DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
ECONOMICS PROGRAM
MASTER’S THESIS

THE IMPACTS OF VOLUME ON VOLATILITY: EVIDENCE FROM THE TURKISH DERIVATIVE MARKET

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İZMİR - 2014

MASTER THESIS/PROJECT
APPROVAL PAGE

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Defence Date	: 17.03.2014
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Majority of votes ( )

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DECLARATION

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ABSTRACT

Master's Thesis

The Impacts of Volume on Volatility: Evidence from the Turkish Derivative Market

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The relation between trading volume of derivative markets and stock market return volatility is one of the most important research fields in financial literature. High fluctuating markets may exhibit different characteristics from the relatively stable stock market. The financial crisis generates a practical case to measure the variation of return volatility in high fluctuating stock markets.

This study sheds a light to the relation between the Turkish derivative market trading volume and stock market return volatility during the crisis period, pre-crisis and compares the movements of the return volatility before and throughout the crisis period and hence different periods.

The sample period is divided into two sub-periods: pre-crisis period and the post-crisis (the cyclical recovery period). The EGARCH model is used to analyze volatility in the market. As results of the analysis, the existence of an asymmetric effect of return volatility in Turkey markets captured. According to the theory of asymmetric volatility, negative news -negative shocks have greater impacts than positive news-positive shocks on the volatility. The analysis on Turkish market also shows the same pattern with theory.

The results in analyzing the impacts of derivative markets trading volume on spot market return volatility in the Turkey markets generally can be listed as follows:

1) There exists asymmetric volatility (leverage effect) in the Turkish derivative markets.

2) Negative news - negative shocks is more effective than positive news-positive shocks on return volatility. The leverage effect is captured in two sub-periods.

3) Three alternative assumptions on error term (i.e., the GED, Student - *t* distribution, and normal distribution) are used in the estimation of EGARCH model. Estimation results from three specifications produce very similar results.

4) Financial markets behave in line with expectations. The Turkish markets are defined in the category of emerging markets. Emerging markets expected to be more volatile under situation negative shocks. The Turkish stock markets behave in line with emerging markets. Hence, negative shocks have greater impact on the volatility of the stock market return.

5) Investors tend to hedge to escape from risks and crises in the spot markets. Derivative markets trading volume tend to increase for the purpose of hedging during times of crisis. Despite the rapid increase of trading volume during crisis period the impact on return volatility in the spot market show similar features to the impacts of regular period.

Keywords: Derivatives Markets, Trading Volume, Return Volatility, Leverage Effect (Asymmetric Volatility), EGARCH, Financial Crisis

ÖZET

Yüksek Lisans Tezi

Hacmin Volatilite Üzerindeki Etkileri: Türkiye Türev Piyasasından Kanıtlar

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Türev piyasaların işlem hacmi ve hisse senedi piyasası getiri volatilitesi arasındaki ilişki, finans literatüründe en önemli araştırma alanlarından birisidir. Yüksek dalgalanma gösteren piyasalar görece istikrarlı borsalara göre daha farklı karakteristikler gösterebilir. Finansal krizler, yüksek dalgalanma gösteren hisse senedi piyasalarında volatilite değişimini ölçmek için pratik bir durum oluştururlar.

Bu çalışma kriz döneminde, kriz öncesi döneminde Türk türev piyasası işlem hacmi ve borsa getiri oynaklığı arasındaki ilişkiye ışık tutmakta, kriz öncesinde-kriz süresince ve dolayısıyla farklı dönemlerde volatilite hareketlerini karşılaştırmaktadır.

Örneklem dönemi iki alt periyoda bölünmüştür: Kriz öncesi dönemi ve kriz sonrası (konjonktürel toparlanma dönemi). Piyasadaki volatilitenin analizi için EGARCH modeli kullanıldı. Analizlerin sonucuna göre, Türkiye'deki piyasalarda asimetrik volatilite (kaldıraç etkisi) etkisinin varlığı tespit edildi. Asimetrik volatilite teorisine göre, olumsuz haberlerin - negatif şokların volatilite üzerindeki etkisi olumlu haberlere - pozitif şoklara oranla daha büyük etkileri vardır. Türk piyasasındaki analizler teori ile aynı özellikleri göstermektedir.

Türkiye piyasasındaki analiz sonuçlarına göre türev piyasalardaki işlem hacminin spot piyasa getiri oynaklığı(volatilitesi) üzerindeki etkileri genel olarak aşağıdaki gibi listelenebilir.

1) **Türkiye Türev Piyasalarında asimetrik volatilite etkisi (kaldıraç etkisi) vardır.**
2) **Getiri Volatilitesi üzerinde negatif haberler-negtif şoklar, pozitif haberler-pozitif şoklara gore daha fazla etkilidir. İki periyotta da kaldıraç etkisi tespit edilmiştir.**
3) **Hata terimi üzerindeki üç varsayım alternatifine gore (Ör: Genelleştirilmiş Hata Dağılımı, Studen-T Dağılımı ve Normal Dağılım) EGARCH modelinin tahmin edilmesinde kullanılmıştır. Tahmin sonuçları üç özelliğe göre de benzer sonuçlar üretmiştir.**
4) **Finansal piyasalar beklentiler doğrultusunda davranış sergiler. Türkiye piyasaları gelişmekte olan piyasa kategorisinde değerlendirilmektedir. Negatif şokların olduğu durumlarda gelişmekte olan piyasalar daha fazla oynaklık gösterir. Türkiye piyasaları da gelişmekte olan piyasaların davranışlarına uygun bir şekilde davranmaktadır. Bu yüzden hisse senedi piyasa getirisi oynaklığı üzerinde negative şoklar pozitif şoklara oranla daha fazla etkiye sahiptir.**
5) **Hisse senedi piyasalarında yatırımcılar risklerden ve krizlerden korunmak için hedge yapma eğilimi gösterirler. Kriz dönemlerinde hedgingden dolayı türev piyasalardaki işlem hacmi artma eğilimi gösterir. Kriz dönemlerindeki işlem hacminin hızla armasına rağmen spot piyasalardaki getiri volatlitesinin etkisi normal dönemlerle benzer özellikler göstermektedir.**

Anahtar Kelimeler: Türev Piyasalar, İşlem Hacmi, Getiri Volatilitesi, Kaldıraç Etkisi(Asimetrik Volatilite), EGARCH, Finansal Krizler

THE IMPACTS OF TRADING VOLUME ON VOLATILITY: EVIDENCE FROM TURKISH DERIVATIVE MARKET

CONTENTS

ABBREVIATIONS

AR	Autoregressive
ARCH	Autoregressive Conditional Heteroscedasticity
ARMA	Autoregressive Moving Average
BIS	Bank For International Settlements
BIST	Borsa Istanbul
BOVESPA	Brasil Stock Exchange Market
CBM	Chicago Board Market
CBOE	Chicago Board of Exchange
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedasticity
FTSE	Financia Times Stock Exchange
FXF	Foreign Exchange Futures
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
ISE(BIST)	Istanbul Stock Exchange(Borsa Istanbul after 30 November 2012)
MA	Moving Average
MDH	Mixture Distribution Hypothesis
NYSE	New York Stock Exchange
OEX	Options with American Style Exercise
OTC	Over The Counters
QMLE	Quasi Maximum Likelihood Estimate
SIAH	Sequential Information Arrival Hypothesis
TURKDEX	Turkish Derivative Exhange(BIST-VIOP now)
UK	United Kingdom
US	United States
VIX	S&P Volatility Index
VIOP	Futures and Option Market(Vadeli İşlem ve Opsiyon Piyasası)
XEO	Options with European style Exercise
XU30-BIST30	The first 30 company in ISE(BIST)

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INTRODUCTION

The impact of index futures trading on the underlying stock market volatility has been increasingly studied in the related literature in last decade. Particularly, this issue has attracted interest of academics, regulators and investors. Previous studies devoted special interest on whether futures markets stabilize or destabilize the underlying markets. In spite of numerous studies in the related literature, there exists considerable controversy over the impact of the index futures market on the spot market volatility. There are mainly two alternative theoretical views among the researchers. The first group of researchers argues that speculative trades in futures markets tend to stabilize or even decrease volatility of the underlying spot market. Hence, they argue that trading in futures market increases market depth, improves efficiency, and decreases spot market volatility. However, the second group of researchers suggests that excessive speculation in futures markets destabilizes and increases volatility of the spot market. This group of researchers argues that futures markets attract uninformed traders because of their high degree of leverage and the activity of those trades increases spot market volatility.

The uncertainty on the impact of futures trading over the underlying spot markets in the related theoretical literature shows that this is basically an empirical issue. However, the empirical literature has also produced mixed results. The previous empirical studies have mostly concentrated on large capitalization equity markets. Hence, the literature pertaining to emerging equity markets is very sparse whereas financial and technological innovation, deregulation and the globalization of financial services make these markets very important for the financial stability of the global system. Examining the impact of futures markets on the underlying spot market could produce valuable information for regulators and investors. Hence, in this thesis, we investigate the Turkish futures market, one of the fastest growing futures market in emerging countries.

The Turkish capital market has undergone a major transformation and structural change in last two decades a result of financial reforms. The main objectives of these reforms were improving market efficiency, enhancing transparency, dismantling of regulatory barriers and free flow of financial capital.

Despite the existence of a stock market for more than two decades, stock index futures trading started on February 4, 2005 with the foundation of Turkish Derivatives Exchange (VIOP), one of the fastest growing futures markets in emerging countries (Kasman, *et al*., 2009). The ISE-30 index futures contract has established itself as the market leader in this segment in Turkey. The market share of this index futures contracts has increased from 60% in 2006 to about 90% in 2013. Hence, this significant growth trading volume of index futures contract reveals the interest in this instrument that is shared by a broad cross section of market participants.

The main objective of this thesis provide further evidence regarding the impact of derivatives trading in spot market and possible spillage of information in returns and volatilities between the futures and spot markets in Turkey. Since the introduction of stock index futures in Turkey is a recent phenomenon, there has hardly been any attempt to examine the impact of their introduction on the underlying stock market volatility. A few papers investigated the Turkish derivatives market. Tokat and Tokat (2010) examines the volatility transmission mechanism between the futures and corresponding underlying asset spot markets, focusing on Turkish currency and stock index futures traded on the Turkish Derivatives Exchange. Their main implication is that investors need to account for volatility spillovers and asymmetries among the futures and the spot markets to correctly build hedging strategies. Kasman and Kasman (2008) examine the impact of the introduction of index futures trading on the underlying stock market volatility. Their findings show that the introduction of futures trading reduced the volatility of the ISE-30 index. Finally, Kasman *et al*. (2009) investigate the impact of futures trading volume on spot market volatility in Turkey over the period May 2005 – December 2008. Their results indicate that futures trading volume contributes information to the volatility process of underlying stock index. This study significantly differs from the previous studies on the Turkish derivatives market. In this study, in contrast to Tokat and Tokat (2010) and Kasman and Kasman (2008), we analyze the impact of futures trading volume on the underlying spot market volatility. This study also differs from Kasman *et al*. (2009) in terms of data period and the model used.

The contribution of the thesis to the related literature is threefold: First, this thesis investigates the impact of index futures trading volume on the spot market volatility by taking into account the effect of recent global financial crisis. We divide the sample period into two sub-periods: pre-crisis and post-crisis. By doing this, we aim to investigate behavior of the futures market before and after financial crisis. Because of the lack of in-depth research on the ISE and its possible relation with futures trading on VIOP, the results of this study provide additional insights into the existing literature. Second, we use an asymmetric GARCH model to model volatility. EGARCH, an asymmetric volatility model, produce some important information on leverage effect in the market. Third, findings of this study will provide valuable information for regulators and investors. Any information on the impact of index futures trading volume on the underlying spot market will be beneficial to create a better risk management. Moreover, having information about the effects of futures trading volume on the spot market volatility would help regulators to decide whether further regulations on capital markets are needed.

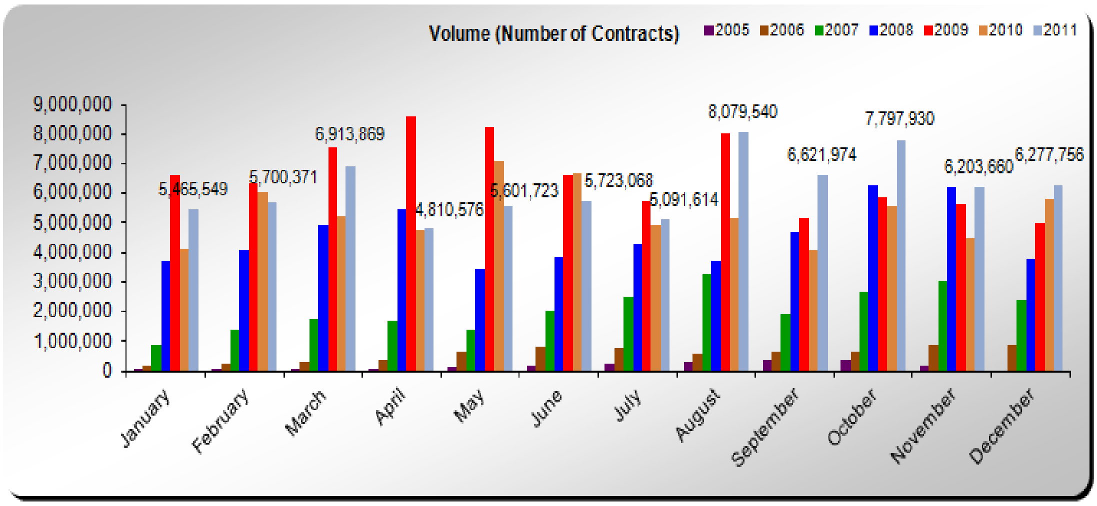
CHAPTER ONE
AN OVERVIEW ON VIOP DERIVATIVE MARKETS

1.1 A BRIEF HISTORY OF THE VIOP

The Turkish Derivatives Exchange (TURKDEX, VIOP from now on) was established in 2003 and formal trading in futures contracts started in 4th of February 2005. Opening bell in market rang with 11 shareholders and 34 members. The VIOP is the only entity authorized by the Capital Market Board (CBM) to produce a derivatives exchange and membership to the VIOP is restricted to financial intermediaries. Currently, it has 100 members. The main objective to establish a derivatives exchange in Turkey, which has one of the most volatile stock markets in emerging economies, was to provide financial instruments to help investors to manage risk effectively against a volatile business environment.

The number of contracts traded in VIOP follows an increasing trend since 2005. The number of contracts in 2011 was 74,287,630. In 2011, the number of contracts traded decreased by 16% in comparison to the trading volume of the year 2010. As can be seen in Figure 1, the number of contracts increased significantly from 2005 to 2009. The main reason behind significant increase in year 2009 can be interpreted as the effect of global financial crisis in 2008 and 2009. Hence, investors tried to hedge themselves in these years.

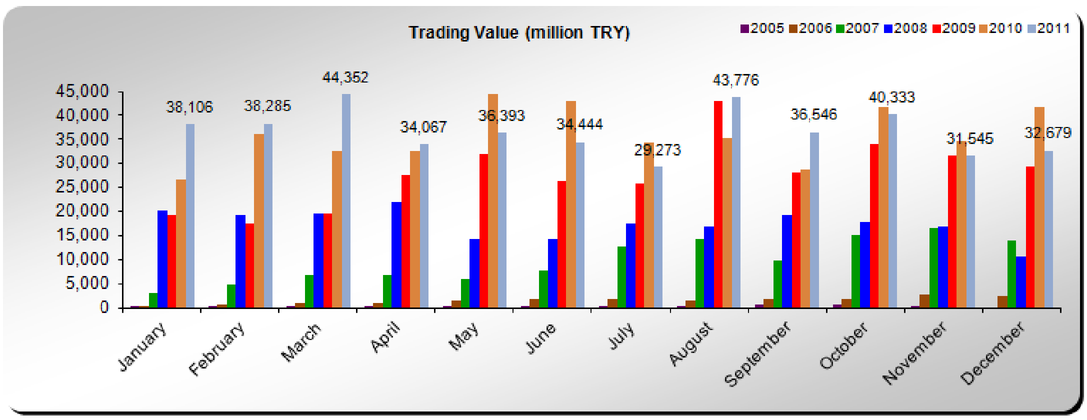
Figure 1: Number of Contracts in VIOP



Source: VIOP, 2012. http://www.turkdex.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339, 30.05.2012.

The trend of annual trading value is shown in Figure 2. Trading Value in 2010 is TRY 439,799,289,264. As shown in the figure, significant increase in trading value is observed between 2005 and 2011.

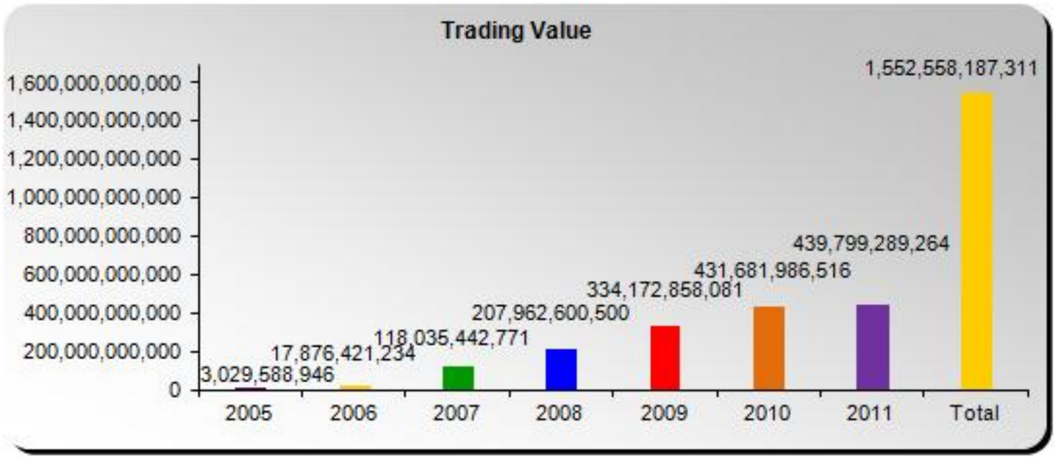
Figure 2: Trading Value in VIOP



Source: VIOP, 2012, http://www.turkdex.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339, 30.05.2012.

As seen in Figure 3, the highest level of trading value has been observed in 2011 since first operation date.

Figure 3: Total Trading Value in VIOP



Source: VIOP, 2012, http://www.turkdex.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339, 30.05.2012.

The VIOP provides risk management tools in terms of stock index, commodity, interest rate and currency futures and options contracts. However, futures contracts have dominated options contracts, which have started recently. As seen in Figure 3, the tracing value was almost TRL 3 billion at the end of 2005 and witnessed a significant increase over the following years, reaching around TRL 440 billion at the end of 2011. Moreover, the total trading value between 2005 and 2011 is around TRL 1.5 trillion. Although negative developments impacted the financial markets in recent years, trading volume of futures contracts have continued to increase during crisis period in VIOP.

The shareholders of the VIOP are listed in Table 1.

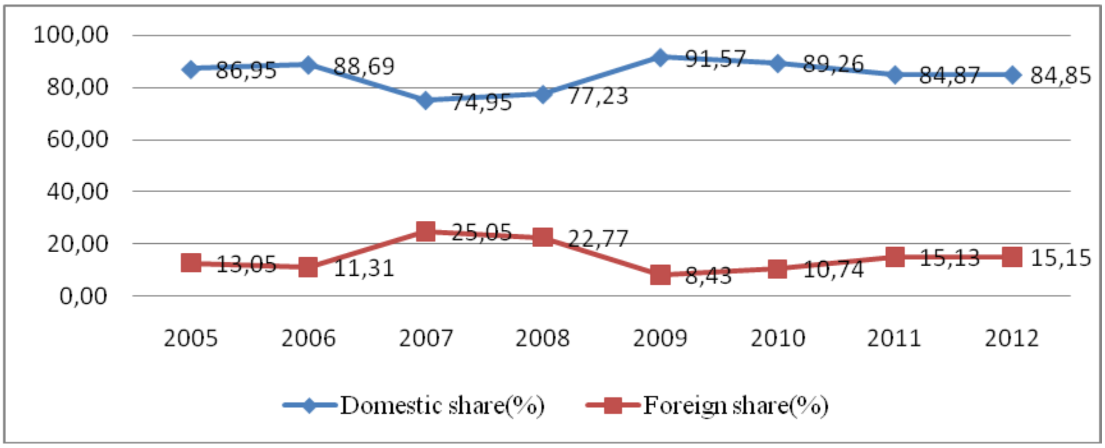
Table 1 : Shareholders of VIOP

Shareholder	Percentage
The Union of Chambers and Commodity Exchanges of Turkey	25%
Istanbul Stock Exchange	18%
Izmir Commodity Exchange	17%
Yapi ve Kredi Bankasi A.S	6%
Akbank T.A.S.	6%
Vakif Investment Securities	6%
Turkiye Garanti Bank A.S.	6%
Is Investment Securities	6%
The Association of Capital Market Intermediary Institutions of Turkey	6%
ISE Settlement and Custody Bank	3%
Industrial Development Bank of Turkey	1%

Source: VIOP, 2012, http://www.turkdex.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339, 30.05.2012

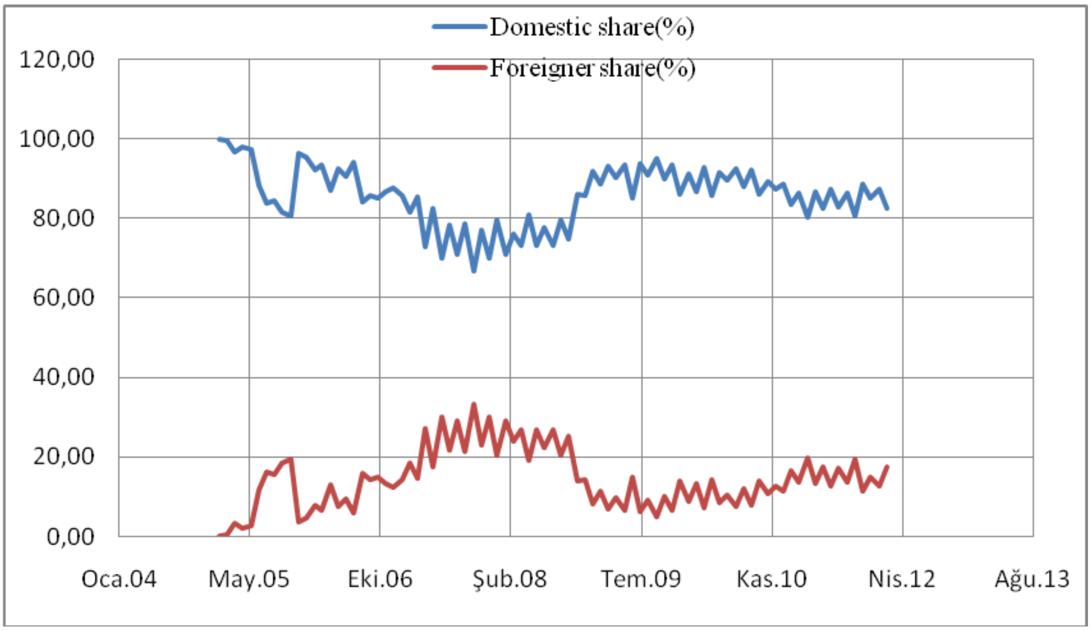
The participants in VIOP are both foreign and domestic hedgers, arbitrageurs and speculators. The accelerated growth in the futures trading volume, as shown before, has been attracting the foreign investors. As seen in Figure 4 and 5, the foreign whose participation fluctuated between 2005 and 2011. The figures show monthly and annually percentage changes in number of contracts (volume) and trading value.

Figure 4: The Share Of Foreign And Domestic Investors In The VIOP (Anually)



Source: VIOP, 2012, http://www.VIOP.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339

Figure 5: The Share of Foreign And Domestic Investors In The VIOP (Monthly)



Source: VIOP, 2012 , http://www.VIOP.org.tr/VOBPortalEng/detailsPage.aspx?tabid=339

The VIOP currently lists futures contracts on equity indices, foreign currencies, debt and commodities. These all products are available for trading electronically on the VIOP trading platform. The VIOP planning to launch new futures and options contracts the future. These products are:

1. Equity Index Futures
   - ISE-30
   - ISE-100
   - ISE 30-100 Index Spread
2. Commodities
   - Wheat Futures
   - Cotton Futures
   - Gold Futures
   - US Dollar/Ounce Gold Futures
   - Live Cattle
3. Interest Rate Futures
   - T-Benchmark Government Bond
4. Currency Futures (cash-settled and physically-delivered)
   - USD/Turkish Lira
   - EURO/Turkish Lira
   - EURO/US Dollar Cross Currency
5. Energy
   - Base Load Electricity Futures

All financial and commodity contracts listed above are cash settled. The most liquid and successful financial instruments in the Turkish derivatives market are “VIOP -ISE 30 Equity Futures” and “Dollar/TRY Futures”.

The Capital Market Board Law no. 6362 went into force after being published in the Official Gazette dated December 30, 2012. Borsa Istanbul (BIST) brings together all the exchanges operating in the Turkish capital markets under a single roof. The VIOP and Borsa Istanbul Futures & Options Market trading platforms have merged since August 5, 2013. Following the merger, all future and option contracts in Turkey will be traded on a single platform under the roof of the Borsa Istanbul Futures & Options Market.

The merger process of the Turkish Derivatives Exchange (TURKDEX) operating in Izmir and Borsa Istanbul Futures & Options Market platforms has been completed since August 5, 2013, and the name of TURKDEX became VIOP.

CHAPTER TWO
A REVIEW OF BACKGROUND STUDIES

2.1 LITERATURE REVIEW: THEORETICAL EXPLANATIONS OF THE RETURN-VOLUME-VOLATILITY RELATIONS

After the futures trading has been incepted in all main stock exchanges, the economic and financial literature intensified the debate on the economic and social impact of futures and options trading. Although many studies have attempted to understand whether futures markets stabilize or destabilize spot markets, the previous findings were not in agreement, however, more recent studies seem to present some common results indicating similar conclusions. The uncertain nature and their relationship between price volatility and trading volume in financial market has led many researchers, academicians, policy makers and investors to examine if there is an asymmetric relationship between these two variables in various contexts by employing a wide range of analytical techniques.

The early literature is well represented by Ragalski (1978:270), Figlewski and Cornell (1981:307) who studied the basic relationship between the variables. The linear and non-linear causality between the stock prices and trading volume has also received a substantial amount of attention in the literature (Campbell et.al, 1993:908; Hiemstra and Jones 1994:1645). This investigation has also been extended to bond and futures markets Clark (1973), Hanna (1978), Grammatikos and Saunders (1986) and the examination of cross-country spillovers between trading volume and stock returns (Lee and Rui, 2002:55).

Granger and Morgenstern (1963) examine the dynamic relation between stock market returns, trading volumes and volatilities in selected Asia-Pacific stock market. Previous empirical research has focused only on positive contemporaneous relationship between asset price volatility and trading volume but they also study to shed a light to the sign and size of new information arrival and the effects on trading. The underlying argument for price-volume relationship relies on the rate of information arrival in the financial market. In general, two famous competing hypotheses was put forward in explaining these phenomena are (1) to investigate the casual relationship between stock returns and trading volume and (2) the sign and size of new information shocks is conditional and similarly affects the trading volume. Many studies reported a contemporaneous correlation between stock returns and trading volume. But the casual relationship between two variables is still remains like muddy a water. (Granger and Morgenstern, 1963:4)

There have been a number of theoretical studies investigating the relationship between trading volume and return volatility. Among them, the mixture of distribution hypothesis (MDH) suggested by Clark (1973:135) plays a prominent role in the empirical finance literature. Further empirical studies by Epps and Epps (1976) and Tauchen and Pitts (1983:487) confirm the predictions of this hypothesis. According to the MDH, returns and trading volume are driven by the same underlying latent news arrival, or information flow, variable so that the arrival of unexpected ‘good news’ results in price increase, whereas the arrival of ‘bad news’ results in a price decrease.

Karpoff (1987:112) cites in his comprehensive survey on the return and volume relationship in both spot and future markets was positively correlated.

Since the introduction of the S&P 500 index futures contracts, there has been a vast amount of literature examining the effect of stock index futures on its underlying spot market with mixed evidence. Harris (1989), Damodaran (1990), Lockwood and Linn (1990), Schwert (1990) demonstrated a positive relation between futures market trading and variances of the S&P 500 index stock returns, indicating that volatility of the S&P 500 stock index increased after the S&P 500 index futures trading began, supporting the destabilization theory. In contrast, Santoni (1987) and Brown-Hruska and Kuserk (1995) revealed an inverse relation between the S&P 500 index futures trading volume and volatility of the S&P 500 market index, suggesting that an increase in futures trading activities leads to a reduction in spot market volatility, confirming the stabilization theory.

Still, Edwards (1988a, 1988b), Grossman (1988), Conrad (1989), Smith (1989), Darrat and Rahman (1995), Kumar *et al*. (1995), Pericli and Koutmous (1997) and Board *et al*. (2001) analyzed the impact of introduction of futures market on the volatility of spot market and reported that the existence of stock index futures market did not affect the S&P 500 spot price volatility. Bessembinder and Seguin

(1992) provided some reconciling evidence that unexpected futures trading were positively related with spot market volatility, but the relationship between spot market volatility and expected trading activity of the S&P 500 index futures was negative.

In the early years most research were applied on data from the US markets and the evidence of empirical investigations were ambiguous, but over time, several other studies enlarged this scope beyond the US market, especially for developed markets. Freris (1990) argued that the introduction of stock index futures trading in Hong Kong had no measurable effect on the stock price volatility, partly because of no concrete and quantifiable evidence of program trading or portfolio insurance taking place in Hong Kong. Hogson and Nicholls (1991) investigated the Australian All Ordinaries Index for the six year period surrounding futures introduction in 1983 and concluded that futures introduction had no impact on stock market volatility. In a multi-country study on futures introduction, Lee and Ohk (1992), who examined the spot market volatility in Australia, Hong Kong, Japan, UK and USA before and after the start of futures trading, concluded that volatility in the underlying stock market increases significantly with the exception of the Australian and the Hong Kong stock markets after the introduction of stock index futures, thereby confirming the results of Freris (1990) and Hogson and Nicholls (1991).

During the last decades a number of interesting studies have sought to explain the empirical relationship between trading volume and stock returns. Odean (1998) analyzes the relation between volume, volatility, price and profit under the assumption that all traders are informed and all traders are above average. The paper examines markets in which price-taking traders, a strategic-trading insider, and risk-averse market makers are over confident. Over confidence increases expected trading volume, increases market depth and decreases the expected utility of overconfident traders. Its effect on volatility and price quality depend on who is overconfident. Overconfident traders can cause markets to under-react to the information of rational traders. Markets also under-react to abstract, statistical, and highly relevant information, and they overreact to salient, anecdotal and less relevant information.

Jochum and Kodres (1998) and Dennis and Sim (1999) indicated little or no significant impact of futures trading on spot market volatility for the Australian market and for the three nations of Mexico, Brazil, and Hungary, respectively.

Bologna (1999) provided evidence that the introduction of stock index futures trading in the Italian Stock Exchange reduced the volatility and that lagged futures volume was inversely related to stock market conditional volatility while Antoniou and Holmes (1995) and Kyriacou and Sarno (1999) documented increased spot market volatility after the introduction of futures trading in FTSE 100 index.

Ibrahim *et al*. (1999) and Oliveria and Armada (2001) did not find any significant change on the spot market volatility of the Malaysia and Portuguese stock markets respectively. Number of studies has been carried out by different academicians to detect volatility of the underlying market declined after introduction of derivatives trading in the Indian market (Thenmozhi, 2002; Gupta, 2002; Raju and Karande, 2003; Nath, 2003). On the other hand, some studies found that, since the introduction of futures trading, the structure of volatility of the underlying spot market did not change (Kumar and Mukhopadhyay, 2002 and Shenbagaraman, 2003).

Gulen and Mayhew (2000) examined stock market volatility before and after the introduction of index futures trading in twenty-five countries and found that volatility increased after the listing of stock index futures in the US and Japan, but decreased or stayed roughly the same in most of the other countries. In the six European countries, Becchetti and Caggese (2000) revealed that the introduction of index options increased volatility in the German market, decreased it in the Dutch market and had no effect in the Austrian, French, Swiss and the UK markets.

Bologna and Cavallo (2002) and Pilar and Rafael (2002) reported that the introduction of stock index futures trading has led to decrease stock market volatility in the Italian and Spanish stock markets, respectively.

Bae *et al*. (2004) and Ryoo and Smith (2004) examined the effects of introducing an index futures market on the volatility of the spot market in Korea and both found that there was an increase in spot price volatility after the introduction of futures trading.

The relationship between derivative market and stock prices in developed markets have been extensively examined, there is relatively limited evidence on the relationship between variability of underlying spot market and futures trading activity reported for emerging markets.

Pok and Poshakwale (2004) documented an increase in the volatility of the spot market subsequent to the introduction of stock index futures for the Malaysian stock market. For the Greek stock market, Spyrou (2005) pointed out that the introduction of derivatives markets has a stabilizing effect in cash markets, as volatility in the latter market seems to be reduced following the introduction of derivatives trading. While Baklaci and Tutek (2006) examined the impact of futures market on spot volatility in the Turkish market, using data from 2004 to 2006, Kasman and Kasman (2008) enlarged the scope of this study by employing longer period of time and an asymmetric GARCH model to model volatility. Both studies indicated that the introduction of futures trading reduced the volatility of ISE-30 index.

A study by Pati (2005) investigates the maturity and volume effect on volatility and the study attempts to examine the volatility dynamics and investigate the Samuelson Maturity Hypothesis, a source of non-stationary in volatility of futures price in the context of Indian Futures Market, by taking Nifty Index Futures traded on NSE. The study uses ARMA-GARCH, ARMA-EGARCH models for empirical analysis. The empirical evidence suggests that there is time-varying volatility, volatility clustering and leverage effect in Indian futures market. The study does not provide support for the Samuelson Hypothesis in Indian futures market. With respect to volume-volatility relationship, the results indicate a clear acceptance of Mixtures of Distribution Hypothesis i.e. there is positive contemporaneous relationship between futures prices volatility and volume. Hence the study concludes that time-to-maturity is not a strong determinant of futures price volatility, but rate of information arrival proxied by volume and open interest are the important sources of volatility.

Lamoureux and Lastrapes (1990) have conducted one of the pioneer studies on testing the validity of MDH by using the trading volume as a proxy for the rate of daily information arrival. They specified a GARCH model and concluded that the volatility persistence diminishes by including trading volume in the conditional variance equation of stock returns. Similar results found in Brailsford (1994) for Australian equities, Bohl and Henke (2003) for Polish market, Gallagher and Kiely (2005) for Irish market, Wang, *et al*. (2005) for Chinese market, and Gallo and Pacini (2000) for the US market. In contrast, Ahmed, *et al*. (2005) for Malaysian market, Huang and Yang (2001) for Taiwanese market, Salman (2002) and Yuksel (2002) for Turkish market, and Chen, *et al*. (2001) for nine developed markets found that persistence in return volatility remains even after volume is included in conditional variance equation, results conflicting with previous studies and with MDH.

Some theoretical models which are proposed to explain the relation between two variables is Osborne (1959), Westerfield (1977), and Rogalski (1978). These include mixture of distribution model for asymmetric information was proposed by Clark (1973), Epps and Epps (1976), Tauchen and Pitts (1983) and Harris (1986). Therefore, the trading volume reflects information about price changes and investor expectations (Harris and Raviv, 1993). Wang, Ping, Wang, Peijie and Liu, Aying (2005) investigate the dynamic relationship between stock return volatility and trading volume for individual stocks of Chinese stock market and market portfolios of selected stocks. They found that the inclusion of trading volume, which issued as a proxy of information arrival, in the GARCH specification reduces the persistence of the conditional variance dramatically, and the volume effect is positive and statistically significant in all the cases for individual stocks.

In general, both Mixture of Distribution Hypothesis and sequential arrival of information hypothesis support a positive and contemporaneous relationship between volume and absolute return and assume symmetric effects of price increase and decrease for futures contracts (see Karpoff, 1987). The Mixture of Distribution Hypothesis is initially developed by Clark (1973) who argues that the values of the consequential price change and trading volume are distributed independently from each other. Pyun Lee and Nam (2000) provide positive evidence from the Korean stock market. Bohl and Henke (2003) shows support for the Polish stock market, while Luckey (2005) finds mixed evidence for the mixture of distribution hypothesis in the Irish stock market. Furthermore, Ragunathan and Pecker (1997) focus on the relationship between volume and price variability for the Australian futures market and explore positive relationship between volume and volatility by documenting asymmetric volatility response to unexpected shocks in trading volume by using the model developed by Bessembinder and Seguin (1993).

Jones, et al (1994) show that the positive volatility-volume relation documented by numerous researchers actually reflects the positive relation between volatility and the number of transactions using Schwert's (1990) GARCH model. The study shows that positive unexpected shocks to trading volume were found to induce an average increase in volatility at 76 per cent, while negative unexpected shocks to trading volume induce a smaller response in volatility.

Campbell, et al (1993) examine the level of price changes is influenced by high volume will tend to be reversed, and the reversal will be less due to price changes on days with low volume.

Santoni(1987) finds a negative correlation between S&P500 futures volume and the daily spot (high-low)/close, suggesting that an increase in futures trading does not lead to an increase in the volatility of the index.

Admati and Pfleiderer (1988), draw a theoretical shape of the intraday trading volume and variability of returns. The article develops a theory in which concentrated-trading patterns arise endogenously as a result of the strategic behavior of liquidity traders and informed traders.

Blume, et al, (1989) stated that a portion of the losses on S & P stocks in October, 1987 was related to the magnitude of the trading volume.

Smith (1989) found that S&P500 futures volume had no effect on changes in the volatility of S&P500 index returns.

Schwert (1990) says that when volatility for the S&P 500 index is high, stock market and future volume are also high.

Lamoureux and Lastrapes (1990) use stochastic time series econometric framework to test whether there are GARCH effects remaining after the conditional volatility specification expand to include the contemporaneous trading volume, which is a proxy for information arrival.

Bessembinder and Seguin (1992) report that expected (i.e. informationless) S&P500 futures trading activity was negatively related to spot market volatility when spot market activity variables were included in the analysis. This result supports the notion that futures trading improves liquidity provision and depth in spot markets, and rejects the hypothesis of the destabilizing effect of the futures market.

Gallant, et al. (1992) investigated the price and volume co-movement using daily data from 1928 to 1987 for New York Stock Exchange and found positive correlation between conditional volatility and volume.

Jones, et al, (1994) found that the positive volatility-volume relation documented by numerous researchers reflected a positive relationship between volatility and the number of transactions.

Blume et.al (1994) derives that investors can able to predict the market information with past price and trading volume. Wang (1994) shows that investors trade informational and non-informational reasons will also lead to different dynamic between trading volume and stock returns.

Moosa and Al-Loughani (1995) examine four Asian stock markets using monthly data and finds strong evidence for causality running from volume to absolute price changes and from price changes to volume in all markets except Philippines.

Darrat and Rahman (1995) concluded that futures volume did not affect S&P500 spot price volatility.

Brown-Hruska and Kuserk (1995) also found evidence for the S&P500 that an increase in futures volume, relative to spot volume, leads to a drop in spot volatility.

Brailsford (1996) found the irrespective of the direction in price change was significant across three measures of daily trading volume for the aggregate market and was significant for individual stocks. The main message to take from this empirical and theoretical survey is that there seems to be a strong relationship between return volatility and trading volume. The major stylized fact emerging from this study is that the level of trading volume is positively correlated with the contemporaneous price volatility; price changes and volume both exhibit patterns of conditional heteroscedasticity as well. Both volume and volatility display strong serial dependence.

Saatcioglu and Starks (1998) find that volume lead stock prices changes in four out of the six emerging markets of Latin American countries (Brasil, Chile, Columbia, Venezuella, Mexico and Argentina)

Kyriacou and Sarno (1999) found that contemporaneous and lagged futures volume for the FTSE 100 has a significantly positive effect on spot volatility measured using a GARCH model.

Daigler and Wiley (1999) examine the volume-volatility relation in futures markets for Chicago Board of Trade for four types of traders.

Chorida and Swaminathan (2000) analyze the correlation between volume and short-term returns. They conclude that trading volume plays a significant role in propagating a wide range of market information. Recently stochastic time series model for conditional heteroscedasticity have applied to explore this relationship between trading volume and stock returns. Also Chen et.al (2001) report the persistence in volatility is not eliminated when lagged or contemporaneous trading volume level is incorporated into the GARCH model, a result contradicting the findings of Lamoureux and Lastrapes (1990).

The concept of the volume impact is built on the fact that prices need volume to move, thus, the high volatility of stock prices may be produced as consequence of volume volatility and trading activities. Various studies reported that there are significant relationships between volume and stock price movement and volatility, due to the fact that trading volume is a source of risk because of the flow of information.

Chan et al (2000) found that trading volume for foreign stocks is strongly associated with NYSE opening price volatility.

Säfvenblad, (2000) found that Swedish index returns exhibit high autocorrelation when trading volume is low.

Lee and Rui (2000) use VAR methodology to examine the dynamic relations –causal relations and the sign and magnitude of dynamic effects – between stock market trading volume and returns and volatility for both domestic and cross-country markets by using the daily data of New York, Tokyo, and London the three largest stock markets. According to their findings trading volume does not Granger-cause stock market returns on each of three stock markets. There exist a positive feedback relationship between trading volume and return volatility in all three markets, sub-sample analysis show evidence of stronger spillover effects after 1987 market crash and increased importance of trading volume as an information variable after the introduction of options in the US and Japan.

W.Lo and Wang (2000) analyzes trading volume in a wide theoretical definition. They examine the implication of portfolio theory for the cross-sectional behavior of equity trading volume.

A study of 25 countries by Gulen and Mayhew (2000) found that information less futures volume had a positive effect on spot volatility in Denmark, Germany and Hong Kong, a negative effect in Austria and the UK, and no effect in the remaining 18 countries.

Ibrahim and Othman (2000) present an empirical analysis of the relationship between trading volume, returns and volatility on the Main Board of Kuala Lumpur Stock Exchange. They found strong evidence of positive relationship between trading volume and volatility using ARCH methodology. The paper also focused on the non-normality in returns (ARCH effects-persistence in volatility) through the rate of arrival of information, the study shows that there is a reduction in the significance and magnitude of persistence in volatility.

Mixon S. (2001) paper's presents a market microstructure that is consistent with several empirical regularities. The study tries to investigate the intuition and relation between volume and volatility comparing different models and tries to capture the cause of volatility persistency and also the study tries to finds the answer if the reason for volatility comes from the news or from the noise. The study suggests Kyle model (1985) differently from ARCH-like process.

Board, et al.(2001) focuses on the behavior of volatility in two parallel markets: the equity (spot or cash) market and the market for futures on an equity index. Although these markets are linked by arbitrage relationships between the price of the futures contract and the underlying market index, it has often been observed that futures returns are more volatile than the corresponding spot returns. The study sheds a light to the relationship between futures market volatility and spot market prices and ask whether the higher volatility of the futures market might distort spot market prices. The resulting analysis, which applied the stochastic volatility model to the UK, found no evidence to support the hypothesis that futures trading instantly destabilize the spot market. They found that there was also no evidence that spot trading instantly destabilizes the spot market, or that an increase in volume in one market, relative to the other, instantly destabilizes the spot market

Using data on nine Australian stocks on which individual share futures are traded, Dennis and Sim (1999) found that futures volume had no significant impact on spot volatility.

Goetzmann and Massa (2003) argue behavioral bias of volume, volatility and price impact relations. An important challenge to behavioral finance is to find a direct link between individual investor behavior and asset price dynamics. Few doubt that large numbers of investors behave irrationally and are prone to behavioral heuristics that lead to sub-optimal investment choices, however the empirical evidence that these investors affect prices has been elusive. After analyzing disposition effect in their paper, they also result they article with the conclusion of that the study has further implications for volatility studies and micro-structure effects. They find evidence that both volume and volatility may depend in general upon the composition of the market, and more specifically on disposition-prone investors.

Kiymaz and Berument (2003) investigate the day of the week effect on the volatility of major stock market indexes for the international stock markets. They found that the day of the week effect is exist in both return and volatility using conditional variance framework. The paper supports the argument that high volatility would be accompanied by low trading volume because of the unwillingness of liquidity traders to trade in periods of high stock market volatility.

Kouki (2003) found that volume has no information content on volatility by using GARCH methodology to analyze the relation trading volume, volatility, order flow and spread in the Tunisian markets. Nor volume, or order flow have an information content on spread. According to study dollar spreads increases the volatility.

Hsin, et al. (2003) examined the empirical evidence on the impact of speculative trading on return volatilities in Taiwan stock markets and found speculative trading activities through day trades, which increases the intraday price volatility.

Basci et al (1996) reports that stock price levels and trading volume in Turkish stock markets are co-integrated. According to studies reported that stock trading volume represents the highest positive correlation to the emerging stock price changes; thus represent the most predicted variables in increasing price volatility in both emerging and developing stock markets (Sabri, 2004, Sabri, 2008b).

Song, et al, (2005) examined the roles of the number of trades, size of trades, and share volume in the volatility-volume relation in the Shanghai Stock Exchange and confirm that mainly the number of trades drives the volatility-volume relation. Mei, et al. (2005) found that trading caused by investors' speculative motives could explain a significant fraction of the price difference between the dual-class shares.

Manganelli S. (2005) presents a framework to model duration, obtaining an econometric reduced form that incorporates causal and feedback effects among duration, volume and returns. A clearer picture about the trading environment of a specific market can be obtained by observing depth, spread and trading volume clusters. Some results of the study shows that traded stocks seem to be characterized by different information transmission mechanisms.

Kim et al (2006) investigate the stock volatility-volume- relation in the Korean market for the period 1995-2001 and try to shed a light to the impact of liberalization on the Korean stock market. By using GARCH type model to analysis the relationship between volume volatility and spillover effects they found strong evidence that 'foreign' volume tends to have more information about volatility which suggests the increased importance of 'foreign' volume as an information variable and also another strong implication is that volatility is related only to 'domestic' volume before the 1997 crisis whereas after the crisis a bidirectional feedback relation between 'foreign' volume and volatility begins to exist. Kasman and Baklaci(2006) indicated that trading volume significantly contributes to the return volatility in the Turkish Stock Market by using MDH methodology.

Medeiros and Doornik (2006) investigate the empirical relationship between stock returns, return volatility and trading volume using data from the Brazilian stock market (Bovespa). They use as cross-correlation analysis, unit-root tests, bivariate simultaneous equations regression analysis, GARCH modeling, VAR modeling, and Granger causality. They find support for a contemporaneous as well as dynamic relationship between stock returns and trading volume, implying that forecasts of one of these variables can be only slightly improved by knowledge of the other. On the other hand, the results indicate that there is a contemporaneous and dynamic relationship between return volatility and trading volume. Additionally, by applying Granger's test for causality, their findings show that return volatility contains information about upcoming trading volume and vice versa.

Mavuluri and Nagarjuna, (2006) is another worthy study that theoretical models have been advanced to address the issue 'why volume-volatility relationship arises'. Majority of the study is based on explanation from asymmetric information models, corresponding to both strategic and competitive models, which argue that informed traders with the help of quality information in hand, may submit strategically different trade sizes (i.e. volumes) therefore, exists varied association between volume and volatility. In competitive "asymmetric information" models, informed trades with the help of quality information in hand prefer to trade large volumes at any given price. That generates more volatility and volume, hence exists positive relationship. However, in strategic "asymmetric information" models, informed trader by putting small volumes (trade sizes) than larger volume may conceal his trading activity, which generates the positive relation.

Griffin, et, al. (2007) investigated the dynamic relation between market-wide trading activity and returns in 46 markets and reported strong positive relationship between turnover and past returns.

Lin and Kensinger (2008) present evidence of a significant increase in both trading volume and return volatility on the effective inclusion of a stock added to major market such as S&P500. They conclude that the change in trading patterns results from increased trading pressure due to index arbitrage.

Kasman, *et al.* (2009) investigates the impact of futures trading volume on spot market volatility, using data from the Turkish derivatives and spot markets, and also analyzes long memory in volatility using the FIGARCH model in order to assess the efficiency of the market in processing information. The results show that the volatility series is a long memory process and that futures trading volume contributes information to the volatility process of underlying stock index.

Dawson and Staikouras (2009) investigate the relation between S&P 500 index volatility derivatives and volatility of S&P 500 using Conditional heteroscedastic processes, as originally proposed by Engle (1982), Bollerslev (1986, 1987), and Engle and Bollerslev (1986). Their findings indicate the impact of volatility of derivatives on volatility suggest that the onset of the volatility derivatives trading has lowered the volatility of both the cash market volatility and the cash market index, and significantly reduced the impact of shocks to volatility. The study shows that when big sudden events hit financial markets, however, the volatility of volatility seems to elevate in the U.S. equity market as a result of increased global correlations. Regardless of the period under examination and the estimator employed, long-run volatility persistence is present. The latter drops significantly when the credit crunch period is excluded from the post-event date sample period. The correlation between the broad equity index and the return volatility remains low, which in turn strengthens the role of volatility derivatives to facilitate portfolio diversification. The analysis also shows that volatility is mean reverting, whereas market data support the impact of information asymmetries on conditional volatility. In the post-event date phase, no asymmetries are found when the recent crisis is not accounted for. Finally, comparisons with other international equity indices, with no volatility derivatives listed, unveil that these indices exhibit higher volatility and slower recovery from shocks than the S&P500 index.

Kartsaklas' (2008) examines whether different types of traders, distinguished by the information they possess, have a positive or negative effect upon volatility while the trader type volume is partitioned into expected and unexpected components. His empirical results show that surprises in non-member investors trading volume are positively related with volatility in most of the cases. These results are more reinforcing in the case of log volume and generally consistent with existing theoretical and empirical evidence. He shows that the long run effect of non-member investors trading seems to be important and stabilizing over futures prices in the case of institutional and foreigners but destabilizing over futures prices in the case of individuals, especially up to the end of the financial crisis.

Zafar, et al (2008) investigate the effects of interest rate volatility on stock market returns and volatility by using GARCH(1,1) methodology. They used monthly returns of the Karachi stock exchange and 90 days T-bill rate for the four years from January 2002 to June 2006. Results revealed that conditional market return has a negatively significant relation with interest rates whereas conditional variance of returns has a negative but insignificant relationship with interest rates.

Lamoureux and Lastrapes (2009) compare volume with GARCH effect and the paper provides empirical support for the notion that Autoregressive Conditional Heteroscedasticity (ARCH) in daily stock return data reflects time dependence in the process generating information flow to the market. Daily trading volume, used as a proxy for information arrival time, is shown to have significant explanatory power regarding the variance of daily returns, which is an implication of the assumption that daily returns are subordinated to intraday equilibrium returns. Furthermore, ARCH effects tend to disappear when volume is included in the variance equation. The paper provides empirical support for the hypothesis that ARCH is a manifestation of the daily time dependence in the rate of information arrival to the market for individual stocks. Thus, this form of heteroskedasticity is an artifact of the arbitrary, albeit natural, choice of observation frequency. While this conclusion is strictly valid only for sample of actively traded stocks, it is plausible to surmise that similar results would be found for other asset return series that can be explained by ARCH (e.g., foreign exchange rates), where in many instances more appropriate measures of information arrival time are not available.

Choi *et al* (2010) uses EGARCH model to investigate the effect of volatility spillovers between stock market returns and exchange rate changes in New Zealand (NZ) market which is accepted as small market that influenced by big markets. Their findings show that when the exchange rate volatility is higher, the stock market volatility is lower before the 1997 stock market crash. However, this volatility spillover becomes significantly positive after the crash. On the other hand, they find significant volatility spillovers from stock market returns to NZ dollar movements in the foreign exchange market only before the 1997 crash but not after, i.e., volatility spillovers between exchange rate changes and stock market returns change over time.

CHAPTER THREE
METHODOLOGY

3.1 VOLATILITY MODELS

In this thesis, to investigate the impact of trading volume in the derivative markets on the volatility of spot market, the extension of GARCH models are used. Given the rapid growth in financial markets and the continual development of new and more complex financial instruments, there is an ever-growing need for theoretical and empirical knowledge of the volatility in financial time series. It is widely known that the daily returns of financial assets, particularly stock prices, are difficult, if not impossible, to predict, although the volatility of the returns seems to be relatively easier to forecast. Therefore, financial volatility has played such a central role in modern pricing and risk management theories. Several models have been developed for estimating volatility of financial time series in last two decades years. The ARCH model and its extensions are in this section.

The basic version of the least squares model assumes that the expected value of all error terms, when squared, is the same at any given point. This assumption is called homoscedasticity, and it is this assumption that is the focus of the *ARCH* model. Data in which the variances of the error terms are not equal, in which the error terms may reasonably be expected to be larger for some point so ranges of the data than for others, are said to suffer from heteroscedasticity. In the presence of heteroscedasticity, the regression coefficients for an ordinary least squares regression are still unbiased, but the standard errors and confidence intervals estimated by conventional procedures will be too narrow, giving a false sense of precision. Instead of considering this as a problem to be corrected, the *ARCH* model treats heteroscedasticity as a variance to be modeled. As a result, not only the deficiencies of least squares are corrected, but a prediction is computed for the variance of each error term. This prediction turns out often to be of interest, particularly in applications in finance.

In financial time series the key issue is the variance of the error terms and what makes them large. This question often arises in financial applications where the dependent variable is the return on an asset or portfolio and the variance of the return represents the risk level of those returns. Even a cursory look at financial data suggests that some time periods are riskier than others; that is, the expected value of the magnitude of error terms for some period is greater than the others. Moreover, these risky periods are not scattered randomly across time. Instead, there is a degree of autocorrelation in the riskiness of financial returns. Financial analysts, looking at plots of daily returns, can observe the amplitude of the returns varies over time and describe this as “volatility clustering.”

The *ARCH* model and its extensions have commonly used for estimating volatility of financial time series in last two decades. These models can be used in financial decisions concerning risk analysis, portfolio selection and derivative pricing. The econometric challenge is to specify how the information is used to forecast the mean and variance of the return, conditional on the past information. While many specifications have been considered for the mean return and have been used in efforts to forecast future returns, virtually no methods were available for the variance before the introduction of *ARCH* models. The primary descriptive tool was the rolling standard deviation. This is the standard deviation calculated using a fixed number of the most recent observations. For example, this could be calculated everyday using the most recent month (22 business days) of data. It is convenient to think of this formulation as the first ARCH model; it assumes that the variance of tomorrow’s return is an equally weighted average of the squared residuals from the last 22 days. The assumption of equal weights seems un-attractive, as one would think that the more recent events would be more relevant and therefore should have higher weights. Furthermore the assumption of zero weights for observations more than one month old is also unattractive. The ARCH model proposed by Engle (1982) lets these weights be parameters to be estimated. Thus, the model allowed the data to determine the best weights to use in forecasting the variance.

A useful generalization of this model is the GARCH parameterization introduced by Bollerslev (1986). This model is also a weighted average of past squared residuals, but it has declining weights that never go completely to zero. It gives parsimonious models that are easy to estimate and, even in its simplest form, has proven surprisingly successful in predicting conditional variances. The most widely used GARCH specification asserts that the best predictor of the variance in the next period is a weighted average of the long-run average variance, the variance predicted for this period, and the new information in this period that is captured by the most recent squared residual. Such an updating rule is a simple description of adaptive or learning behavior and can be thought of as Bayesian updating (Engle, 2001).

The Autoregressive conditional heteroscedasticity of order *p*, or *ARCH*(*p*), model is specified as follows:

$$h_t = \omega + \sum_{j=1}^{p} a_j \varepsilon_{t-j}^2 \tag{1}$$

for the case $p=1$, $\omega > 0$, $\alpha_1 > 0$ are sufficient conditions to ensure a strictly positive conditional variance, $h_t > 0$. The *ARCH (or* α_1*)* effect captures the short-run persistence of shocks.

ARCH provides a framework for the analysis and development of time series models for volatility (Brooks C., 2008:405). In this model, the error term is heteroscedastic, which means variance changes over time. The most important feature of the process at this point is that, the description of financial asset returns behavior which is defined as volatility clustering or volatility pooling. Volatility clustering describes the tendency of large changes in asset prices (of either sign) to follow large changes and small changes (of either sign) to follow small changes. In other words, the current level of volatility tends to be positively correlated with its level during the immediately preceding period (Brooks C., 2008:379). The *ARCH* model can be specified as follows:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + u_t, u_t \sim N(0, \sigma^2) \tag{2}$$

where,

$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2$$

Instead of calling the conditional variance σ_t^2 in the literature it is often called h_t, so that the model would be ;

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + u_t , u_t \sim N(0, \sigma^2)$$
$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + a_2 u_{t-2}^2 + \dots + a_q u_{t-q}^2 \tag{3}$$

where q denotes lags of squared errors which known as ARCH(q).

The GARCH(p,q) model is specified as follows:

$$h_t = \omega + \sum_{j=1}^{p} a_j \varepsilon_{t-j}^2 + \sum_{i=1}^{q} \beta_i h_{t-i} \tag{4}$$

For the case

$$p = q = 1, \quad \omega > 0, \quad a_1 > 0, \beta_1 \geq 0$$

are sufficient conditions to ensure a strictly positive conditional variance, $h_t > 0$. The *ARCH* (or α_1) effect captures the short-run persistence of shocks, and the *GARCH* (or β_1) effect indicates the contribution of shocks to long-run persistence ($\alpha_1 + \beta_1$).

Several important theoretical results are relevant for the *GARCH* model. In *ARCH* and *GARCH* models, the parameters are typically estimated using the maximum likelihood estimation (*MLE*) method. The conditional log-likelihood function is given as follows:

$$\sum_{t=1}^{n} l_t = -\frac{1}{2} \sum_{t=1}^{n} \left(\log h_t + \frac{\varepsilon_t^2}{h_t} \right) \tag{5}$$

In the absence of normality of the standardized residuals, η_t , the parameters are estimated by the Quasi-Maximum Likelihood Estimation *(QMLE)* method. Ling and McAleer (2002) established the necessary and sufficient conditions for strict stationary and ergocity, as well as for existence of all moments, for the univariate *GARCH(p,q)* model, and Ling and McAleer (2003) demonstrated that the *QMLE* for *GARCH (p, q)* is consistent if the second moment is finite,

$E(\varepsilon_t^2) < \infty$

and asymptotically normal if the fourth moment is finite,

$$E(\varepsilon_t^4) < \infty .$$

The necessary and sufficient condition for the existence of second moment of ε_t for the *GARCH(1,1)* model is

$$\alpha_1 + \beta_1 < 1$$

Another important result is that the log-moment condition for *QMLE of GARCH(1,1),* which is a weak sufficient condition for the QMLE to be consistent and asymptotically normal, is given by

$$E\left(\left(\log(a_1\eta_1^2) + \beta_1\right)\right) < 0$$

The log-moment condition was derived in Jeantheau (1998) for consistency, and in Boussama (2000) for asymptotic normality. In practice, it is more straightforward to verify the second moment condition than the weaker log-moment condition, as the latter is a function of unknown parameters and the mean of the logarithmic transformation of random variable. In empirical examples, the parameters in the regularity condition are replaced by their *QMLE*, the standardized residuals, η_t , are replaced by the estimated residuals from the *GARCH* model, for

$$t = 1 \dots n,$$

and the expected value is replaced by their sample mean.

The *GARCH* model was developed independently by Bollerslev (1986) and Taylor (1986). The *GARCH* model allows the conditional variance to be dependent on previous own lags, so that the conditional variance equation in the simplest case is defined as below (Brooks C. 2008:408).

$$\sigma_t^2(\boldsymbol{h}_t) = a_0 + a_1u_{t-1}^2 + a_2u_{t-2}^2 + \beta_1\sigma_{t-1}^2 \qquad (6)$$

As general definition of *GARCH* model the formula would be;

$$\sigma_t^2 = a_0 + \sum_{i=1}^{q} a_i u_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{7}$$

in the *GARCH* model conditional variance is changing but unconditional variance of u_t is not defined. For the conditional variance $\alpha_0>0$, $\alpha_1 \geq 0$, $\beta \geq 0$ and $\alpha_1+\beta<1$ conditions must be satisfied. In this model α_1 represent short run shock (*ARCH* effect) and β long run shock (*GARCH* effect).

GJR-GARCH model is one of the asymmetric volatility models. When return of a stock is more volatile it is assumed to be more risky. In asymmetric models, leverage effect defined as small positive shocks having a greater impact on conditional volatility than small negative shocks and large negative shocks having a greater impact on conditional volatility than large positive shocks (Morimune, 2007). In *GJR* model of *GARCH*, Glosten *et al*. (1992) developed an extended *GARCH* model to capture possible asymmetries between the effects of positive and negative shocks of the same magnitude on the conditional variance. This asymmetry shows that negative shocks have greater impacts on volatility than positive shocks. *GARCH* model assumes that positive and negative shocks has the same impact on conditional volatility but in practice this assumption violated. In order to accomodate the possible differential impact on conditional volatility from positive and negative shocks Glosten *et al* (1992) extended the *GARCH* model to capture possible asymmetries between the effects of positive and negative shocks of the same magnitude on the conditional variance. The *GJR* (*p*,*q*) model is given by;

$$\boldsymbol{h}_t = \omega + \sum_{j=1}^{p} a_j \varepsilon_{t-j}^2 + \gamma I(\varepsilon_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{q} \beta_i \boldsymbol{h}_{t-i} \tag{8}$$

where the indicator variables, $I(\varepsilon_{t-1})$ is defined as

$$\boldsymbol{h}_t = \omega + \sum_{j=i}^{p} a_j \varepsilon_{t-j}^2 + \gamma I(\varepsilon_{t-1}) + \sum_{i=1}^{q} \beta_i \boldsymbol{h}_{t-i} \tag{10}$$

For the case

$$p = q = 1, \qquad \omega > 0, \qquad \alpha_1 > 0, \qquad \alpha_1 + \gamma > 0, \qquad \beta_1 \geq 0$$

are sufficient conditions to ensure a strictly positive conditional variance, $h_t > 0$. The indicator variables distinguish between positive and negative shocks, where the asymmetric effect, $\gamma > 0$ measures the contribution of shocks to both short-run persistence $\alpha_1 + \gamma/2$ and long-run persistence $\alpha_1 + \beta_1 + \gamma/2$.

Exponential *GARCH* (*EGARCH*) proposed by Nelson (1991) model is another asymmetric volatility model that has been used commonly in the literature. The *EGARCH* model is specified as follows:

$$\log(h_t) = \omega + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-1}}{h_{t-1}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{h_{t-k}} + \sum_{j=1}^{q} \beta_j \log(h_{t-1}) \tag{11}$$

As the range of the $\log(h_t)$ is the real number line, the *EGARCH* model does not require any parametric restrictions to ensure that the conditional variances are positive. Furthermore the *EGARCH* specification is able to capture several stylized such as small positive shocks having greater impact on conditional volatility than negative shocks, and large negative shocks having greater impacts on conditional volatility than large positive shocks. Such features in financial returns and risk are often cited in literature to support the use of *EGARCH* to model conditional variances.

Unlike the *ARCH, GARCH* and *GJR* models, *EGARCH* uses the standardized models rather than unconditional shocks. Moreover as the standardized shocks have finite moments, the moment conditions of *EGARCH* are straightforward and may be used as diagnostic checks of the underlying models. If the standardized shocks are independently and identically distributed, the statistical properties of *EGARCH* are likely to be natural extensions of (possibly vector) ARMA time processes.

To investigate impact of trading volume on return volatility, this thesis uses closing prices to compute returns. Daily returns based on closing prices are computed using the following equation;

$$R_t = \ln\left(P_t/P_{t-1}\right) \tag{12}$$

or

$$R_t = \log(P_t) - \log(P_{t-1}) \tag{13}$$

where P_t and P_{t-1} are the closing prices on day t and $t-1$, respectively. It is widely documented that daily financial return series display strong conditional heteroscedasticity. This finding strikes at the heart of empirical financial research. The estimated return variance is routinely used as a simple, albeit crude, measure of risk, and the return variance enters directly into derivative pricing formulas such as the Black-Scholes (1976) formula. Moreover, tests of market efficiency based on asset returns must incorporate corrections for heteroscedasticity in order to produce the appropriate asymptotic distributions of the test statistics. And perhaps most importantly, empirically relevant asset pricing theories typically relate expected returns, i.e risk premia, to the joint second order moments of returns and other stochastic processes. Again, heteroscedasticity must be accounted for in order to derive efficient estimation and testing procedures. Finally, a better characterization of return volatility sheds light on the virtues of alternative specifications for the return generating mechanism.

From a market microstructure perspective, price movements are caused primarily by the arrival of new information and process that incorporate this information and process that incorporates this information into market prices. Theory suggests that variables such as the trading volume, the number of transactions, the bid-ask spread, or the market liquidity is related to the return volatility process. However, the focus of the market microstructure literature is on intraday patterns rather than inter-day dynamics, so there are typically no explicit predictions regarding the relation among these variables at the daily frequency (Andersen, 1996).

The Mixture of Distribution Hypothesis (*MDH*) hypothesis (Clark, 1973, Eps and Eps, 1976) is based on the assumption that all traders simultaneously receive the new price signals. The *MDH* provides one plausible explanation, and states that daily returns seem to be generated by a mixed distribution. In particular, the rate of daily information arrivals can be viewed as a generating process by the stochastic mixing variable. Hence, an appropriate model from ARCH family can capture the time series properties of such mixing variables (Baklaci and Kasman, 2005:75). The *MDH* hypothesis states that volatility and volume are driven by the same information flow simultaneously (Donmez, 2005:125).The central proposition of MDH is that daily price changes and trading volume are driven by the same underlying latent “news” - arrival, or information flow, variable. The arrival of unexpected “good news” results in a price increase, whereas “bad news” results in a price decrease (Luu and Martens, 2002). On the other hand, The Sequential Information Arrival Hypothesis (*SIAH*) of Copeland (1976), Jennings, Starks and Fellingham (1981) assume that traders receive new information in a sequential, random fashion. However, traders do not receive the information signals simultaneously (Donmez, 2005:98).

The asymmetric response of volatility to positive and negative shocks is well known in the finance literature as the leverage effect of stock market returns (Black, 1976). Researchers have found that volatility tends to rise in response to ‘bad news’ (excess returns lower than expected) and to fall in response to ‘good news’ (excess returns higher than expected). The asymmetric *GARCH* (i.e., *EGARCH*) model is used to estimate the return volatility. As mentioned above, in contrast to the conventional *GARCH* specification, which requires non-negative coefficients, the *EGARCH* model does not impose non-negativity constraints on the parameter space since it models the logarithm of the conditional variance.

The following AR(p)-EGARCH (1,1) specification is used to investigate the relationship between the trading volume and conditional return volatility of spot market prices:

$$r_t = \vartheta_0 + \varepsilon_t$$

$$\log(\sigma_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\frac{\varepsilon_{t-k}}{h_{t-k}} + \beta\log(h_{t-1}) + \delta DVOL \qquad (14)$$

Here σ_{t-1}^2 known as the conditional variance since it is a one period ahead estimate for the variance calculate on any past information thought relevant. The coefficient α represents *ARCH* effect, the coefficient β represents *GARCH* effects on the volatility. β measures the persistence in conditional volatility irrespective of anything happening in the market . When β is relatively large, the volatility takes a long time to die out following a crisis in the market.

The coefficient γ predicts the asymmetric effect (leverage effect) in the conditional variance. The left-hand side is the log of the conditional variance, this means that the leverage effect is exponential, rather than quadratic, and the forecast of the conditional variance are guaranteed to be nonnegative. This is the significant advantage of *EGARCH* models which even if the estimated parameters- such as ω, α, β, γ, δ- is negative, σ_t^2 will be positive.

The presence of leverage effects tested by the hypothesis that $\gamma_i<0$. There exist asymmetric impact if $\gamma_i<0$ and $\gamma\neq0$. If $\gamma= 0$, then the model is symmetric. The impact is asymmetric if $\gamma\neq0$. When $\gamma<0$, the positive shocks or good news generate less volatility than negative shocks or bad news. When $\gamma>0$, it implies that any positive innovations are more destabilizing than any negative innovations (Su, 2010). Nelson (1991) assumes that the ε_t follows a Generalized Error Distribution. The *GED* distributed innovations around zero mean are identified by ε_t in model of equation above.

CHAPTER FOUR
DATA AND EMPIRICAL RESULTS

4.1 DATA DESCRIPTION AND DEFINING SUB-PERIODS

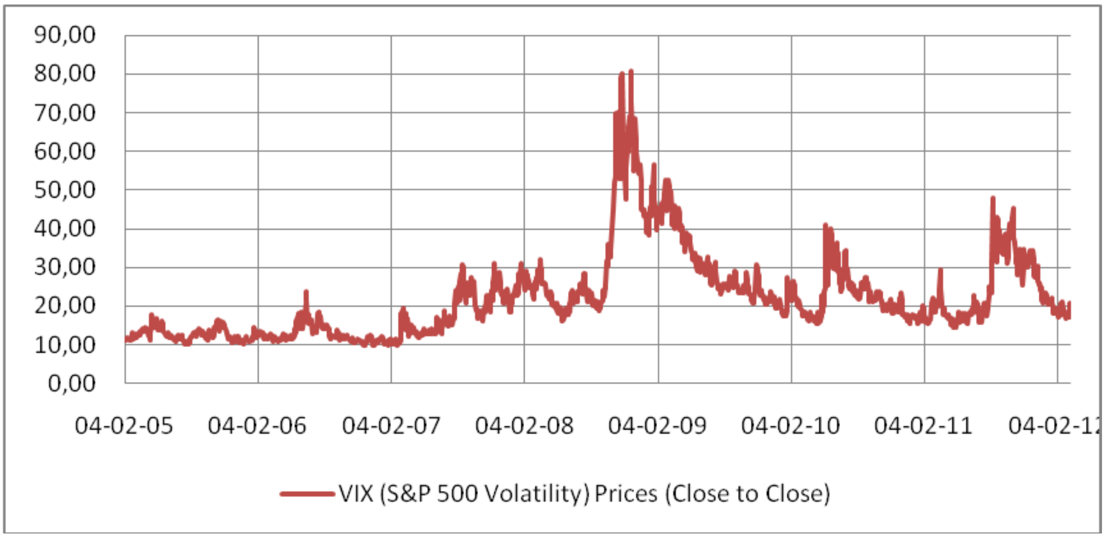
This study analyzes the volume and price volatility relationship in the Turkish stock markets in order to determine the impact of changes in trading volume on the volatility of stock prices. The data used are the daily closing prices of the Istanbul Stock Exchange (or Borsa Istanbul) 30 index (ISE-30 hereafter), which is a value-weighted index that tracks the continuous price performance of thirty actively-traded, large capitalization common stocks listed on ISE. Our data covers the period between February 2005 and May 2012. The ISE-30 stock index futures were launched in the Turkish Derivatives Exchange, VIOP, on February 4, 2005. The sample data obtained from the VIOP and Istanbul Stock Exchange.

The sample period is divided into three sub-periods to examine the impact of global financial crisis on returns volatility. The sub-periods are defined with respect to the VIX behavior which can be defined as below:

4.1.1 The Relation Between S&P Volatility Index (Vix) And Financial Markets

One of the most interesting features of VIX, and the reason it has been called the "investor fear gauge," is that, historically, VIX hits its highest levels during times of financial turmoil and investor fear. As markets recover and investor fear subsides, VIX levels tend to drop. Another interesting aspect of VIX is that, historically, it tends to move opposite its underlying index.

Figure 6: VIX Close To Close Prices From 2005:2 to 2012:3



Source: finance.yahoo.com, 30.05.2012

4.1.2 What Exactly Vix Is?

In 1993, the Chicago Board Options Exchange® (CBOE®) introduced the CBOE Volatility Index®, VIX®, and it quickly became the benchmark for stock market volatility. It is widely followed and has been cited in hundreds of news articles in the Wall Street Journal, Barron's and other leading financial publications. Since volatility often signifies financial turmoil, VIX is often referred to as the "investor fear gauge".

VIX measures market expectation of near term volatility conveyed by stock index option prices. The original VIX was constructed using the implied volatilities of eight different OEX option series so that, at any given time, it represented the implied volatility of a hypothetical at-the-money OEX option with exactly 30 days to expiration. The New VIX still measures the market's expectation of 30-day volatility, but in a way that conforms to the latest thinking and research among industry practitioners. The New VIX is based on S&P 500 index option prices and incorporates information from the volatility "skew" by using a wider range of strike prices rather than just at-the-money series.

VIX is based on real-time option prices, which reflect investors' consensus view of future expected stock market volatility. Historically, during periods of financial stress, which are often accompanied by steep market declines, option prices - and VIX - tend to rise. The greater the fear, the higher the level of VIX is. As investor fear subsides, option prices tend to decline, which in turn causes VIX to decline. It is important to note, however, that past performance does not necessarily indicate future results. VIX uses options on the S&P 500 Index, which is the primary U.S. Stock market benchmark.

4.1.3 VIX and Market Behavior

VIX measures market risk. When VIX start to rise it means that the risk of the market also high and the crash possibility of the market starts to rise. Remember that during the 2008 crisis the volatility was in its peak. As seen from the graph above in closest to the end of the 2008 the VIX goes to in its peaks. This date is also the date of the crash of 2008-2009 That's why I divide the whole data into three periods and analyzed. These periods are; The Whole Period, Pre-Crisis Period, Post-Crisis Period. The periods are defined as follows:

The Whole Period: The whole data consist of 1718 observations (2005:2-2012:3).
Pre-Crisis Period: In this study the pre-crisis period defined as the period before 2008. It is assumed that the market crash in the USA stared in the beginning of 2008. Hence, this period contains 709 observations (04.02.2005 - 04.01.2008).
Post-Crisis Period: The crisis period is defined as the period between 04.01.2008 2008:1 and 2012:03 and contains 1012 observations.

Table 2, 3, and 4 report the descriptive statistics of the variables used in the analysis. The descriptive statistics for the variables include mean, median, standard deviation, maximum, minimum, skewness, kurtosis, and Jarque-Bera statistics. The statistically significant Jarque-Bera statistics in three periods reveal that all series have non-normal distribution. While the distributions of the return and volume series are skewed to the left in whole sample period and pre-crisis period. However, they are skewed to the right in post-crisis period. Moreover, excess kurtosis of series shows that return and volume series have leptokurtic distribution.

Table 2 : Descriptive Statistics For Whole Sample (2005:2-2012:3)

	Volume	Return (ISE-30)
Mean	19.218	0.000
Median	20.368	0.001
Maximum	21.780	0.127
Minimum	10.359	-0.097
Std. Dev.	2.589	0.021
Skewness	-1.417	-0.055
Kurtosis	4.021	5.753
Jarque-Bera	649.668	542.912
Observations	1717	1717

Note: Volume is in natural logarithm. Jarque-Bera normality test statistic has a chi-square distribution with 2 degrees of freedom.

Table 3 : Descriptive Statistics For Pre-Crisis Period (04.02.2005 - 04.01.2008).

	Volume	Return (ISE-30)
Mean	16.886	0.0013
Median	17.256	0.001
Maximum	20.761	0.072
Minimum	10.359	-0.085
Std. Dev.	2.577	0.019
Skewness	-0.486	-0.173
Kurtosis	2.247	4.024
Jarque-Bera	44.697	34.505
Observations	709	708

Note: Volume is in natural logarithm. Jarque-Bera normality test statistic has a chi-square distribution with 2 degrees of freedom.

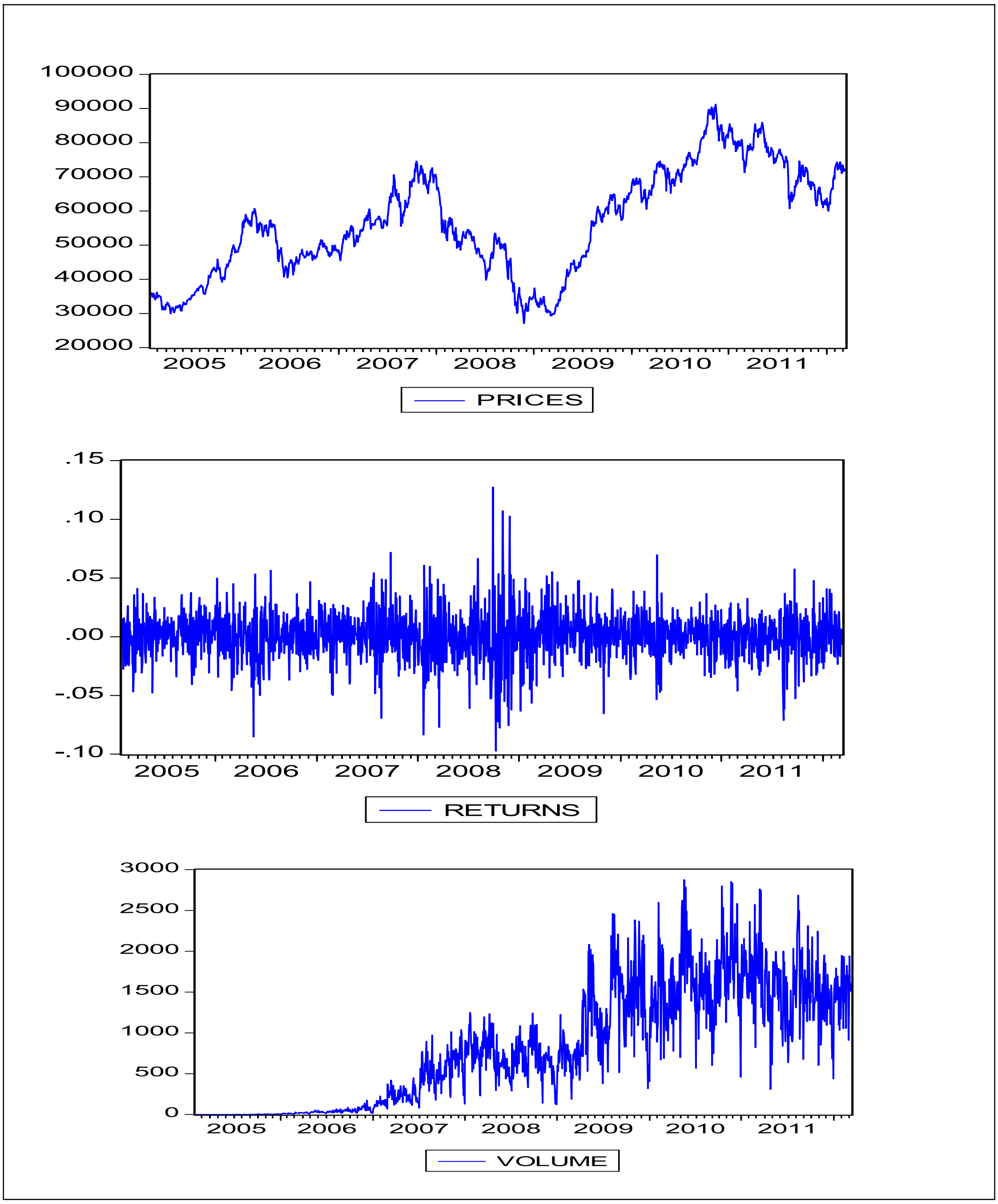
Table 4 : Descriptive Statistics For Post-Crisis Period (2008:1 And 2012:03)

	Volume	Return (ISE-30)
Mean	20.855	0.000
Median	20.958	0.001
Maximum	21.780	0.127
Minimum	18.614	-0.097
Std. Dev.	0.494	0.022
Skewness	0.849	0.016
Kurtosis	4.0199	6.210
Jarque-Bera	165.597	434.407
Observations	1012	1012

Note: Volume is in natural logarithm. Jarque-Bera normality test statistic has a chi-square distribution with 2 degrees of freedom.

Figure 7 shows descriptive graphs of daily prices and index for ISE-30 index and stock index futures trading volume over the whole sample period. As seen in Figure 7, the impact of global crisis of 2008 on the Turkish stock market is clear. The index decreased dramatically during the crises. As for the returns, the volatility increased significantly during this period. Volatility of index futures trading volume also increased this period. As seen in the last graph, trading volume starts to rise after the crisis. Trader preferred to invest in derivative markets during crisis period to hedge themselves.

Figure 7: Plots Of The ISE-30 Price Index, Respective Returns And Futures Trading Volume



4.2 EMPIRICAL RESULTS

As highlighted in the tables above both series are negatively skewed. The excess kurtosis estimate of the returns also implies that the distribution of returns has fat tails, leptokurtic, relative to the normal distribution. Furthermore, the significant Jarque-Bera statistics of series indicate a departure from normality through rejecting the hypothesis of symmetric distribution.

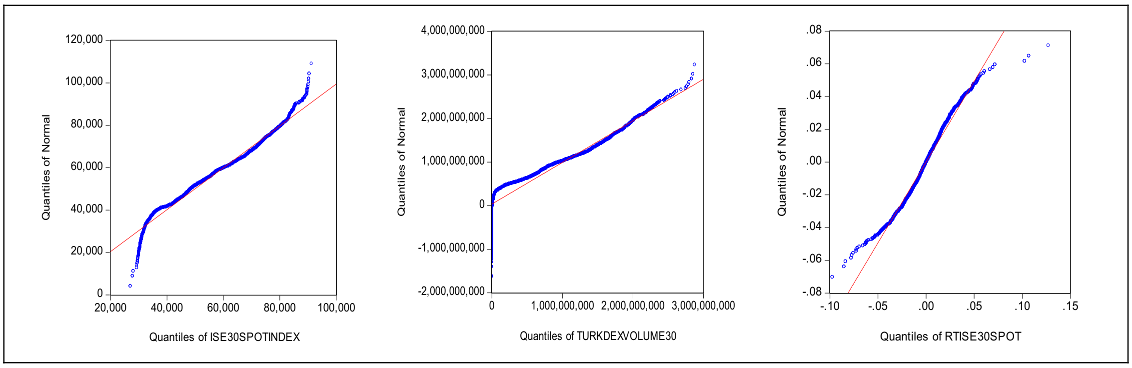
All these findings clearly shed light on the existence of GARCH effects in the series. The empirical investigation of equity returns were initially done by Fama (1965) and Mandelbrot (1963). Studies usually have shown that returns, especially in the short run are not normal. The return distributions do show negative skewness and a high kurtosis value. A kurtosis value larger than three implies of course the distribution has a fat tail problem. Efforts have been made to solve the fat tail problem by using the models such as ARCH and GARCH which are based on volatility clustering assumption. (Bollerslev*, et al*., 1992; Akgiray, 1989; Akgiray, *et al*., 1989; Aparicio and Estrada, 2001). Since the data shows non-normality features ARCH and GARCH analyzes can be used for examining return behaviors.

Theoretical quantile-quantile plots are used to assess whether the data in a single series follow a specified theoretical distribution; e.g.whether the data are normally distributed (Cleveland, 1994; Chambers, *et al*., 1983). If the two distributions are the same, the *QQ*-plot should lie on a straight line. If the *QQ*-plot does not lie on a straight line, the two distributions differ along some dimension.

The pattern of deviation from linearity provides an indication of the nature of the mismatch. If the residuals are normally distributed, the points in the *QQ*-plots should lie alongside a straight line. The plot indicates that it is primarily large negative shocks that are driving the departure from normality. The *QQ*-plot of data sets does not lie on a straight line (see quantile figures below). When *QQ*-plot does not lie on a straight line one can observe the shocks from the quantiles tables. The returns or system is exposed to negative and positive shocks. As seen from the figures below there are positive and negative shocks that affect the historical data. Hence, the return series are suitable to analyze the asymmetric impact and we should look at the EGARCH results to analyze the impacts of the negative and positive shocks and the impacts of trading volume on volatility.

The quantiles below show the pattern of all data of conjuncture that have been chosen for analyses. Moreover, the quantiles for different periods show that there exist positive and negative information flow to the markets.

Figure 8: Quantiles For Whole Period



There are positive and negative deviations from the straight line. It means that the information flow affect the historical data positively and negatively. One can read the figures as the sign of the existence of negative and positive shocks to the system.

Figure 9: Quantiles For Pre-Crisis Period

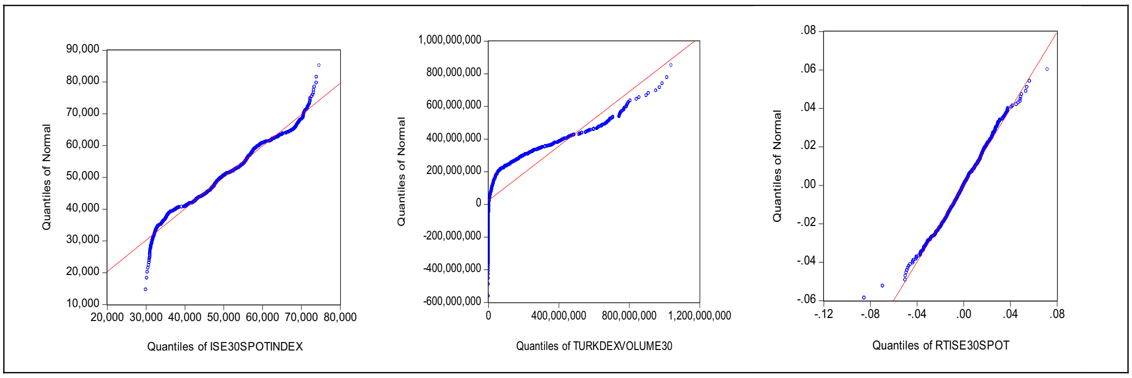
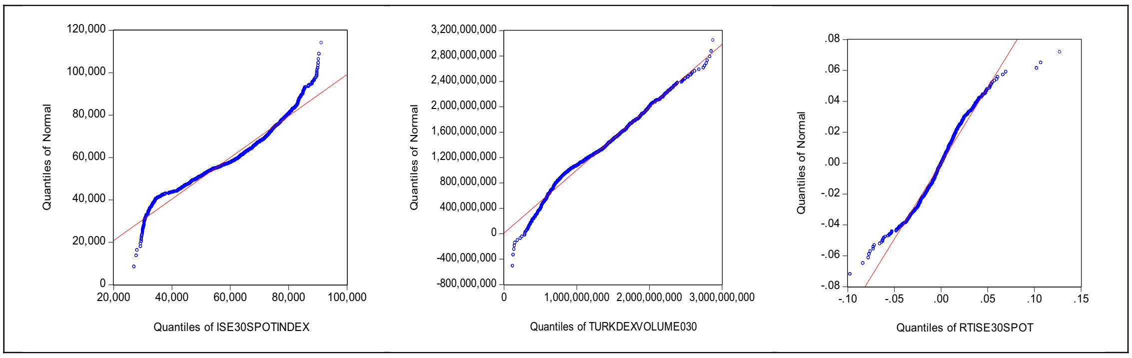


Figure 10: Quantiles For Post-Crisis Period



As mentioned above, we divided the sample period into three sub-periods: Pre-crisis period, post-crisis period, and whole period. EGARCH model is estimated under student-t, Generalized Error Distribution (GED), and normal distributions. We extended the EGARCH equation by including daily trading volume of ISE 30 contracts in VIOP market as regressor. In all three regression, the lagged value of futures trading volume Dlog(Vol_{t-1}) is used as the proxy for uneven information flow. *D* represents difference. To avoid spurious results and guarantee the positive estimated variance we use difference used log formation of the volume. Moreover, since volume series contain a unit root, the first difference of series included in the regression. Regression results are reported in Table 5, 6 and 7. To check the performance of our model, we performed some specification tests on the normalized residuals. The ARCH-LM test is used to test whether there are any ARCH effects left in the normalized residuals. We also performed the Ljung-Box statistics whether there is serial dependence in squared residuals. The tests results indicate that no serial dependence persists left in squared residuals. Hence, Our EGARCH models are reasonably well specified to capture the ARCH effects.

The regression results in Table 5 are produced estimating EGARCH model under student-*t* distribution. The student-*t* EGARCH model, introduced by Bollerslev (1987), assumes that the conditional distribution of market shocks is *t* distributed. The degrees of freedom in this distribution become an additional parameter that is estimated along with the parameters in the conditional variance equation. The results in Table 5 indicate that the coefficient γ is significantly negative in all sub-period, implying statistically significant asymmetric effects. This result suggests that negative shocks have greater impact than the positive shock in the Turkish stock market. The results also indicate that the dependence of volatility on its past behavior is confirmed, as α and β coefficients appear to be statistically significant. Hence, the behavior of asymmetric effect in the market remains the same pre- and post-crisis period. Table 5 also reports the estimation results for the impact of futures trading volume on the spot market volatility. The coefficient δ is significantly positive in all periods, implying that spot market volatility is in fact affected by the trading volume in the futures market. Hence, this result suggests that futures trading volume contributes information to the return process of the ISE-30 index in pre- and post-crisis period. As seen in Table 5, the coefficient δ increased significantly in post-crisis period, suggesting that traders particularly tried to hedge themselves in post-crisis period.

To analyze whether our results are consistent under different distributions, we also estimate the EGARCH model under Generalized Error Distribution (GED) and normal distribution (Gaussian). The regression results are reported in Table 6 and 7. The results are very similar. Hence, using different distributions does not change the main findings.

Table 5 : Estimation results of EGARCH model under Student-t Distribution

$$\log(\sigma_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\frac{\varepsilon_{t-k}}{h_{t-k}} + \beta\log(h_{t-1}) + \delta DVOL$$

Parameter	The Whole Period		Pre-crisis period		Post-crisis period	
	coefficient	P-value	Coefficient	P-value	coefficient	P-value
ω	-0.360*	0.000	-0.615*	0.004	-0.194*	0.002
α	0.131*	0.000	0.140*	0.004	0.088*	0.003
γ	-0.077*	0.000	-0.095*	0.001	-0.075*	0.000
β	0.968*	0.000	0.938*	0.000	0.985*	0.000
δ	0.793*	0.000	0.688*	0.000	1.138*	0.000

Note: * denotes significance level at 1% level.

Table 6 : Estimation results of EGARCH model under GED distribution

$$\log(\sigma_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\frac{\varepsilon_{t-k}}{h_{t-k}} + \beta\log(h_{t-1}) + \delta DVOL$$

Parameter	The Whole Period		Pre-crisis period		Post-crisis period	
	coefficient	P-value	coefficient	P-value	coefficient	P-value
ω	-0.374*	0.000	-0.380*	0.000	-0.247*	0.002
α	0.135*	0.000	0.139*	0.000	0.108*	0.002
γ	-0.078*	0.000	-0.077*	0.000	-0.075*	0.000
β	0.967*	0.000	0.967*	0.000	0.980*	0.000
δ	0.766*	0.000	0.761*	0.000	0.991*	0.000

Note: * denotes significance level at 1% level.

Table 7 : Estimation results of EGARCH model under Normal distribution (Gaussian)

$$\log(\sigma_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\frac{\varepsilon_{t-k}}{h_{t-k}} + \beta\log(h_{t-1}) + \delta DVOL$$

Parameter	The Whole Period		Pre-crisis period		Post-crisis period	
	coefficient	P-value	Coefficient	P-value	coefficient	P-value
ω	-0.374*	0.000	-0.381*	0.000	-0.281*	0.000
α	0.137*	0.000	0.141*	0.000	0.124*	0.000
γ	-0.076*	0.000	-0.076*	0.000	-0.076*	0.000
β	0.967*	0.000	0.967*	0.000	0.977*	0.000
δ	0.743*	0.000	0.739*	0.000	0.891*	0.000

Note: * denotes significance level at 1% level.

CONCLUSION

In this thesis, the impact of futures trading volume on the volatility of the underlying spot market is investigated, using data over the period 2005:2 – 2012:3. To check the possible impact of global financial crisis of 2008 on the volatility, the three periods were defined in the thesis: pre-crisis, post-crisis and whole period. This paper also used the EGARCH model to examine whether ISE-30 index exhibits asymmetric effects. The EGARCH model was also estimated under different distribution for robustness check. The results for two sub-periods and the whole period indicate that negative shocks have greater impact than the positive shocks in the Turkish stock market. Hence, there exists leverage effect. The results also show the dependence of volatility on its past behavior. As for the impact of futures trading volume on the spot market volatility, the results indicate that futures trading volume contributes information to the return volatility process of the spot market stock index. This conclusion is confirmed for all time periods.

We also estimated EGARCH model under different distributions such as GED, student-*t* and normal distribution (Gaussian). Three specification for all time periods produced very similar results. Hence, our results are robust.

Turkish stock and derivative markets showed a good performance during 2008-2009 crisis period. The precautions and pro-active policies made the Turkish markets stronger than relative markets, the US and European markets. Despite external shocks the Turkish markets remain stable.

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