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TESTING THE WEAK-FORM EFFICIENCY OF THE TURKISH STOCK MARKET ISE

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MASTER THESIS WITHIN THE MAIN PROFILE OF INTERNATIONAL BUSINESS

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ABSTRACT

This study examines the Turkish Stock Market, Istanbul Stock Exchange (ISE) to determine whether it is weak-form efficient. For this purpose, daily observations of the closing prices of ISE100 index have been tested for the period between 04.01.1988 and 11.04.2012. The data has been tested for the validity of the market efficiency hypothesis at the weak level by two empirical tests, namely test of serial correlation and Lo and MacKinlay's variance ratio test. The tests were applied to both the full sample period and four sub-periods in order to see if the level of (in)efficiency differs among periods and if the Turkish stock market has been moving towards efficiency. Both the serial correlation test and the variance ratio test suggest that the market is not weak-form efficient. However, the analyses on the sub-periods show that the level of inefficiency varies through time and it is lowest at the last period which is between 2009 and 2012.

PREFACE

This thesis is written within the Master of Science in Economics and Business Administration.

With the effort to contribute to the research community in finance and bring attention to possible stock market inefficiencies in emerging economies, the Turkish stock market has been tested for the validity of the weak-form market efficiency and its evolvement through time. Two empirical tests, namely serial correlation test and variance ratio test, have been conducted on the return series of the daily data for the full sample and four sub-periods of the ISE100 index which is used as the basic index for ISE stock market. The data set is very broad and ranges from 1988 to 2012. To complement the empirical tests, the Turkish economy and the Istanbul Stock Exchange has been analyzed in a historical perspective.

The possibility of having abnormal profits due to market inefficiency makes this topic very interesting for both investors and researchers. Therefore, this motivated us to study the features of the Turkish stock market and contribute to the literature on market efficiency for emerging economies.

ACKNOWLEDGEMENTS

The semester that I spent to write this thesis has been very stressful and challenging. It required lots of efforts and motivation to accomplish my goal. However, the satisfaction I got after finishing it is totally priceless. Nevertheless, this could not have been possible without extra support from a number of people. Therefore, I would like to use this opportunity to show how grateful I am to all those who helped me in this period of my life.

I would like to start by thanking to my advisor, Jonas Andersson who supported me with his guidance, supervision and advices through the writing process.

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1. INTRODUCTION

1.1 BACKGROUND

As the world becomes globalized and developed, people started to look for new instruments to invest their money in. Today one of the biggest instruments for investments is stock markets. Stock markets are crucial for individuals and institutions to raise capital or funds to make new investments or to expand their current operations. Its importance makes both investors and scholars to be very interested in stock market price movements.

The ability to guess price fluctuations in the stock markets would lead to huge capital gains. That is why there are a lot of speculations, theories and methods for forecasting them and people are trying to exploit them with the hope to gain better stock returns by making analyses in various ways. Many scholars has been discussing if it is really possible to find a way to forecast the future stock prices or if the stock prices are totally random. The belief in the latter created what we call today as The Random Walk Theory which is the basis for the weak-form market efficiency hypothesis. It suggests that successive stock prices or returns are independently and identically distributed and that past stock prices have no predictive content to forecast future stock prices (Chung, 2006). In other words; if the stock markets are weak-form efficient, it is not useful to makes analyses on the historic stock prices to forecast the future prices and therefore make abnormal profits.

There has been a vast amount of research on the validity of the efficient markets hypothesis over the last decades. These researches include both empirical studies on developed and developing countries. However in both cases the studies give mixed results. While old studies done on developed economies supports the idea of the market efficiency at the weak level, recent studies on developed economies give results which contradict to the hypothesis. The situation is almost the same for developing countries. The results of the empirical research for the validity of market efficiency give mixed results depending on the country, data set and tests employed. Therefore, it is hard to make a claim on the validity of the weak form efficient market hypothesis for both developed and developing countries.

All of the puzzling results for the validity of the market efficiency hypothesis at the weak-form motivate us to study the Turkish stock market, which is an upper middle income developing country, with up to date data in terms of both weak-form market efficiency and the evolvement process of the efficiency or inefficiency through time.

Turkey has one stock market, Istanbul Stock Exchange (ISE) which is located in Istanbul, the biggest city of the country. It has been operating since 1986 and there have been many structural and operational changes at ISE throughout the years together with the macroeconomic changes in the Turkish economy. As of 2010, Turkey is the second fastest growing country among the G20 countries, so it would not be wrong to expect foreign investors to give more attention to the stocks traded at the ISE.

There have been several empirical studies on the ISE which mostly utilize data from the initial years of the market and/or they give mixed results in terms of the validity of weak-form efficiency. Thus, this thesis tries to test weak-form efficiency for the ISE with the longest possible data set.

1.2 OBJECTIVE OF THE STUDY

The objective of this master thesis is to investigate the Turkish stock market (Istanbul Stock Exchange) to decide if the market is weak form efficient in the periods between 1988 and 2012. The main reason that made me interested into investigating that is the fact that most of the studies on ISE (Istanbul Stock Exchange) in terms of weak form efficiency are outdated, they mostly employ data until 1990s. However, many macroeconomic values has changed in Turkey over the last 20 years and Turkey became more integrated to the rest of the world which was also shown in a study by Berument and Ince that S&P500 index (Standard & Poor Stock Index USA) return affects ISE positively (Berument & Ince, 2004), showing a link between the American and Turkish markets and indicating the integration of the Turkish economy to the rest of the world. A research by Smith and Ryoo on weak form efficiency on developing European countries including Turkey uses a data until 1997 for Istanbul Stock Exchange, shows that the market follows a random walk, thus is weak form efficient (Smith & Ryoo, 2003). Another study conducted by Suleyman Kilic uses the data between 1987 and 2004 shows that ISE prices fully reflect all the available historic prices and therefore is weak form efficient (Kilic), while the study by Korkmaz and Akman shows that ISE is not weak form efficient for the time period between 2003 and 2009. These puzzling results made me willing to investigate the current situation. So, the thesis starts with the examination of the current situation with the belief of finding support for weak form efficiency in the Turkish stock market. In order to do that, I used daily observations of the ISE100 index which is used as the basic index for ISE stock market. It consists of 100 stocks which are selected among the stocks of companies listed on the National Market and the stocks of real estate investment

trusts and venture capital investment trusts listed on the Corporate Products Market. By using two different statistical tests, namely serial correlation and variance ratio test, I tried to reach a conclusion about the validity of the weak-form market efficiency in an empirical way.

One other objective of this study is to examine the evolvement of efficiency at the Turkish stock market, so the data got divided into four sub-periods according stock price and return fluctuations which also corresponds to the crisis times at the Turkish economy. That is to be able to find evidence if the efficiency changes through time. Finally, the same statistical tests were applied to the 4 sub-periods and results were compared with each other.

1.3. OUTLINE OF THE STUDY

The rest of the thesis is organized as follows: Section 2 provides information on the Turkish economy and the stock market in a historical perspective. In section 3, together with the market efficiency concept, the efficient market hypothesis and possible methods to test them is explained. Section 4 continues with a general literature review of weak-form efficiency on developed countries followed by a detailed literature review on developing countries including Turkey. Section 5 presents data and methodology for the empirical analysis and the results of the empirical tests are summarized and explained in section 6. Finally, section 7 has concluding remarks while section 8 has references used in the thesis.

2. TURKISH ECONOMY AND TURKISH STOCK MARKET

2.1 DEVELOPMENT OF THE TURKISH ECONOMY

Turkey, the bridge country between The Middle East and Europe, is classified as an upper middle income country with a GDP of $734,364,471,760 as to 2010 according to The World Bank (Bank) . After the crisis in 2008, Turkey has gone through a rapid recovery period and had a GDP growth of 8.9% in 2010 which makes Turkey the second fastest growing economy among the G20 countries (Basarir & Kirankabes, 2012). As it can be seen from the Figure 1, even though there are sharp decreases in GDP of Turkey in some years, generally there is an increasing trend over the years between 1988 and 2010.

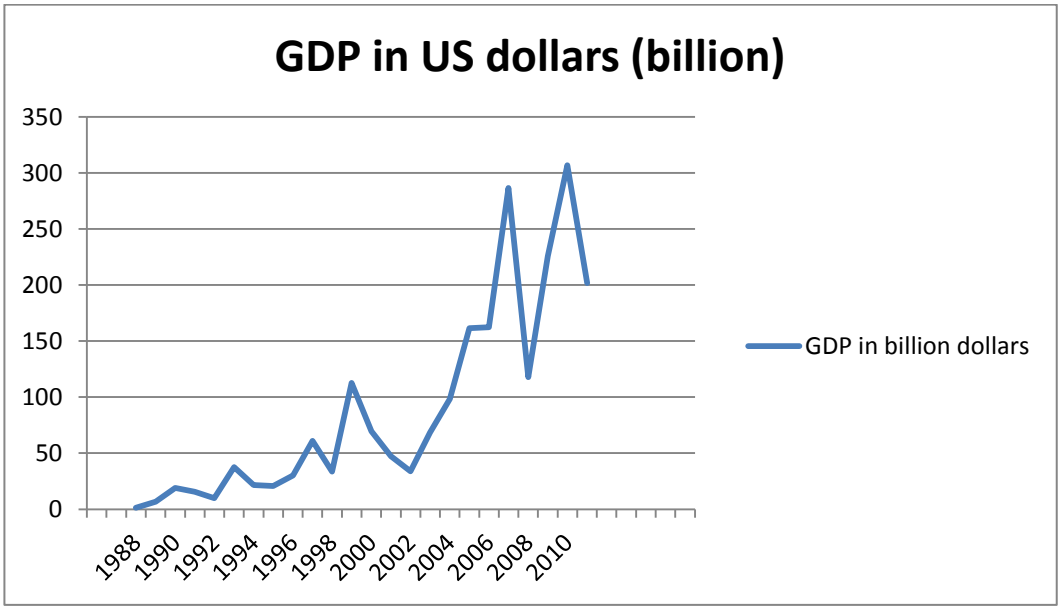

Figure 7: GDP of Turkey in billion US dollars (Bank)

GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

According to IMF's definition, Turkey is a developing country (Nielsen, 2001). As a developing and fairly young country Turkey cannot yet be categorized as industrialized even

though there have been many improvements in the Turkish economy since the early years. In 1923 when the Turkish Republic was founded, it was mainly an agrarian country on subsistence level. It can be said that there was no industry especially after the out migration of Greek, Armenian and Jew entrepreneurs. After the turmoil of the World War I and the collapse of the Ottoman Empire, Turkey started to fully recover its agricultural sector and initiated state owned industrialization (Takim & Yilmaz, 2010).

Over the years import substitution strategies were followed both in 50s and 70s where the strategy was inward-looking and domestic demand oriented. 70s were characterized by public investment programs where heavy manufacturing and capital goods production has expanded (Boratav & Yeldan, 2001). Nevertheless the planned economy created some unbalances such as subsidies to capital intensive sectors while there is lack of skilled labor and plenty of unskilled unemployed people. There is no surprise that one of the biggest economic crises took place in 1970's; sharp increase in exports caused a balance of payments problem. Military interventions in 1960 and 1971 made the situation even worse since politicians chose to boost the spending and overheat the economy after the military coups, instead of making structural changes in the economy. Adding all those together with the oil crises in 1973, it can be claimed that Turkey had its worse crises in 70's (Country Slides).

The time period between 1980's to 2000 for Turkish economy can be divided into two periods such as the period between 1980 to 1989 and 1989 to 2000. After the third military coup in Turkish history in 1980, the liberalization process had begun. Liberalization in the domestic markets was followed by trade liberalization in 1984 which led to Customs Union with the EU eleven years later and capital accounts liberalization in 1989. So 80's can be seen as a period where the Turkish economy is an open economy where macro and fiscal instruments have gone under structural changes thanks to structural adjustment loans and debt reliefs. Import liberalization, export promotion with managed floating exchange rate were the main characteristics of the time period in which the annual GDP growth rate was 6.5% (Boratav & Yeldan, 2001).

The domestic financial liberalization process was not so easy for Turkey. The domestic market had to be de and re-regulated after the first liberalization since the rapid lack of control on deposit interest rates led to the emergence of plenty money brokers and their collapse all together. In 1984 banks were allowed to accept foreign deposits from the citizens and Central Bank's control on the domestic banks was reduced to reserve requirement and

liquidity revision. Only after 2 years from those changes in the domestic financial market, Capital Market Board was founded and it is responsible from the management, auditing and regulations of the stock market Istanbul Stock Exchange which was established with the purpose of ensuring that securities are traded in a secure and stable environment (Boratav & Yeldan, 2001).

The establishment of ISE was followed by the foreign exchange regime in 1989 which allows all foreigners to invest in Turkish securities and all citizens to invest in foreign securities. However, the years after the establishment of the stock market, stock price changes have not been very smooth because of political and economic changes. It is discussed that macroeconomic values have an effect on stock prices by changing the expectations of stock holders. It is also claimed in a study by Dopke et al. that stock market volatility tends to rise during business cycle downturns (Dopke, Hartmann, & Pierdzioc, 2006). 1990's political environment and sharp changes in the stock prices is in line with that argument. In 1994 Turkey had another crisis which caused a sharp increase in unemployment, decrease in output and depreciation of Turkish Lira which then was followed by 10.3% decrease in the ISE100 index in Istanbul Stock Exchange (Durgut, 2002).

Due to the political clashes between the Prime Minister and the President in 2001, the stock market got significantly affected and the ISE100 index fell by 15%. Central Bank raised overnight interest rates and its reserves dropped by $5.3 billion. Thus the government increased the monthly interest for Treasury bills to 144%. As a result of these rapid ups and downs in the economy, two new institutions were established to stabilize the market, namely "Regulation of the Investors Protection Fund" and the "Regulation Regarding the Procedures and Principles of the Progressive Liquidation of the Intermediary Institutions" (Yildirtan, 2007).

2.2 ESTABLISHMENT AND THE DEVELOPMENT OF THE ISTANBUL STOCK EXCHANGE

Istanbul Stock Exchange was established on December 26, 1985 for the purpose of ensuring that securities are traded in a secure and stable environment, and had its first trading day on January 3, 1986. According to the Governmental Decree in Force of Law (KHK) No.91, the ISE is a public corporation operating as an autonomous and professional institution. The ISE is entitled to issue legal regulations related to the subjects and fields within the scope of its authority. It has memberships with The World Federation of Exchanges

(WFE), Federation of Euro-Asian Stock Exchanges (FEAS) where there are 32 stock exchange members exist from 29 countries, Federation of European Securities Exchanges (FESE), International Securities Services Association (ISSA), International Capital Market Association (ICMA), European Capital Markets Institute (ECMI) and International Organizations of Securities Commissions (IOSCO).

The ISE has contributed to the development of Turkish capital markets and Turkish economy since the date of its establishment through series of developments to in the stock markets which include the introduction of continuous auction trading in 1987, odd-lot trading in 1990, double session extension, full automation of the fully electronic systems and the establishment of the National Market in 1994, followed by the establishment of Regional, Wholesale and New Companies Markets in 1995 and Watchlist Companies Market in 1996. During the 2000's there have been extensions in trading hours and finally the introduction of A, B, C classifications of traded companies took place in 2010. The classification is done according to the shares in circulation of the listed companies and with the decision of The Capital Markets Board (ISE, Annual Report 2010).

As it can be seen from the figure below, Turkish Stock Market has the 14th place among emerging countries in terms of stock market capitalization according to 2010 data in ISE's database, whereas its market capitalization of the listed companies has been growing since 1988 despite several significant ups and downs according to the Figure 3.

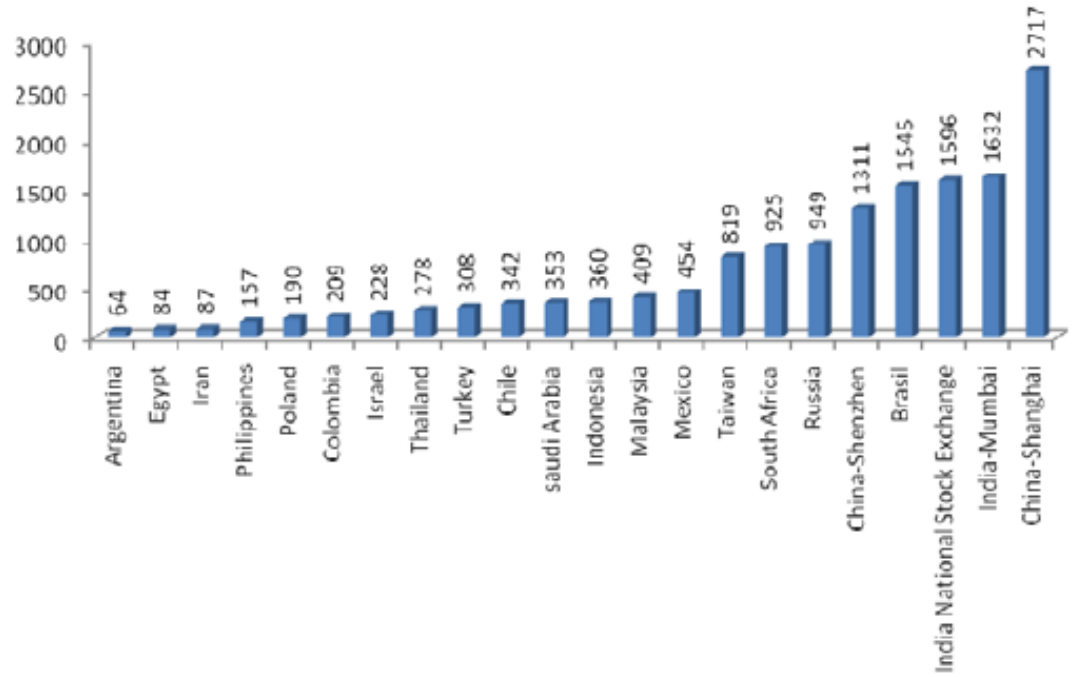

Figure 8 Stock Market Capitalization end-2010 US dollars billion(Emerging Country Comparison) (ISE, Annual Report 2010)

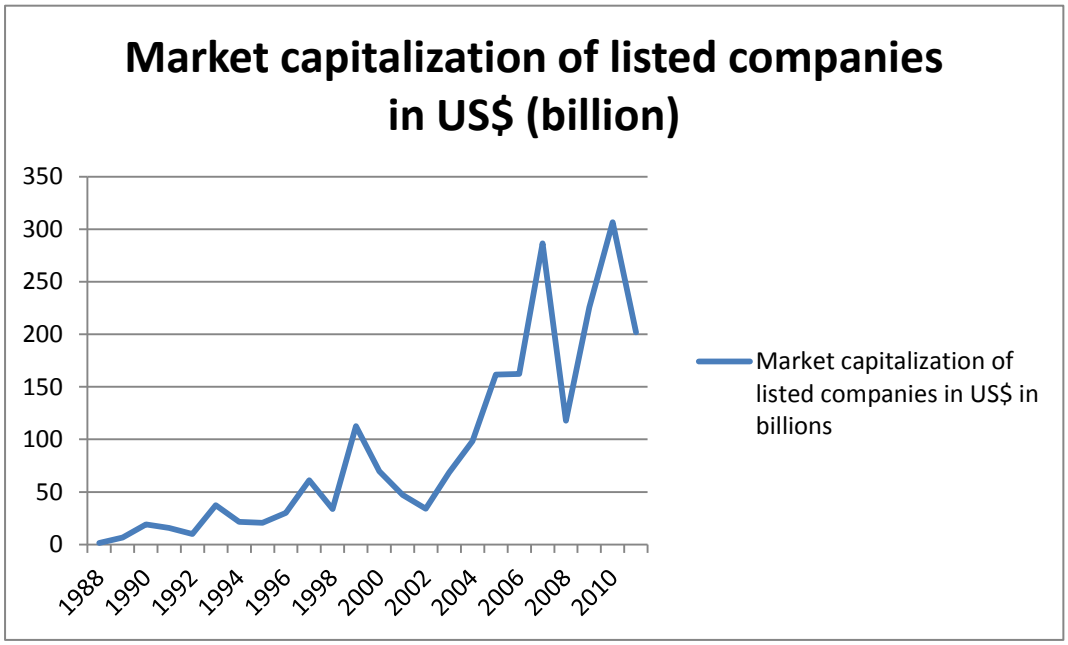

Figure 9 Market Capitalization of Listed Companies in Turkey in US dollars (billion dollar) (Bank)

Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. Data are in current U.S. dollars.

Today the number of listed companies in Istanbul Stock Exchange is more than 300 and they are mainly companies in manufacturing industry and financial institutions like banks and brokerage houses. The listed companies are classified into two different markets namely, the Stock Market and the Emerging Companies Market. Companies that satisfy the listing/registration criteria and fulfill the obligations specified in the legislation are traded on the Stock Market while the companies that fail the ISE listing requirements are traded on the ECM. The companies may be traded on the National Market, the Collective Products Market, the Second National Market, the New Economy Market and on the Watchlist Companies Market. There are 15 calculated indices at ISE and none of them include the stocks traded on the Watchlist Market or stocks in list C. In this thesis mainly the National Market will be analyzed since it is the market where companies which satisfy the ISE listing requirements are traded and they are mainly companies in bigger sizes compared to the companies traded on the other markets at ISE (ISE, ISE).

To sum up, ISE tries to ensure the continuous delivery of company information to domestic and international investors to contribute to publicity while using the audit mechanisms of the capital markets to speed up the institutionalization process so that all the shareholders can reach information about the stocks on the data section of the ISE webpage and on the Public Disclosure Platform (ISE, ISE).

3. THEORY

3.1. MARKET EFFICIENCY CONCEPT

Market efficiency concept is about informational efficiency, using information in an efficient way. Behind the concept of efficiency are rational expectations which suggest that the agents are not systematically wrong. Rational expectations require that information is freely available to everyone and markets are competitive. So it is a setting where prices are set by rational, informed agents in competitive markets and those markets are assumed to have the reflection of all the relevant information on their prices. This process also requires that there is no transaction costs so that the prices not just reflect information but fully reflect them (Gjølberg, 2011). However, in reality there is no market where all the information is available to everyone and also for free. Another problem which may hinder market efficiency is transaction costs. Even though today's global economy is mostly open and competitive, there are still some barriers to trade or some transaction costs even in a small economy. In addition to that, the psychological and behavioral aspects of stock price determination are another argument used against market efficiency (Malkiel, 2003). That is why there is no surprise that the market efficiency concept has been a very popular concept among academicians and investors and even today academicians repeatedly try to test efficiency in various markets despite the fact that the efficient market hypothesis has a lot of opponents with solid arguments and tests; as the financial economist at Harvard, Michael Jensen writes: "there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis." (Clarke, Jandik, & Mandelker). However there is a huge body of literature on the topic where some of them accept and some of them reject it and several of them will be discussed in the Section 4.

3.2. THE MARKET EFFICIENCY HYPOTHESIS

The emergence of the efficient market hypothesis dates back to the early twentieth century to the theoretical contributions of Bachelier (1900) in his "Theory of Speculation". In his research, he worked on stock and commodity prices in order to find out if they fluctuated randomly or not (Yalcin, 2010). However, Bachelier's study on the randomness of the prices and difficulty to beat the market did not get as much attention as Fama's and Samuelson's researches in 1965, probably also because it was after 1950's when time-series analyses could be utilized by computers.

The empirical studies conducted by many scholars like Cowles and Jones (1937), Kendall (1953), Cootner (1962), Osborne (1962), Granger and Morgenstern (1963), Fama (1965) together with Samuelson (1965) helped shaping the Efficient Market Hypothesis which is the proposition that current stock prices fully reflect all available information about the value of the stocks or the firm, and there is no way to earn abnormal profits, more than the market overall, by using this information. It is associated with the idea of a "random walk", a term used in the finance literature to characterize a price series where all subsequent price changes represent random departures from previous prices. The logic of the random walk idea is that if the flow of information is unimpeded and information is immediately reflected in stock prices, then tomorrow's price change will reflect only tomorrow's news and will be independent of the price changes today and news is by definition unpredictable, thus, resulting price changes must be unpredictable and random. (Malkiel, 2003).

In the study by Samuelson (1965) 'Proof that Properly Anticipated Prices Fluctuate Randomly', he discusses information and efficiency. In an informationally efficient market, price changes must be unforeseenable if they are properly anticipated, that is, if they fully incorporate the information and expectations of all market participants (Lo, 2007).

Another influential academic theory for market efficiency came from the doctoral dissertation of Eugene Fama in 1965. According to Fama, a market where prices always fully reflect all available information is called an efficient market and it is impossible to gain abnormal profits by analyzing the history of the price change series because successive price changes are independent (Fama, 1965). According to Fama, there has to be 3 conditions satisfied for the existence of market efficiency. These conditions are absence of transaction costs, free information available to all market participants and finally the fact that the current prices of a security fully reflects all available information. These conditions ensure investors possessing available information cannot gain above-competitive returns (Fama, Efficient Capital Markets: A Revire of Theory and Empirical Work, 2970).

One of the most important contributions of Fama's research is that he divides the efficient market hypothesis into three degrees according to information level present at the market.

1) Weak Form Efficiency

Today's prices contain all information in historic prices. So, historic prices cannot be used to improve upon today's price. Historic prices cannot give us any additional information about tomorrow's price if the market is weak form efficient.

2) Semi-Strong Form Efficiency

Today's price contains all relevant public information. It means that we cannot say anything about tomorrow's price beyond what is in today's price even if we include all kinds of public information if the market is semi-strong form efficient.

3) Strong Form Efficiency

All (both public and private) relevant information is baked into today's price, meaning that it is not possible to improve our predictions about tomorrow's price by using all relevant public and private information if the market is strong form efficient.

3.3. TESTING EFFICIENCY

All of the three efficiency levels require different empirical methods to be able to test them. To test for semi-strong-form efficiency, the adjustments to previously unknown news must be of a reasonable size and must be instantaneous. To test for this, consistent upward or downward adjustments after the initial change must be looked for. If there are any such adjustments it would suggest that investors had interpreted the information in a biased fashion and hence in an inefficient manner (Science).

The test for the strong-form efficiency can be done through checking if internal people, like money managers, act different than outsiders. If so, then it means that private information is not baked into today's price. However, it is hard to test this since there are hundreds of internal people in the stock markets and a few of them might as well have gained abnormal profits by coincidence.

To test for weak-form efficiency, having observations of historic stock prices is enough and there are many empirical tests to apply on them which are shown to be more or less solid. That is why, for the practical reasons, this thesis tests only for weak-form efficiency in the Turkish stock market.

4. LITERATURE REVIEW

Empirical investigation of weak-form efficiency in stock markets was mainly based on 2 tests; serial correlation and runs tests. Recently, variance ratio test started to be commonly employed after the contributions of Lo and MacKinlay (1988) and Cochrane (1988). While there was a vast literature on developed countries on random walk hypothesis or specifically weak-form efficiency, the number of studies conducted on developing countries has been also increasing in the last decades. One of the reasons for the increasing interest to developing countries comes from the fact that it is believed that most of the less developed markets suffer from the problem of thin trading. In addition, in smaller markets, it is easier for big dealers to control the market. That is why it is generally believed that the emerging markets are less efficient (Awad & Daraghma, 2009). Therefore, researchers have focused on whether these markets are informationally efficient or not, in other words there may be possibilities of having systematic paths in the stock prices which can lead to abnormal profits if analyzed well. The other reason is that even though there has been a large body of empirical research concerning the validity of the random walk hypothesis or weak-form efficient market hypothesis with respect to stock markets in both developed and developing countries, empirical research on testing the random walk hypothesis has produced mixed results.

The literature review section will start with literature on developed countries and will continue with a more detailed review of the literature on developing countries.

4.1. LITERATURE ON DEVELOPED COUNTRIES

The study by Lee (1992) uses variance ratio test to determine whether returns of weekly stock indices follow a random walk. The countries in the analysis are USA, Australia, Belgium, Canada, France, Italy, Japan, the Netherlands, Switzerland, UK and Germany for the period from 1967 to 1988. He concludes that random walk hypothesis cannot be rejected for those countries' weekly return series in that time period (Lee, 1992).

Choudhry (1994) analyzes the stock indices in seven OECD countries: the United States, the United Kingdom, Canada, France, Germany, Japan and Italy in terms of weak-form efficiency. He uses Augmented Dickey-Fuller and KPSS unit root tests, and Johansen's co-integration test with the observations as the log of monthly stock indices from the period 1953 to 1989. He concludes that stock markets in seven OECD countries are efficient during the sample period. The results from both unit root tests show that all seven indices seem to

contain a stochastic trend and they are non-stationary in levels. However, the result of Johansen's co-integration test shows contradictions with that finding. Therefore, he concludes that those seven countries are weak-form efficient (Choudhry, 1994).

Al-Loughani and Chappel (1997) examine the validity of the weak-form of efficient market hypothesis for the United Kingdom stock market using the Lagrange multiplier (LM) serial correlation, Dickey-Fuller unit root and Brock, Dechert and Scheinkman (BDS) non-linear tests with daily data ranging from 1983 to 1989. While Dickey-Fuller test gives results in line with the random walk hypothesis, BDS and serial correlation test reject the hypothesis. So the study is concluded that the UK stock market does not follow a random walk and is not weak-form efficient for the period between 1983 and 1989 (Al-Loughani & Chappell, 1997).

Lima et al. tested weak-form efficiency for Japan and US together with 11 emerging countries for the period between 1992 and 2002 by mainly applying variance ratio test to the return series of the daily closing prices. They found out that both US and Japan are weak-form efficient (Chang, Lima, & Tabak, 2003).

Lima and Tabak (2004) analyzed Hong Kong and Singapore stock markets in terms of random walk hypothesis by using variance ratio test for the daily data from 1992 to 2000 and found that the random walk hypothesis is only rejected for Singapore (Lima & Tabak, 2004).

The study conducted by Worthington and Higgs tests weak form efficiency on 16 developed and 4 developing countries in Europe, namely Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Greece, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and The United Kingdom with the data between 1986/87 and 2003. They employ a combination of four tests such as serial correlation, runs test, KPSS unit root test and multiple variance ratio tests. As a result of those tests they find that among all the developed countries they tested for weak form efficiency only 5 of them (Germany, Sweden, Portugal, Ireland and The United Kingdom) comply with criteria of weak-form efficiency (Worthington & Higgs, 2004).

4.2. LITERATURE ON DEVELOPING COUNTRIES

There have been many empirical studies to test weak form efficiency in developing/emerging countries in the recent years. Some of those studies will be summarized in the section to find the chance to make a comparison between Turkish Stock Exchange and the stock exchanges in other developing countries. The literature on developing countries is separated according to regions in order to make a region-wide comparison.

4.2.1. Mena Countries

Middle Eastern and North African countries have a lot of literature with recent data. Most of the studies on Mena countries have similar results even though all of the studies differ in terms of extent and content of the data and the variety of the tests utilized. They all with some exceptions conclude that the stock market is not weak-form efficient.

The study on Saudi Arabia, which is a developing country with high income level, by Al-Saleh and Al-Ajmi uses both daily and weekly data sets between 1994 and 2007 for 8 industry based indexes and one composite index from Saudi Stock Market. Employment of 10 different empirical tests gives mixed results on weak form efficiency. The results of the unit root test, Lo and MacKinlay's variance ratio test, Chen and Deo's multiple variance ratio test cannot reject the random walk hypothesis while results from runs test, other rank and sign based single and multiple variance ratio tests reject the hypothesis (Al-Ajmi & Al-Saleh, 2012).

Awad and Dragma conducted a study on Palestine Securities Exchange for the time period between 1998 and 2008 and applied parametric and non-parametric empirical tests for efficiency at the weak level for the daily data of 35 stocks in general and sector indices. The results of both the serial correlation test and the runs test indicate that PSE is inefficient at the weak form while Augmented Dickey Fuller and Phillips-Peron unit root tests supports the idea of weak form efficiency. However, the authors of the article claim that it is possible to gain abnormal profits from stocks traded at PSE by carefully analyzing old stock prices at the market (Awad & Daraghma, 2009).

The study by Al-Jafari on Bahrain Securities Market tests the weak-form efficiency between the years 2003-2010 by using daily observations of the all share index. In this study both parametric and non-parametric tests give the similar results concerning the weak-form

efficiency of the Bahrain Securities Market. All the tests conclude that the market is inefficient at the weak-form, indicating a possibility of abnormal returns (Al-Jafari, 2011).

Al-Ahmad's study on Damascus Securities Exchange (Syria) examines the weak-form efficiency for a two years period, 2009-2011 with daily observations of the DWX index. He concludes the study by stating that the securities exchange is not weak-form efficient after conducting autocorrelation test, runs test, unit root test, variance ratio test and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) one model (Al-Ahmad, 2012). The same topic is also analyzed by Jaradat and Al-Zeaud on Amman Stock Exchange with daily data from 1999 to 2009. The results of the runs test, autocorrelation test and unit root tests suggest that the ASE is not weak form efficient which is not a surprising outcome, considering the results of all the other studies conducted in Mena region.

4.2.2. European Emerging Countries

The studies conducted on the European emerging countries, mainly eastern and central European, give mixed results depending on the time periods included in the studies, tests employed and countries selected. However, it can be claimed that it is not very seldom to see results rejecting weak-form efficiency for EEC countries.

Abrosimova et al. tested the Russian Stock Market for weak-form efficiency with data sets from 1995 to 2001. They used unit root test, autocorrelation test and variance ratio test on daily, weekly and monthly data and showed that only monthly data supports the hypothesis that the Russian Stock Market is weak-form efficient. They also discussed the possibility of a profitable trading rule due to the limited evidence they found on the short term market predictability of stock prices (Abrosimova, Dissanaike, & Linowski, 2002).

The study by Hayek on Hungary, Poland and Czech Republic with data from 1995 to 2005 shows that Hungarian stock index is in line weak-form efficiency for weekly data while it is not the case for Czech and Polish stock markets. There are unsystematic deviations in the Polish market so the author suggests that it is more like to have a short term profit strategy only for the Czech market (Hayek, 2007).

The master thesis written by Zgaljic tries to test for weak-form efficiency in Polish Stock Market, Warsaw Stock Exchange for the period between 1991 and 2003. By utilizing autocorrelation test and runs test for different sub-period he concludes that generally the

Warsaw Stock Exchange is inefficient. However, as a result of the analysis on the sub-periods he explains that the efficiency has been increasing over time (Zgaljic, 2004).

By employing non-linear unit root test procedure Omay and Karadagli tests Bulgarian, Greek, Hungarian, Polish, Romanian, Russian, Slovenian and Turkish stock markets for weak-form efficiency with data sets ranging from 2002 to 2010. As a result of the non-linear test, the null hypothesis that the markets are weak-form efficient is rejected for Russia, Romania and Poland. They continue their analysis by applying linear and non-linear panel unit root tests but they give puzzling results; while the linear panel unit root test indicates that all the countries in the analysis are efficient, the non-linear test indicates the exact opposite (Karadagli & Omay, 2010).

Lastly, Guidi et al. made a similar analysis on emerging European countries including Poland, Hungary, the Czech Republic, Slovakia, Romania, Bulgaria and Slovenia. Daily prices from 1999 to 2009 were used in this research. The results from the variance ratio test, runs test and autocorrelation test shows mixed results; where autocorrelation test suggests that the stock market indices do not follow random walk in weak-form efficiency sense, runs and variance ratio tests conclude that the efficiency has improved after joining EU.

4.2.3. Asian Countries

Making a generalization for Asian countries; whether their stock markets are weak-form efficient or not is very hard. Every study on that topic uses different tests to measure efficiency and some tests tend to give contradicting results for the same data. In addition to that hardships stems from the fact that data choices vary a lot from study to study.

Liu et al. tested the Pakistani Stock Market for weak-form efficiency by weekly data for the period between 2000 and 2010. By using Lo and MacKinlay's variance ratio test, autocorrelation and runs tests they concluded that the stock market does not follow a random walk and thus is not weak-form efficient (Haque, Liu, & Nisa).

In the study done by Mobarek and Keasey the Dhaka Stock Market in Bangladesh is tested for weak-form efficiency. The sample includes daily price indices from 1988 to 1997. It is tested by both parametric and non-parametric tests and those tests provide that reject the null hypothesis that the Dhaka Stock Market is weak-form efficient (Mobarek & Keasey). In addition to that, another study conducted on the banking sector in Bangladesh in 2011 by

Siddik et al. on daily returns for a period of 11 years. As a result of Dickey Fuller unit root test and runs test it is concluded that Dhaka Stock Market indices do not follow random walk, thus is not weak-form efficient (Khandoker, Siddik, & Azam, 2011).

Lim et al. analyzed Chinese market for weak-form efficiency. They investigated Shanghai and Shenzhen Stock Exchanges for the period between 1991 and 2003. They conclude that the two stock markets are weak-form efficient in the long run while there may be some periods in the short run that new information is not fully reflected into the stock prices since they detected serial dependencies in the both exchange markets (Lim, Habibullah, & Hinich). For the period between 2002 and 2005 Niblock and Sloan found that Chinese stock markets are still not weak-form efficient despite continual financial liberalization in China in the last years (Niblock & Sloan).

Lock analyzed the Taiwan market by using weekly data from 1990 to 2006 and tested it by Lo and MacKinlay's variance ratio test. It was found out that the Taiwan stock market follows random walk (Lock, 2007).

The study by Higgs and Worthington tests weak-form efficiency for 10 emerging Asian countries. They employ daily returns data for China, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Sri Lanka, Taiwan, and Thailand. The study used several tests including serial correlation coefficient, runs test, Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin unit root tests and multiple variance ratio tests. However, not all the tests gave the same answer for random walk. According to the serial correlation and runs test all of the 10 countries are weak-form inefficient while they are weak-form efficient according to unit root tests (Worthington & Higgs, 2005).

4.2.4 Other Developing Countries

Harvey (1995) studied volatility and returns predictability of six Latin American, eight Asian, three European and two African emerging stock markets and found evidence for strong serial correlation in the stock returns which makes them more predictable and thus it is concluded that those developing markets are not weak-for efficient (Harvey, 1995).

The Nairobi stock exchange has been analyzed in terms of weak-form efficiency by Parkinson (1987) with monthly data from 1974 to 1978. Runs test was used as the empirical method and it suggested that the market is not weak form efficient (Parkinson, 1987). For the

same stock market Dickinson and Muragu (1994) concluded that the market is weak-form efficient from 1979 to 1989 by the serial correlation test and runs test on weekly observations (Dickinson & Muragu, 1994).

Lima et.al tested weak-form efficiency on daily closing prices for Argentina, Brazil, Chile, India, Indonesia, Malaysia, Mexico, the Philippines, Taiwan, South Korea and Thailand from 1992 to 2002. They used variance ratio test since the series were not normally distributed according to Jarque- Bera test. The empirical results suggest that all the Asian countries in the analysis and Chile are shown to be not weak-form efficient (Chang, Lima, & Tabak, 2003).

Worthington and Higgs tested for market efficiency by using market value-weighted equity indices for seven emerging Latin American markets; namely, Argentina, Brazil, Chile, Columbia, Mexico, Peru, Venezuela. The series encompass dissimilar sampling periods given the varying availability of each index. The end date for all series is 28-May-2003 with ARG, BRZ, CHL and MEX commencing on 31-Dec-1987 and COL, PRU and VEN on 31-Dec-1992. As a result of test of serial correlation and multiple variance ratio tests, it was concluded that the null hypotheses of no serial correlation for Brazil, Chile, Columbia, Mexico, Peru and Venezuela are rejected at the .01 level or higher, while that for Argentina is rejected at the .05 level or higher. Similarly, multiple variance ratio tests also reject the weak-form efficiency for the Latin American countries (Worthington & Higgs, 2003).

4.3 LITERATURE ON TURKEY

Yalama and Celik investigate semi strong form efficiency in Istanbul Stock Exchange Market, Foreign Exchange Market and Interbank Money Market in respect to changes in Currency in Circulation by using Toda Yamamoto Causality Test for the period between 1990 and 2008. As a result, there is a causality relationship running from Currency in Circulation to Foreign Exchange Market and Currency in Circulation to Interbank Money Market; however there is no causality relationship running from Currency in Circulation to Istanbul Stock Exchange Market. This result implies that while money markets are semi strong form efficient, capital market is not in Turkey (Yalama & Celik, 2008).

Balaban investigates Istanbul Stock Exchange in terms of informational efficiency by applying first order Markov process to the daily return data of the ISE composite index from 1988 to 1994. Empirical results verify that ISE composite index is neither weak-form nor semi-strong form efficient even though the degree of inefficiency differs across periods (Balaban, 1995)

The study by Kilic investigates Istanbul Stock Exchange to see ISE 100 index follows a random walk. He uses daily data from 1987 to 2004 and applies Markov chain methodology as his main method. He concludes that at all times stock prices reflect all available historical information, so ISE is weak-form efficient (Kilic S.).

The study by Smith & Ryoo (2003) on weak form efficiency for developing European countries including Turkey uses a data until 1997 for Istanbul Stock Exchange and it shows that the market follows a random walk, thus is weak form efficient.

The study by Muslumov, Aras and Kurtulus not only tests for weak form efficiency in the Turkish stock market but also how it has been evolving towards efficiency. They used ISE100 index for the period between 1990 and 2002. They used generalized auto-regressive conditional heteroscedastic (GARCH) model to test their hypothesis on sub-periods. It was concluded that while ISE-100 index do not follow random walk for the initial period of the analysis, it gains random-walk behavior in the second period (Muslumov, Aras, & Kurtulus, 2003).

ISE was also investigated by Korkmaz and Akman in 2010 in terms of weak-form efficiency. They used unit root tests and co-integration test for two stock market indices; ISE100 and ISE industry. It was concluded in the study that ISE indices are not weak-form efficient as well as the two indices do not co-integrate in the long run (Korkmaz & Akman, 2010).

The study conducted by Aga and Kocaman used the index that they calculated which consists of the most liquid companies in ISE. They used monthly data from 1986 to 2005 and applied auto regression with 6 lags (AR6) to find out if the stock prices of ISE's most liquid companies are weak form efficient. The finding was supportive for efficiency in the weak sense (Aga & Kocaman, 2008).

Buyuksalvarci and Abdioglu analyzed the Turkish stock market in order to find out whether it is weak-form efficient. They used various indices like ISE100 index, services index, financial index, industrial index with daily observations from 1987 to 2011. They applied both parametric and non-parametric tests which are serial correlation, Augmented Dickey-Fuller unit root test, variance ratio test, Phillips-Peron unit root test and runs test. They concluded that all the tests except the runs test indicate that the Istanbul Stock Exchange is not weak-form efficient (Buyuksalvarci & Abdioglu, 2011).

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5. METHODOLOGY AND DATA

5.1. DATA

To examine the Turkish Stock Market in terms of weak-form market efficiency, daily data starting from 04.01.1988 until 11.04.2012 has been used. The source of the data is Istanbul Stock Exchange's own web site. Closing prices for every week day have been the main price indicators. The reason why I used daily data instead of weekly or monthly data is that I wanted my analysis to contain as much information as possible. Taking average prices to make an estimate for weekly data eliminates some information, so that is why I preferred to use daily data for the analyses. The index used in this thesis is ISE100 index which is used as the basic index for ISE stock market. It consists of 100 stocks which are selected among the stocks of companies listed on the National Market and the stocks of real estate investment trusts and venture capital investment trusts listed on the Corporate Products Market. ISE 100 index automatically covers some other indices such as ISE 30 and ISE 50 stocks.

The analyses were applied to both the full sample and some sub-periods. The sample got divided into 4 sub-periods according to significant changes in the stock prices and returns, which also correspond to crisis times in the Turkish economy. The division is done in order to be able to compare the changes in efficiency through time. The periods used in the analysis can be also seen from Table 1.

Table 5 Periods used in the analysis

ISE 100	
Period 1	1988-2012
Period 2	1988-1993
Period 3	1994-2000
Period 4	2001-2008
Period 5	2009-2012

I believe the division of the sample provides us with greater variety of information which include the most significant changes in the Turkish economy that may have affected the stock price fluctuations and their efficiency in the weak sense.

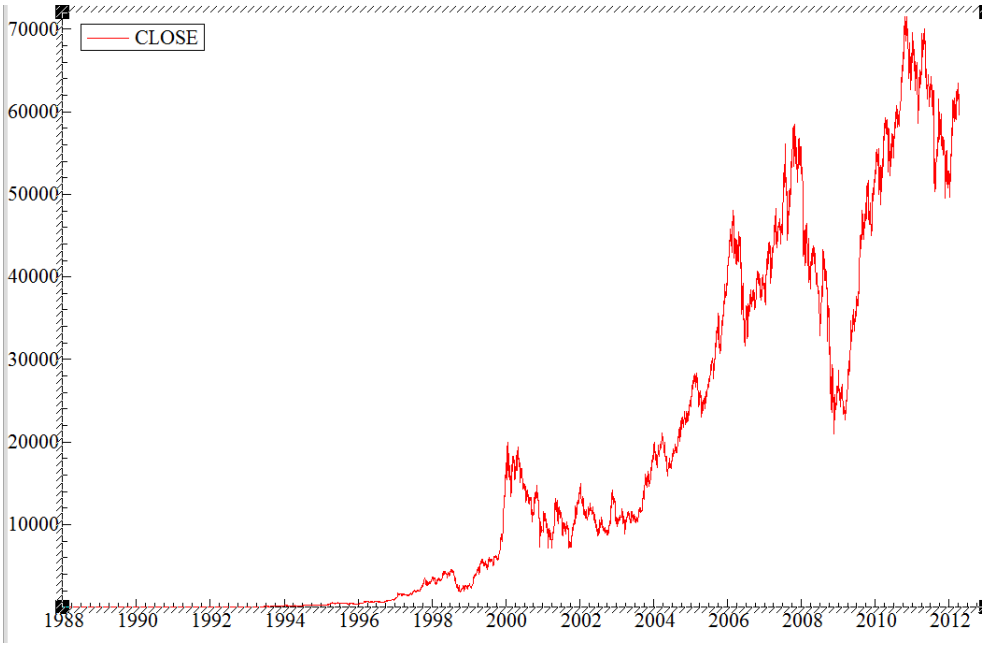

Figure 10 Time series plot of the Turkish Stock Market Index ISE100

According to the Figure 4, the stock prices have moved up significantly from 1988 to 2012, it clearly shows how many improvements have been made at ISE and Turkey in general over time. Moreover, despite this increasing trend in the stock prices, there are several points in time where stock prices experienced huge fluctuations which corresponds to severe crises in the Turkish economy.

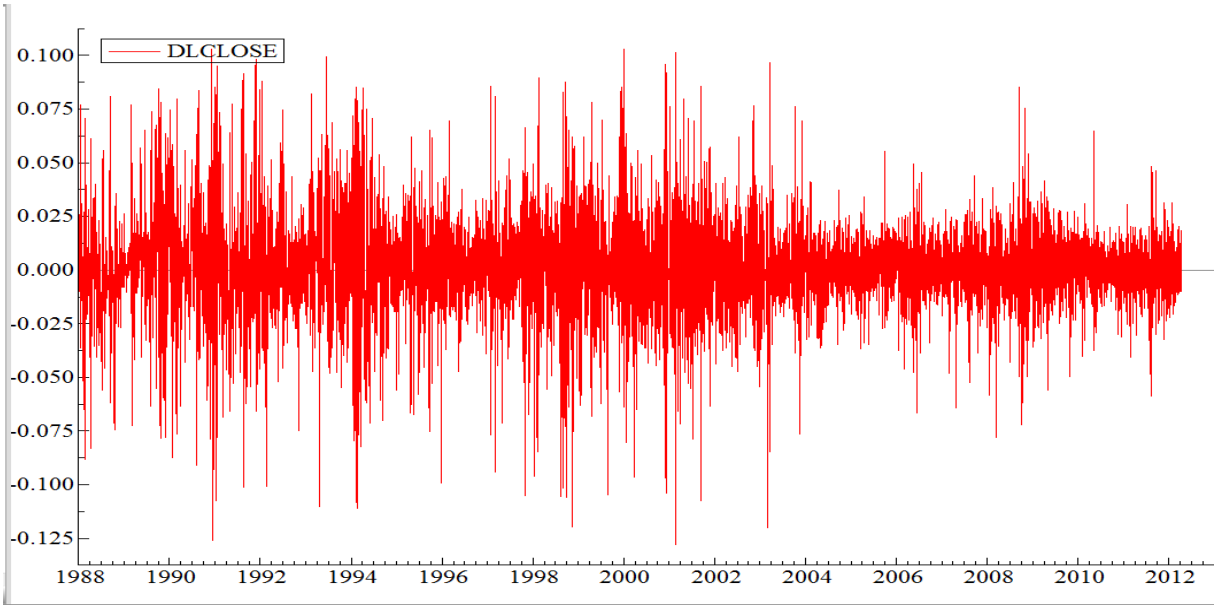

Figure 11 Time series plot of the daily returns of ISE100

As can be seen from Figure 5, in 1994 there are big fluctuations in daily stock returns which is not very surprising since 1993-1994 are also the years when as a result of large salary increases for state employees and transfer increases for state enterprises Turkey experienced high inflation, increasing real exchange rate, decrease in exports and increase in trade and account deficits.

Turkey experienced two big crises in a row, one in 1999 and 2001 as a result of bankruptcy in banking sector in 1998 and the big earthquake which took place in 1999 in Izmit which is very close to Istanbul and is one of the biggest industry centers. The earthquake destroyed many industries in the area for some following years. It is possible to see these sudden changes in both Figure 4 and 5.

Figure 4 shows that stock prices are going up more or less steadily for the period between 2001 and 2008; however in 2008 there is a massive decline in the stock price index which is due to the fact that like many other economies, the Turkish economy has been affected by the global financial crisis. Although there are some economists claiming that Turkey has not been affected by the crisis as badly as other emerging economies, it is still obvious that some things have changed tremendously in the economy and in the stock market which caused the sudden decline of the stock price index until 2009.

The time period between 2009 and 2012 can be considered as a recovery period where trust in the market rises and some regulations changes which takes the stock market price index up.

Finally, the testable hypothesis should be defined as the following; the main objective of this thesis is to examine if the Turkish Stock Market is weak-form efficient. Therefore, the null hypothesis is:

H_0: The Turkish Stock Market (Istanbul Stock Exchange) is weak form efficient.

H_1: The Turkish Stock Market is not weak form efficient.

In order to observe whether the Turkish Stock Market has moved towards efficiency, I used the same hypothesis for the 4 sub-periods. Lastly, the null hypothesis for efficiency at weak level is tested by some empirical tests including serial correlation and variance ratio test, applied to both the full sample and the 4 sub-periods.

5.2. Statistical Tests for Market Efficiency

In this study, 2 statistical methods were used, namely serial correlation and variance ratio test. The data tested to determine the level of dependency among successive returns of the Turkish stock market index. Where serial correlation test is used for short term dependency, variance ratio test by Lo and MacKinlay (1988) is used to test long run dependency. It has been shown that variance ratio test by Lo and MacKinlay (1988) is more powerful compared to other tests for random walk like runs test and it is a more reliable test for the random walk hypothesis for its 3 versions. These tests are discussed in detail in the next section of the thesis.

Both of the tests were applied to the return values of the ISE100 price index. The returns of the prices in the index have been calculated as logarithmic returns with the following formulation:

$$R= \ln(P_t/P_{t-1})$$

Where

R: return of the price

P_t: Price in time period t

P_{t-1}: Price in the rime period t-1

5.3. Serial Correlation Test

Serial correlation test is one of the most commonly used tests in market efficiency literature. It measures the correlation coefficients between a series of returns and lagged return in the same time series. The null hypothesis of the serial correlation test is that correlation coefficients are significantly different from zero. Serial correlation test gives insights on the short term dependency, so the returns of the Turkish Stock Market are tested to see if there is serial dependence between returns.

$$\alpha_k= \mathrm{Cov}(r_t, r_{t-k}) / \sqrt{Var}\,(r_t)\,\sqrt{Var}\,(r_{t-k})= \mathrm{Cov}(r_t, r_{t-k}) / \mathrm{Var}(r_t)$$

Where:

α_k: autocorrelation coefficient of the time series r_t

r_t : return on a security at time t

k: the lag period

Cov(r_t, r_{t-k}): Covariance between the returns at time t and time t-k

Var r_t: Variance of the return at time t

A simple model of serial correlation can be written as the following equation where k is equal to 1:

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \varepsilon_t$$

Where:

ε_t is the error term

H_0 : $\alpha_1=0$ meaning that there is no relation between return today and return yesterday.

In this model it is automatically assumed that the error term ε is homoscedastic which means that the error terms are independent from each other and they are normally distributed with zero mean and constant variance. Hence, normality of the series is required for this test.

The model can be generalized like the following:

$$r_t = \alpha_0 + \sum_{i=1}^{k} \alpha_t r_{t-i} + \varepsilon_t$$

H_0: All $\alpha_i=0$ with the same assumption for the error term.

5.4. Variance Ratio Test

Although traditional random walk tests like serial correlation assumes that error terms are identically distributed (i.i.d.), there is strong evidence in finance literature that financial time series often do not have this prerequisite, it is not so seldom that they possess time-

varying volatilities and they deviate from normality. This feature of the traditional random walk tests decreases their precision on forecasting the correlation between returns in time series. Therefore new tests which are sensitive to correlated price changes, such as variance ratio test, has been introduced to the finance literature by many scholars like Fama and French (1987), Campbell and Mankiw (1987), Cochrane 1987) and French and Roll (1986).

In this analysis the variance ratio test developed by Lo and MacKinlay (1988) will be used. The variance ratio test of Lo and MacKinlay (1988) examines the residuals in the series, under the assumptions of both homoscedastic and heteroskedastic increments.

5.4.1. Homoscedastic Increments

The null hypothesis starts with the assumption that the error terms ε_t are independently and identically distributed with zero mean and variance σ_0^2.

$$H: \ \varepsilon_t \text{ i.i.d. } N(0, \sigma_0^2)$$

One important property of random walk Xt is that the variance of its increments is linear in the observation interval. That is the variance of $X_t - X_{t-2}$ is twice the variance of $X_t - X_{t-1}$ (Lo & MacKinlay, Stock Market Prices Do Not Follow Random Walks: Evidence From A Simple Specification Test, 1988). More generally, if time series follows a random walk process, the variance of q period returns should be q times as large as the one-period returns:

$$VR(q) = Var [r_t(q)] / Var[r_t] = q$$

Lo and MacKinlay (1988) derive asymptotic standard normal test statistic for their variance ratio. As a result, the null hypothesis of no autocorrelation coefficient can be tested by computing the standardized statistics. Under the null hypothesis of homoscedastic increments, the standard normal test statistic $Z(q)$ is defined as:

$$Z(q) = [VR(q) - 1] / \Phi(q)^{1/2} \sim N(0,1)$$

Where:

$$\Phi(q) = 2(2q-1) /3q(nq)$$

Where nq is the number of observations and $\Phi(q)$ is the asymptotic variance of the variance ratio under the assumption of homoscedasticity.

5.4.2. Heteroscedastic Increments

The rejection of random walk under homoscedasticity may result from either heteroscedasticity and/or autocorrelation existence in series (Worthington & Higgs, 2004) and the rejection of the random walk hypothesis because of heteroscedasticity would not be of much interest. Therefore Lo and MacKinlay derived a version of the variance ratio test of the random walk hypothesis which is robust to changing variances. As long as the increments are uncorrelated, even in the presence of heteroscedasticity the variance ratio must still approach unity as the number of observations increase, for the variance of the sum of the uncorrelated increments must still equal the sum of the variances (Lo & MacKinlay, Stock Market Prices Do Not Follow Random Walks: Evidence From A Simple Specification Test, 1988). The heteroscedasticity-consistent standard normal test statistic, Z*(q) is then defined as:

$$Z^*(q) = [VR(q) - 1] / \Phi^*(q)^{1/2} \quad \sim N(0,1)$$

Where:

$$\Phi^*(q) = 4\sum_{k=1}^{q-1}[1 - k/q]^{1/2}\,\delta(k)$$

And

$$\delta(k) = nq \sum_{j=k+1}^{nq}(p_j - p_{j-1} - \mu)^2 (p_{j-k} - p_{j-k-1} - \mu)^2 / [\sum_{j=1}^{nq}(p_j - p_{j-1} - \mu)^2]^2$$

Where $\delta(k)$ is the heteroscedasticity-consistent estimator, p_j is the price of the security at time t and $\hat{\mu}$ is the average return. Under the null hypothesis, the value of the variance ratio is one. If the heteroscedastic random walk is rejected, then there is evidence of autocorrelation presences in series (Worthington & Higgs, 2004). Thus it is claimed that returns are predictable if variance ratio is greater than one. Since it is common to use the lags of 2, 4, 8, 12 and 16 days, those 5 lags are also applied in this study which give us the chance to compare the results of the variance ratio test with the other studies in the same literature.

6. EMPIRICAL RESULTS

6.1. Descriptive Statistics

A summary of the descriptive statistics of the return of the Turkish Stock Market ISE100 index for the whole sample period between 1988 and 2012 are presented in the Table 2. As it can be seen from the Table 2, the returns of ISE100 index have a positive mean and the highest value that the return series has is 0.10309 where the lowest value is -0.12789. The standard deviation is much lower in this thesis compared to the standard deviation found in the study by (Kilic S.) which also uses ISE100 index returns for the period between 1987 and 2004. It shows that after 2004 the return values have been much closer to the mean compared to the period until 2004. Since standard deviation is an indicator for volatility, it would not be wrong to claim that the time period between 2004 and 2012 has been less volatile.

Skewness and excess kurtosis at the Table 2 shows that the returns are not normally distributed. The returns have negative skewness, in order words the series is skewed to the left which means that bulk of the values is to the left of the mean, including the median. Negative skewness also indicates a high probability of large decreases in the return values than large increases. The positive excess kurtosis indicates a leptokurtic distribution which means that more of the variance is a result of infrequent extreme deviations. Jarque- Bera test and its p value used to test the null hypothesis that the return series of the ISE100 stock index is normally distributed. However, since the p value is smaller than the critical value, we reject the hypothesis that the return series is normally distributed.

Table 6 Descriptive Statistics for the Daily Returns of ISE100 index. N represents the total number of observations and the estimation starts from 1988 and ends in 2012.

The Full Sample	N	Mean	Maximum	Minimum	Standard Deviation
Return Series	10341	0.00087842	0.10309	-0.12789	0.020621
	Skewness	**Excess Kurtosis**	**Jarque-Bera**		**P value**
Return Series	-0.17721	4,49520	8760.7		<0.001

6.2. Serial Correlation

Before applying the serial correlation test, autocorrelation function of the returns of ISE100 index for the full sample has been checked. It shows in the Figure 6 that the returns are related to each other with various lags either positively or negatively. It also includes 20th lag, since the figure shows that between the present value of the return series and its 20th lag there is a positive correlation. That is why I chose to apply the serial correlation test with 20 lags to both the full sample and the 4 sub-periods. Another reason to have 20 lags is that it takes some time until new information gets reflected on the prices and since I used daily data it is logical to have a longer period to lag, in other words historical information embedded in longer period of lags would be as influential in determining the future price as that of information embedded in shorter lag lengths. The results of the serial correlation test are given in the Table 3.

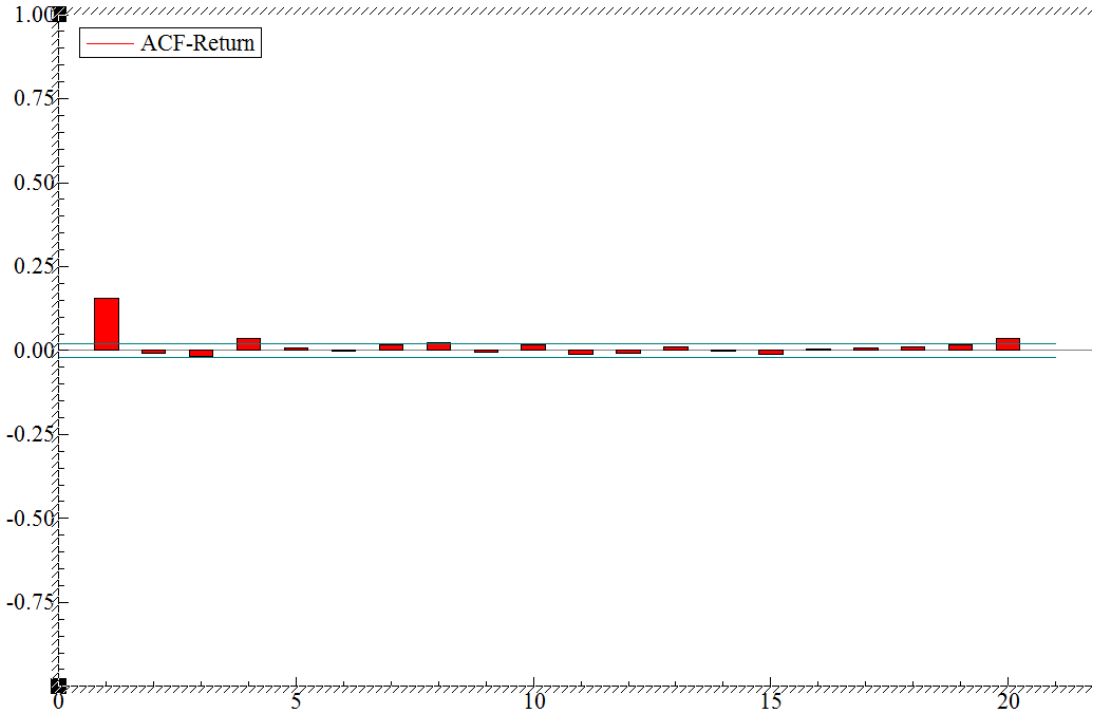

Figure 12 ACF Autocorrelation Function of the Return of ISE100 index for the full sample

Table 7 The results of the serial correlation on the returns for the whole sample and the 4 sub-periods. In this table α represents the coefficients of the various lags of the returns and *, ** and * indicate statistical significance at the 1%, 5% and 10% levels.**

	Istanbul Stock Exchange ISE100 Index				
	1988-2012	**1988-1993**	**1994-2000**	**2001-2008**	**2009-2012**
α1	0,161379***	0,238341***	0,171158***	0,075050***	0,0690***
α2	-0,027752***	-0,0901016***	-0,00339723	-0,00918353	-0,045728*
α3	-0,0205249**	0,0101044	-0,05853***	0,0145456	0,0038789
α4	0,0424091***	0,0294589	0,0552851***	0,0247894	0,0228078
α5	-0,00422644	0,0333431	-0,0165448	-0,029354*	-0,0212327
α6	-0,0040177	-0,014031	0,0155333	-0,05088***	-0,0022027
α7	0,0171033*	0,0229964	0,0107797	0,0255232	0,0184652
α8	0,0211926**	0,0100153	0,037846**	0,0167684	-0,0278866
α9	-0,0177357*	-0,00783048	-0,048266***	0,0042029	0,0357633
α10	0,023542**	0,0768406***	0,00107206	-0,0065788	0,0142686
α11	-0,0172302*	0,0425877	-0,055286***	-0,0260802	-0,0467708
α12	-0,00971287	-0,024263	-0,00159359	-0,0190002	-0,0232829
α13	0,0148132	0,0308917	0,0251266	5.88983e	-0,0078190
α14	-0,00743761	0,0100316	-0,0171658	-0,0256996	-0,0131306
α15	-0,0116659	0,0206451	-0,0253127	-0,0225217	-0,0315557
α16	0,00661329	-0,0384939	0,0106441	0,0342634**	0,0193025
α17	0,00447661	-0,00169194	0,0200122	0,0103853	-0,0104444
α18	0,0076178	-0,000870677	-0,0010234	0,0196994	0,0224594
α19	0,0134027	0,00815269	0,0161506	0,0208815	-0,0168612
α20	0,029796***	0,0179172	0,013850	0,0472327***	0,0270901
Constant	0,0006674***	0,00144947*	0,001012**	0,000231907	0,000504*

It can be seen from the Table 3 that the serial correlation test for all of the periods suggests some significant correlation between various lags. The analysis on the full sample shows that the return today is significantly correlated with the return yesterday and before, to be precise it is lags of 1, 2, 3, 4, 20 days at 1% significance level, lags of 8 and 10 days at 5% significance level and finally lags of 7, 9 and 11 days at 10% significance level. Constant in the regression is also significant at 1% significance level. Thus the null hypothesis that the returns are not correlated with each other and that all α values are equal to zero can be rejected. The results indicate that it is possible to use old prices to earn abnormal profits today at the stock market by analyzing historic return series. As a result of the serial correlation test for the full sample, it can be claimed that Istanbul Stock Exchange does not follow random walk and/or it is not weak-form efficient. This result is in line with the result found by Balaban (1995) which concludes that Turkish stock market is neither weak-form nor semi-strong form efficient for the periods between 1988 and 1994. Korkmaz & Akman (2010) also concluded that the Turkish stock market is not weak-form efficient for the time period between 2003 and 2009.

The analysis on the first sub-period, which is between the years 1988-1993, shows that the lags of 1, 2 and 10 days are significant at 1% significance level. In other words, this result means that the null hypothesis can be rejected for the first sub-period. According to these results the Turkish stock market is not weak-form efficient from 1988 to 1993 and it is possible to gain abnormal profits from the stock market by making analyses on the historic stock prices and returns.

The second sub-period between the years of 1994 and 2000 also shows some significant correlations between the return today and lagged returns at 1, 3, 4, 8, 9 and 11. Thus the null hypothesis that the Turkish stock market is weak-form efficient and all α values are equal to zero can be rejected at 1% and 5% significance levels.

The third sub-period is also not different from the previous ones in terms of inefficiency. It has significant coefficients for the lagged period at 1, 5, 6, 16 and 20 days. Therefore the null hypothesis can again be rejected for this sub-period. The conclusion reached here is not very surprising since between 2001 and 2008 Turkish economy has been experiencing many financial crises which may have an effect on the efficiency at the stock market.

The last sub-period starting from 2009 and ending in 2012 has one significant coefficient on the first lag. It shows that it is possible to analyze yesterday's price and return to make a guess on today's price and return to beat the market. However, it is also possible to compare all the sub-periods with each other in terms the level of inefficiency. In the serial correlation test for the full sample, the null hypothesis has been rejected for 9 lagged return coefficients, where it is 3 for the first sub-period, 6 for the second sub-period, 5 for the third sub-period and 2 for the last sub-period. The number coefficients rejected at the 1% significance level also varies from sample to sample, it is 4 coefficient for the full sample while it is 3, 5, 3 and 1 for the first, second, third and the fourth sub-periods respectively. It shows that even though the Turkish stock market is not weak-form efficient, it can still be claimed that inefficiency in different sub-periods are different from each other, therefore it would not be wrong to say that the less inefficient period is the period between 2009 and 2012 which corresponds to the recovery period in the Turkish economy in general and according to the Figure 4, it is the period for the Turkish stock prices to rise and fluctuate less compared to the previous periods.

6.3. Variance Ratio Test

The results of the variance ratio test on the return series of the ISE100 index for the full sample period and the four sub-periods are reported in Table 4 where VR(q) represents the variance ratio of the returns, and Z(q) and Z*(q) represent the statistics of the variance ratio under the assumption of homoscedasticity and heteroscedasticity, respectively. The variance ratio test is conducted for various lags of q (i.e., 2, 4, 8, 12 and 16 days) for each time period.

Table 8 The table presents results of the variance ratio tests for returns on the ISE100 index for the Turkish stock market for the full sample period and the four sub-periods. Estimates of variance ratios, VR(q) , the statistics Z(q) and Z*(q) for q=2, 4, 8, 12 and 16 days aggregation intervals periods are reported below. N denotes the total number of observations while q is the interval of the observations, VR(q) is the estimated variance ratios and Z(q) and Z*(q) are the asymptotic test statistics under the assumption of homoscedasticity and heteroscedasticity, respectively.

			Holding period of days (q)				
			2	4	8	12	16
Time Series	**N**						
Full Sample							
	10341	**VR(q)**	1.15607	1.21997	1.28987	1.33867	1.35890
		Z(q)	9.69366***	7.25816***	6.123 ***	5.73381***	5.25349***
		Z(q)*	2.22225***	2.1864***	2.13443***	2.1034***	2.08945**
1988-1993							
	1499	**VR(q)**	1.22162	1.29426	1.43230	1.56536	1.70235
		Z(q)	6.46449***	4.66801***	4.42133***	4.64411***	4.99031***
		Z(q)*	1.46724	1.43754	1.37453	1.31305	1.26549
1994-2000							
	3204	**VR(q)**	1.16544	1.24019	1.29399	1.30010	1.27196
		Z(q)	6.22801***	4.68081***	3.64221***	2.97337***	2.31961***
		Z(q)*	1.25023	1.23663	1.20967	1.21482	1.22838
2001-2008							
	3988	**VR(q)**	1.07818	1.12162	1.12988	1.12474	1.08121
		Z(q)	3.12160***	2.62748***	1.80321*	1.39028	0.78603
		Z(q)*	1.20266	1.18081	1.18816	1.19518	1.2166

2009-2012							
	1648	**VR(q)**	1.06385	1.05638	1.05922	1.06792	1.03744
		Z(q)	2.12428***	0.96240	0.64342	0.59360	0.28387
		Z(q)*	1.54369	1.54036	1.54552	1.54546	1.56952

The null hypothesis of the variance ratio test is that return series of the Turkish stock market follows a random walk. If time series follows a random walk process, the variance of q period returns should be q times as large as the one-period returns. Therefore, we would expect VR(q) to be 1 if the return series are following a random walk and if there are significant values Z(q) and Z*(q) then we reject the null hypothesis and state that the return series are not following a random walk, thus are not weak-form efficient.

The variance ratio test of Lo and MacKinlay (1988) has been applied to both the full sample and the four sub-periods we used for the serial correlation test. For the full sample, it can be seen from the Table 4 that the null hypothesis is rejected both under homoscedasticity and heteroscedasticity for all of the lags which means that the Turkish stock market is not following a random walk and is not weak-form efficient. These findings for the full sample are similar to those found by Buyuksalvarci and Abdioglu (2011). This non-random walk pattern based on variance ratio test is also consistent with the findings of serial correlation.

The first sub-period including years between 1988 and 1993 also have significant Z(q) values which leads to the rejection of the null hypothesis under the homoscedastic increments assumption. However, rejection of the null hypothesis under homoscedasticity could result from heteroscedasticity and/or autocorrelation in the return series. After the heteroscedasticity assumption is considered and the test is calculated accordingly then we have Z*(q) values which are not significant, therefore we cannot reject the null hypothesis under the heteroscedastic increments assumption. One reason for the rejection of the null hypothesis under the homoscedasticity assumption can be because of heteroscedasticity in the return series as well as it can be due to positive autocorrelation since the variance ratios of the returns are greater than one for all q values and they are increasing with q.

We have the same situation for the second sub-period which is between 1994 and 2000. There are significant Z(q)'s for all the lags for that period indicating a rejection of the random walk while Z*(q) values for all the lags are non-significant which does not allow us to reject the null hypothesis. This indicates that the rejection of the null hypothesis of a homoscedasticity random walk could be the result, at least in part, of heteroscedasticity in the returns, and cannot be assigned exclusively to the autocorrelation in returns.

For the third sub-period, for the years between 2001 and 2008, Z(q) has a significant value for the first three lags while it is not significant for the lags of 12 and 16 days while all of the Z*(q) values are non-significant for all the five lags. Since the variance ratio of the returns do not seem to be increasing with q, it is hard to claim that the rejection of the null hypothesis under the homoscedasticity assumption for the lags of 2, 4 and 8 days are because of autocorrelation. It seems like most of the explanation about the rejection comes from the heteroscedasticity in returns. Nevertheless, having non-significant Z(q) values for the lags of 12 and 16 indicates that the Turkish stock market has been less inefficient in the third sub-period compared to the previous ones.

In the last sub-period we only have one significant Z(q) value at 1% significance level for the lag of 2 days. All the other Z(q) and Z*(q) values are non-significant indicating that this period is even less inefficient than the third and all other periods in the analysis. We had a very similar result from the serial correlation, showing that all the periods were weak-form inefficient but the less inefficient one is the last period between 2009 and 2012. These results show that Turkish stock market has been moving towards efficiency although it cannot be claimed that the return series of the ISE100 index of the Turkish stock market is weak-form efficient.

7. CONCLUSIONS

The weak-form market efficiency suggests that historic stock prices have no predictive content to forecast future stock prices. Following the theory, there has been a large body of empirical studies on both developed and developing economies. However, the interest to the developing countries has been increasing recently since it is believed that most of the less developed markets suffer from the problem of thin trading. In addition, in smaller markets, it is easier for big dealers to control the market. So, it is generally believed that the emerging markets are less efficient. Therefore, researchers have focused on whether these markets are informationally efficient or not, in other words they may be possibilities of having systematic paths in the stock prices which can lead to abnormal profits in developing economies, if analyzed well. The other reason for this growing interest is that even though there has been a vast amount of empirical research concerning the validity of the random walk hypothesis or weak-form market efficiency hypothesis with respect to stock markets in both developed and developing countries, empirical research on testing the random walk hypothesis has produced mixed results.

In the case for the Turkish stock market, the previous research gives puzzling results and most of them analyses old data. However, there have been many improvements in the Turkish economy and the stock market since the 90s. That is why I wanted to examine the Turkish stock market with recent data ranging from 04.01.1988 to 11.04.2012 and see if the market is efficient in the weak sense. The index used in this master thesis is ISE100 index which is used as the basic index for Istanbul Stock Exchange stock market. It consists of 100 stocks which are selected among the stocks of companies listed on the National Market and the stocks of real estate investment trusts and venture capital investment trusts listed on the Corporate Products Market. ISE 100 index automatically covers some other indices such as ISE 30 and ISE 50 stocks. For the mentioned time period of ISE100 index, I used daily observations of the closing prices as my main indicators. Since there is more embedded information in daily observations compared with weekly or monthly observations. Another objective of this thesis is to decide if the Turkish stock market has been moving towards efficiency, so the full sample is divided into 4 sub-periods according to the changes in the Turkish economy and in ISE100 index prices and returns.

In order to test the weak-form efficiency of the Turkish stock market, two empirical tests, namely serial correlation test and variance ratio test has been applied to both the full

sample and the 4 sub-period which range from 1988-1993, 1994-2000, 2001-2008 and 2009-2012. The empirical results of this study indicate that stock returns in the Turkish stock market do not behave in a manner consistent with the weak-form of efficient market hypothesis. However both the serial correlation and variance ratio tests show that the inefficiency level in the last sub-period is lower compared to the previous sub-periods and the full sample period. This means that the Turkish stock market has been moving towards efficiency even though it still cannot be classified as a weak-form efficient market according the empirical tests applied on the data set in this study.

The findings of this study is more or less in line with the findings of Muslumov, Aras and Kurtulus (2003) which examines the Turkish stock market whether it has been evolving towards efficincy in the period between 1990 and 2002. They conclude that although the empirical analysis on the full sample suggests that the market is not weak-form efficient, it gains some features of efficiency in the last sub-periods. The study by Buyuksalvarci and Abdioglu (2011) also draws a similar conclusion for the Turkish stock market for the years between 1987 and 2011 that the market is not weak-form efficient.

This master thesis is only limited to one index at the Istanbul Stock Exchange, therefore there is room for further research which can be constructed to investigate whether the Turkish stock market is weak-form efficient by using different indices which focus on certain sectors so that the results can be analyzed by checking some sector specific properties. Alternatively, it can be interesting to examine the possible profitable investment strategies to decide if they are applicable in a world which has transaction costs.

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