.05.2020

Lisansüstü Programlar Enstitüsü'ne,

15.05.2020 tarihinde 116673012 numaralı Ömer Faruk Tuna adlı Bankacılık ve Finans Program öğrencisinin “Testing the Efficiency of Borsa Istanbul, via an Algorithmic Model Created by Using Technical Analysis Indicators” konulu tez savunmasında jüri üyesi olarak bulundum.

İlgili tezin **kabulünü** / ~~düzeltilmesini~~ / ~~reddini~~ uygun buluyorum.

Jüri Üyesinin Unvanı, Adı Soyadı : Dr. Öğr. Üyesi Genco Fas



Bağlı Bulunduğu Üniversite: İstanbul Bilgi Üniversitesi

FW: SAVUNMA KARAR FORMU - İleti (HTML)

DosyaİletiYardımNe yapmak istediğinizi söyleyin

Yoksay

Önemsiz

Sil

Arşivle

Yanıtla

Tümünü Yanıtla

İlet

Toplantı

Anlık İleti

Diğer

Taşı ?

Ekip E-postası

Yanıtla ve Sil

Yöneticiye

Bitti

Yeni Oluştur

Kurallar

OneNote

Eylemler

İlke Ata

Sil

Yanıtla

Hızlı Adımlar

Taşı

KB

22.05.2020 Cum 12:58

Kerim Balcı

FW: SAVUNMA KARAR FORMU

Kime Mine Genc

Bilgi Demet Gurkan

İzle. Başlangıç tarihi: 22 Mayıs 2020 Cuma. Bitiş tarihi: 22 Mayıs 2020 Cuma.  
Bu iletiyi 27.05.2020 10:35 tarihinde ilettiniz.

dilektuzunaksu\_savunmakarar.docx  
24 KB

cenktanozyildirim\_savunmakarar.docx  
24 KB

Ömer Faruk Tuna'nın savunmasını başarılı bulduğuma dair belgeyi ekte bilgilerinize sunarım.

İyi çalışmalar,  
Dilek Tüzün Aksu

Tarih:15.05.2020

Lisansüstü Programlar Enstitüsü'ne,

15.05.2020 tarihinde 116673012 numaralı Ömer Faruk Tuna adlı Bankacılık ve Finans Program öğrencisinin “Testing the Efficiency of Borsa Istanbul, via an Algorithmic Model Created by Using Technical Analysis Indicators” konulu tez savunmasında jüri üyesi olarak bulundum.

İlgili tezin **kabulünü** / ~~düzeltilmesini~~ / ~~reddini~~ uygun buluyorum.

Jüri Üyesinin Unvanı, Adı Soyadı : Doç. Dr. Dilek Tüzün Aksu

Bağlı Bulunduğu Üniversite: Yeditepe Üniversitesi