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Inci Cisil Bulmus

RELATIONSHIP BETWEEN RETURN, VOLATILITY AND TRADING ACTIVITY: EVIDENCE FROM TURKISH DERIVATIVES EXCHANGE ISE-30 INDEX FUTURES CONTRACTS

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Author:	Inci Cisil Bulmus
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Name of the Supervisor:	Professor Janne Aijö
Degree:	Master of Science in Economics and Business Administration.
Department:	Department of Accounting and Finance
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ABSTRACT

This study examines the relationship between return, volatility and trading activity of ISE-30 Index Futures Contracts in Turkish Derivatives Exchange in the context of information based models and heterogeneous beliefs of investors, by gathering daily observations of each series from September 2005 through September 2010. The data was obtained from Turkish Derivatives Exchange database. The approaches applied in this thesis are Glosten Jagannathan and Runkle Generalized Autoregressive Conditional Heteroscedasticity (GJR-GARCH) and Vector Autoregression (VAR) analysis.

The present study describes the theory and implementation of methodology for testing the contemporaneous and causal relations between return, volatility and trading activity. First, finding of the positive correlation between trading volume and absolute value of price change is supported by Mixture of Distribution Hypothesis, Rational Expectations and Differences of Opinion Models. Second, causal relation in either direction between trading volume and returns suggests that trading volume adds predictive power in the presence of current and past returns or vice versa. Third, negligible reduction is obtained in the persistence of volatility by the inclusion of lagged trading volume into conditional variance equation by proposing that trading volume is not a good proxy for ISE-30 Index Futures market. Fourth, the evidence of causality for volume-volatility relationship in either direction suggests a feedback system for ISE-30 Index Futures. On one step further, lagged values of volatility (trading volume) have an ability to predict current trading volume (volatility) However, there is no such effect for the volume – open interest relation since the causality only runs from volatility to open interest. Finally, the existence of positive correlation and causality between trading volume and return volatility refers that new information is disseminated sequentially to traders as suggested by Sequential Information Arrival Hypothesis.

KEYWORDS: Volatility persistence, Trading activity, VAR, GJR-GARCH, Information based models, heterogeneous beliefs.

1. INTRODUCTION

A futures market is a very actively traded financial market allowing a wide range of price movement which brings large trading volume as well as liquidity. Many futures markets enable investors to trade 24 hours, therefore provide advantages over the other markets. In contrary to a cash market, a futures market transaction is an agreement for an exchange of the underlying asset in the future. Trading volume which shows how heavily security is traded, and open interest which applies to futures markets primarily, are fundamental measures to guide investors' decisions in these markets. Futures markets are said to be important source of information, especially during the panic times of market. Futures price volatility is, thus monitored more cautiously by active traders, policy makers and researchers (Racine & Ackert, 2000).

There is an extensive body of studies on the relationship between stock price changes, volatility and trading activity which includes both theoretical and empirical aspects. Although low volatilities have been occurred before the subprime mortgage crisis, implied volatility has reached very high levels by the crisis. Heteroscedasticity in financial time series, called volatility clustering, becomes important across the boards. Traders, financial analysts and other parties in various financial markets including commodity, derivatives, foreign exchanges and equity markets have suffered from risks which reduce their current positions dramatically. Prolonged economic downturns may cause these kinds of position risks and consequently lead parties to investigate the origins of volatility clustering. (Raunig and Scharler, 2010.)

Under the Efficient Market Hypothesis of Fama (1965) where the complete markets and homogeneous financial parties exist, it is not possible to obtain information about prices by using trading volume or open interest. However, these parties in financial markets may be heterogeneous with respect to the information they have or differ about the interpretation of the information they obtained. Starting from this point, it can be said that differences motivate investors' trade. Therefore, it is possible that differences have implications on any of the trading activity, trading volume or open interest.

The effects of trading activity on the volatility have not been concluded yet. Both trading volume and open interest may be considered as the determinants of volatility. However, their explanatory powers are different from each other. Trading volume is expected to be positively related to volatility, whereas open interest is anticipated to be negatively associated with volatility. Besides, volatility may be exposed to a balancing effect of trading volume and open interest (Ripple and Moosa, 2009).

Given these possibilities, it becomes an empirical question to ask what kind of relation exists between price changes, volatility and trading activities of a futures market. Therefore, in this study, both trading volume and open interest will be introduced and assigned as derivative trading activities for Istanbul Stock Exchange - 30 Index Futures Contracts.

1.1. Specifications of Futures Market

According to efficient market hypothesis (EMH), which is formulated by Fama (1965), there is no chance to earn excess profit, since the current stock prices reflect all available information about the value of firms. In other words, even investors with precise inside information will be unable to beat the market. In derivatives market, for instance, theoretical futures price consists of price of the underlying and cost of carry. Since the actual futures price is the same with this theoretical price, along with the efficient market theory, no arbitrage opportunity exists in the futures markets.

Futures are derivative instruments that fundamentally designed to eliminate the market risk of any particular investment product. Index futures are contracts whose underlying is the value of the index at any time. Since the first launched of the Value Line Contract[1], stock index futures has broadly evolved and traded with the introduction of new contracts all over the world (Gulen and Mayhew, 2000). There are two types of participants in futures market: hedgers and speculators. Their activities in futures market can be described in terms of trading volume and open interest. The notion is, trading

[1] The Value Line Contract was introduced by Kansas City Board of Trade on February 24,1982.

volume indicates the movements of speculators, whereas open interest refers to hedgers' activity in futures markets (Bessembinder and Seguin, 1993).

The literature has seen a chunk of studies which dedicated to explore whether the existence of futures trading leads to price stabilization in financial markets (Powers, 1970; Danthine, 1978; Turnovsky, 1983; Gilbert, 1989; Debasish, 2009). Futures market can be identified as *a vehicle for price discovery in the stock market* as noted by Koutmos and Tucker (1996:55). Furthermore, the price insurance provided by futures market is said to be more information efficient than spot markets in terms of low transaction costs and fewer regulations. Additionally, market players shape their so called *inventory decisions* by monitoring the futures market. As a result, volatility of cash prices may be less pronounced (Singh, 2007:156).

There is ongoing debate on the effects of introduction of futures market on the underlying cash market volatility. Some authors argue that introduction of futures market increase the underlying cash market volatility. For instance, developed countries respond by increasing volatility (Figlewski, 1981; Lee and Ohk, 1992; Gulen and Mayhew, 2000). It does look that way at first glance: the considerably high leverage effect in futures market usually captivates the uninformed traders therefore leading the excess volatility. On the contrary, others argue that futures trading make the market functional by carrying more efficient information to the underlying spot market and thus stabilizing prices as well as decreasing cash market volatility (Danthine, 1978; Antoniou, Holmes and Priestly, 1998).

1.2. Purpose of the Thesis

The objective of this study is to shed light on the relationship among return, volatility and the measures of trading activity, namely trading volume and open interest, in the context of information based models and heterogeneous beliefs of investors in Turkish Derivatives Exchange, TurkDEX, by employing Istanbul Stock Exchange - 30 Index Futures contracts series. Although a plethora of studies exist related to this subject in the literature, there are very limited researches which have been conducted on emerging market exchanges (Kim, Kim and Kim, 2004; Girard and Biswas, 2007; Yen and Chen, 2009; Debasish, 2009). As noted by Neragadu & Nowbutsing (2009), if the relationship between returns, volatility and volume are interpreted properly, then the microstructure of financial markets can be understood obviously.

The novelty of this study consists of documenting the relationship between return, volatility and trading activity in Turkish Derivatives Exchange by using Istanbul Stock Exchange - 30 Index Futures. First, the contemporaneous and causal relationship of ISE-30 Index Futures return and trading volume is examined. Next, trading volume is assigned as a proxy for changes in the set of information available to investors and persistence behavior of volatility is investigated. Finally, the causal relation of volatility – trading volume and volatility - open interest are analyzed in order to get a better understanding of ISE-30 Index Futures volatility and trading activity relationship.

1.3. Hypotheses

Three main hypotheses will be tested in this thesis. The first hypothesis is based on Chen, Firth and Rui (2001) and Deo, Srinivasan and Devanadhen (2008) models which aims to capture the contemporaneous and causal relations between price changes and trading volume. Following hypotheses are introduced in order to investigate the relation with respect to information based models including Mixture of Distribution Hypothesis and Sequential Information Arrival Hypothesis and, in terms of heterogeneous beliefs of market agents containing Rational Expectation Hypothesis and Differences of Opinion Model:

Hypothesis 1 (a): *There is a contemporaneous relation between ISE-30 Index Futures daily returns and daily trading volume.*

Hypothesis 1 (b): *There is a contemporaneous relation between absolute value of ISE-30 Index Futures daily returns and trading volume.*

Hypothesis 1 (c): *ISE-30 Index Futures daily returns cause daily trading volume.*

The heteroskedastic characteristic of the financial time series exhibits conditional time varying volatility and volatility persistence. Although Autoregressive Conditional Heteroscedasticity (Engle, 1982) and Generalized Autoregressive Conditional Heteroscedasticity (Bollorslev, 1986) models allow changes in the variance, they are not able to explain asymmetric characteristics of the volatility. In this study, the Glosten, Jaggannathan and Runkle Generalized Autoregressive Conditional Heteroscedasticity (GJR-GARCH) model (Glosten, Jaggannathan and Runkle, 1993) will be introduced in order to measure the volatility persistence. After that, lagged trading volume will be incorporated as an explanatory variable into GJR-GARCH model by following to similar approach of Girard & Omran (2009). Therefore the impact of trading volume on volatility persistence will be tested.

Hypothesis 2: *Lagged daily trading volume is a good proxy for daily information flow to the market and reduces the volatility persistence.*

Finally the third hypothesis is constructed based on Okan, Olgun and Takmaz (2009) model in order to understand the causal relation between volatility and trading volume. By following the same approach the author also tests the causal relation between volatility and open interest.

Hypothesis 3 (a): *Trading volume does cause to the ISE-30 Index Futures return volatility.*

Hypothesis 3 (b): *Open Interest does cause to the ISE-30 Index Futures return volatility.*

1.4. Contributions

Over the past decade, futures contracts trading began with the introduction of derivatives exchanges in many developing countries. ISE-30 Index Futures has been one of the most preferred and followed contracts by a wide group of investors in Turkish Derivative Exchange. The research that has been made on TurkDex is very limited due to the fact that trading at this derivative market commenced in 2005. Investigating the relation between trading activity, price changes and volatility in an emerging market is interesting since the degree of sophistication of emerging markets differs from those developed markets. This study extends the literature by fully analyzing the relationship between return, volatility and trading activity of ISE-30 Index Futures with recent dataset by testing the validity of various information based and heterogeneous beliefs models that have not been examined before by other researchers in such kind of study.

1.5. Structure of the Thesis

The thesis comprises two major parts including a theoretical and an empirical. The aim of the theoretical part is to introduce the previous studies done in this field by explaining the main aspects of the return, volatility and trading activity. The empirical part of the study sheds light on the relationship among returns, trading activity and the volatility by comprising Istanbul Stock Exchange - 30 Index Futures data, the empirical methodology and the empirical results along with the research process.

The setup of this paper is as follows. The first chapter presents the brief description of the topic, specifications of futures markets, and the hypotheses to be tested in the study. In Chapter 2, theoretical framework of the thesis is introduced for a better understanding of relevant explanations about variables and theoretical models. Review of the previous studies is given in Chapter 3. Chapter 4 introduces a brief description of the data with the features of Turkish Derivatives Exchange and the empirical methods applied in the study. In chapter 5, findings of the thesis are discussed. Finally, a brief summary, some limitations and suggestions for further research conclude the study in Chapter 6.

2. THEORETICAL FRAMEWORK

The main objective of this chapter is to present theoretical framework for the research problem by explaining the fundamentals of trading activity, volatility and, the information based and heterogeneous beliefs models that are crucial for a better understanding of the relation among return, volatility and trading activity.

2.1. Trading Activity

Trading activity, including trading volume and open interest, is considered to contain information about price changes in financial markets (Gallant, Rossi and Tauchen, 1992; Connolly and Stivers, 2003). In this part, trading volume and open interest are introduced separately in order to explain their fundamentals and basic differences.

2.1.1. Trading Volume

Trading volume, which is one of the measures of trading activity, can be defined as the number of any financial asset that traded over a period, reflecting the intensity of index, equity or commodity. Being an important indicator for traders, volume is one of the most followed data points after the prices. Trading volume mirrors the forego price action. There will be a higher level of trading volume, as the amount of trading increase. Therefore, it is possible to determine upside or downside trend of price by trading volume figures. Trading volume is also able to assess the strength of a price level (Ferris, Park and Park, 2002; Williams, 2007).

Trading volume gives important statistics about the state of financial markets. Since the volume reflects the supply and demand of a stock, for instance, low volume refers an illiquid market and large bid - ask spreads which allows to large price fluctuations in either side. (Pati and Rajib, 2010.)

Daily trading volume can be employed as a proxy for market strength. Using volume as a proxy for market strength has some drawbacks for stock traders. Movements for gaining arbitrage profits can lead to immense buying or selling which may not be a real demand or supply. Furthermore, when a bunch of stock is passed from one fund to other fund, artificial selling or buying pressure may occur. (Williams, 2007:35.)

Different studies use different methods in order to measure trading volume in the literature. Many studies use the total number of shares traded as measure of volume (Epps and Epps, 1976; Gallant et al., 1992) whereas some studies use turnover which is calculated by dividing the total number of shares traded over a period by the average number of shares outstanding for the period (Smidt, 1990; Campell, Grossman and Wang, 1993).

2.1.2. Open Interest

Open interest represents a calculation of number of active trades, so it is available for any futures or option markets. More specifically, it is calculated by adding all of the contracts that are associated with opening trades and subtracting all of the contracts that are associated with closing trades (Kevin, 2009:68). Opening a position can be fulfilled by the first buying or selling a certain amount of security whereas closing a position can be made by offsetting trade in the other direction (i.e. long position is closed by shorting the contract). In principle, when a new buyer and a new seller initiate a new position, open interest is said to be increased by one contract whereas when they close an existing position, open interest decreases by one contract. In that case, a trader with short position closes the existing position by going long (buying the contract) and, the other trader with long position closes the existing position by going short (selling the contract). The open interest does not change, if an existing trader passes off his old position to a new trader. Generally, open interest is said to be hit its highest value, one month before its maturity. The flow of money into the market can be also determined by open interest. For instance, increasing open interest refers to a new flow of money into the market, whereas decreasing open interest indicates market liquidation (Powers, 2001:137 - 140).

Open interest data may provide an additional measure of trading activity. While there is an extensive body of study conducted on trading volume, relatively little empirical work has been done on open interest. The open interest can be treated as a proxy for a potential price change (Bessembinder and Seguin, 1992; Watanabe, 2001). Hence, at the end of each trading day price trend can be deduced from open interest value. Furthermore, the direction of capital flows can be determined by the change in the level of open interest and enhanced the information that provided by trading volume (Ferris et al. 2002:370). Apart from that, the open interest can be assigned to gauge hedging positions (Bhargava and Malhotra, 2006:96).

Market Depth can be defined as the order flow that is required to move prices either up or down by one unit (Kyle, 1985). One can say that, trading activity is associated with market depth, considering the endogenously determined open interest as a trading activity. Hence, open interest can be assigned as a proxy for market depth. Moreover, market depth can be improved as the number of trader increase (Bessembinder and Seguin, 1992). As noted by Danthine (1978), number of informed traders increase with the futures market activity and therefore diminishing the volatility and enhancing the market depth.

2.2. Volatility

In financial markets, volatility is the spread of all likely outcomes of asset returns, in other words tendency of an asset's return to change over time. As the asset price changes a great amount from one day to another, the volatility will be high whereas if the variation of asset price is low from day to day, then volatility will be low as well.

The size of the error made in modeling financial asset returns is generally gauged by volatility which is actually a key parameter that is used in many financial applications

(Engle, Focardi & Fabozzi, 2007). Furthermore, return volatility plays a key role in financial economics as noted by Campell et al. (1993):

"…what distinguishes financial economics is the central role that uncertainty plays in both financial theory and its empirical implementation." (p. 3).

Volatility is mostly used for measuring the risk and forecasting future prices of futures prices of assets (bonds, stocks, derivatives). It needs to be modeled by stochastic process where the conditional variance is driven by non-measurable stochastic element since it is unobservable and evolves stochastically through time. Indeed, the level of uncertainty is also latent. Hence, it is impossible to obtain accurate volatility estimates even if there is a perfect knowledge about the past. In particular, as noted by Andersen, Bollerslev, Christoffersen and Diebold (2006:780) volatility can be forecasted in both discrete and continuous time. In fact, discretely sampled observations of financial asset series (i.e. price, return) are arose from an underlying continuous-time process where the liquid financial markets varies in a near continuous fashion throughout the trading day.

A good volatility model should be able to capture most of these facts. It should be noted that such an analysis is clearly an ex post investigation; i.e., it depends on the past data. However, a true analysis should be based on an ex ante research that obviously requires a forecast of future volatility (Poon and Taylor, 1992).

The volatility is statistically measured by the sample standard deviation:

(1) $$\hat{\sigma} = \sqrt{\frac{1}{T-1} \sum_{t=1}^{T} (r_t - \mu)^2}$$

μ is the average return over the T-day period and r_t is the return on day t and therefore $(r_t - \mu)^2$ can be defined as squared error. Variance, σ^2, is also used as a measurement of volatility. However, each squared error gets an equal weight and any future forecast is thus, time invariant which may not be desirable.

Stylized facts of volatility refer to general statistical properties of volatility. In the following four sections, well-known properties of volatility are introduced so as to understand behavior of volatility in financial time series.

2.2.1. Volatility Clustering

Volatility clustering is one of the stylized facts in financial markets. More specifically, evidence of clustering occurs when the serenity of market is broken by upheavals. Volatility exhibits persistence meaning that the magnitude of volatility is likely to cluster in periods of high volatility and low volatility. This behavior of financial market was first noted by Mandelbrot (1963). He suggested that large return innovations of either sign is followed by large innovations and small return innovations of either sign is followed by small innovations (Mandelbrot, 1963:403).

Presence of volatility clustering are demonstrated in various assets such as exchange rates, interest rate securities and market indices and also corroborated by Autoregressive Conditional Heteroscedasticity, ARCH (Engle, 1982) and various Generalized Autoregressive Conditional Heteroscedasticity, GARCH (Bollerslev, 1986) models (i.e. Exponential GARCH, Threshold GARCH). The presence of prolong periods of high or low volatility can be obviously seen from the graphic of any financial asset's returns. The volatility clustering feature, which is also a non - parametric property, has caused asset returns not to be independent across time when there is no linear autocorrelation in asset returns (Cont, 2005).

2.2.2. Long Memory Effect

Symmetric and asymmetric Generalized Autoregressive Heteroscedasticity (GARCH) models suggest that conditional variance decay at an exponential rate. If short horizons are available, exponential decay works well. Ding, Granger and Engle (1993) were the first noted the evidence of long memory in asset volatility. They reported the long memory in the autocorrelations of both absolute and squared returns of the S&P 500 index. They also provided evidence that impact of shocks take a substantial time to decay. Hence, long memory process suggests that autocorrelation of unknown shocks decays slowly. Regarding to the theoretical aspect, Andersen and Bollerslev (1997) developed a version of mixture of distribution hypothesis for returns. They noted that the volatility is resulted from the aggregation of numerous components that involves some short-run decay components and long-run dependence components (Andersen and Bollerslev, 1997:1002). Short-run components are related to estimation of intraday day data whereas long-run dependence components are more appropriate for the estimation of one day or longer day intervals.

2.2.3. Mean Reverting Process

Generally, a stochastic process tends to move back towards the own average value ultimately. More specifically, asset market returns tend to display mean reversion process by returning their long run mean values eventually. The notion is, volatility has its long run mean level and it will revert back its mean level ultimately. Various studies have been conducted to provide evidence on mean reversion features of financial assets. As documented by Porterba and Summers (1988) stock prices exhibits mean reversion feature. Bessembinder, Coughenour, Seguin and Smoller (1995) investigate the commodity prices in the context of term structure of futures prices and find that commodity prices return their equilibrium mean level. Furthermore, the mean reversion behavior of real exchange rates is examined by Jorion and Sweeney (1996) and they conclude that real exchange rates return their mean level finally. Fouque, Papanicolaou and Sircar (1999:40) examine the mean reversion feature of volatility by using S&P 500 index data. Their study provides evidence that the rate of mean reversion of volatility process is fast for low frequency data whereas volatility process is slow for high frequency data

2.2.4. Leverage Effect and Volatility Feedback

The symmetric responses of market to the positive and negative shocks have been presumed for linear volatility models. Black (1976) suggests a tendency for changes in stock prices to be negatively correlated with the changes in stock volatility. The asymmetric response of volatility to past negative and positive shocks is generally referred to as *leverage effect*, with negative returns resulting in larger future volatilities (Christie, 1982). The notion is, any increase in future volatility can occur due to the reduction in the equity value of firm which causes to increase in debt-to-equity ratio by raising the riskiness of a company (Bollerslev et al., 1992:24).

This asymmetry property can also be attributed to *volatility feedback* effect. Considering the different types of investors, another issue does emerge at this point. It is so called *feedback trading* where the traders seek for trend in stock price. As a result as the number of traders increase, autocorrelation in stock returns has come up. As suggested by Koutmos (1997), positive feedback traders buy shares when prices rise and sell otherwise. Consequently, positive feedback trading may cause the price go beyond its normal level and lead to excess volatility. Conversely, negative type of this kind may offset the prices (Bohl and Siiklos, 2008).

2.3. Information Based Models

Observing both trading volume and open interest may be essential for traders, however how traders learn from trading activity is vague. Any information that is deduced, for example from trading volume, may affect the traders demand and feed back into prices by also leading an increase in trading volume. The Mixture of Distribution Hypothesis, MDH (Clark, 1973; Tauchen and Pitts, 1983; Harris, 1986), and the Sequential Information Arrival Hypothesis, SIAH (Copeland, 1976; Jennings, Starks and Fellingham, 1981) are both appealing theoretical explanations for this phenomenon. Although the existence of heteroscedasticity characteristic is extensively established in many asset return series, the most likely source of this issue has not been found yet.

This section also tries to explain this phenomenon in the context of information based models.

2.3.1. The Mixture-of-Distributions Hypothesis

Anything that leads to financial parties to act can be defined as information in financial markets. Mixture of Distributions Hypothesis (MDH, henceforth) or model suggests that daily returns are generated by a mixture distribution. The rate of information flows into the market is indeed controlled by a *serially correlated mixing variable* in this context. When the well-grounded feature of heteroscedasticity in asset returns is taken into account, MDH can be considered as a theoretical explanation of this fact. Furthermore, heavy tail characteristic of returns can be explained by means of MDH (Okan, Olgun and Takmaz, 2009:97).

There are number of traders with different positions (long or short) and different expectations in the market. MDH posits that all traders get the essential information simultaneously from the market. Considering the basis of information flow into the market, traders may change their expectation in different directions which may cause high or low trading volumes. Hence, large price movements appear due to high volumes and low price movements emerge due to low volumes. To measure the speed of price changes, there should be a so called *imperfect clock* in which is proposed by Clark (1973:146). Therefore, Clark assigns the trading volume for this purpose. He argues by using speculative cotton futures market that if the number of information arrival (i.e. random variables) being added is varied over time, limit distribution of price changes is subordinate to the normal distribution.

Generally, the news process variables such as daily number of transactions, daily cumulative trading volume, number of quotes or number of limit orders are all related to market activity and they can be considered as information flow into the market (Andersen, et al., 2006:816). The formulation can be given as follows:

(2) $y_t = \mu_t s_t + \sigma_t s_t^{1/2} z_t$ or equivalently,

$y_t \mid s_t \sim N(\mu_t s_t, \sigma_t^2 s_t)$

where y_t is the activity variable, μ_t is the mean of response of the variable per news event, σ_t is a scale parameter, s_t is the intensity of relevant news arrival and z_t has independent identical distribution, N(1,0). This formulation refers to a normal mixture model. s_t depends upon the time and it leads to fat-tailed unconditional distribution which is compatible with return or trading volume series. Furthermore, when the relevant news arrivals are positively correlated, shocks to the conditional mean and variance for activity variable, y_t will be persistent. Considering the well defined serial dependencies of for instance trading volume, clustering behavior of markets is thus, consistence.

The joint distribution of trading volume and the price volatility are both depend upon the same but unexpected news process which can be defined as latent rate of information arrival (Tauchen and Pitts, 1983). Generally, market activity variables such as number of transactions or trading volume are latent factors that are relevant to price changes. The arrival of information is, thus directing the relationship between price volatility and trading volume. In other words, there is a contemporaneous respond given by both trading volume and the volatility to new information. Hence, the estimation of latent variables is becoming essential.

MDH proposes a positive contemporaneous relation between absolute value of the price change and trading volume. The notion is, when the demand of a security is changed, it leads a change in the price level. As demand changes, transactions are taken place in response to these changes, until a new equilibrium has been reached in the price level. Thus, it can be said that the volume of the trade increases with the demand regardless of the direction of price change (Clark, 1973; Tauchen and Pitts, 1983).

2.3.2. Sequential Information Arrival Hypothesis

Sequential information arrival hypothesis (SIAH, thereafter), introduced by Copeland (1976), can be defined as a range of dynamic adjustments. There is market equilibrium in the beginning of this process and only one market participant is informed when the new information arrives at the market with respect to this hypothesis. Once the investor informed, he may change his beliefs after the interpretation of new information and re – trade until reaching a new equilibrium price. All this process produces trading volume. Finally, the market reaches a new but temporary equilibrium. Next, following investor is informed and identical process is reproduced. Hence, the participants revise their beliefs and re-trades in a sequential fashion. Sequential transitional equilibriums occur as the new traders are informed and final equilibrium is reached after all the traders have been informed. Thus, new price movements and transactions volume are generated by sequential new information flows. Correlation between volume and volatility arises due to the successive movements. (Copeland, 1976.)

SIAH is based on many assumptions including costless information, unlimited borrowing and lending, unlimited short sales, no transaction costs and no taxes. In the beginning, participants have common beliefs and preferences with one risk free and one risky asset. When the sequential process begins, participants become heterogeneous about their beliefs and preferences concerning to their interpretation of new information. Copeland's SIAH model is extended by Jennings et al. (1981:144). They introduce the *margin requirement* which limits the short sales. Therefore, unlimited short sales assumption of Copeland's model is eliminated. Furthermore, they test the new model considering the effect of short sales restriction on transactions volume – price change relation and obtain a *positive linear* relationship (Jennings et al., 1981:156).

Overall, the sequential reaction to information proposes that lagged values of volatility may be able to predict current trading volume or, vice versa. Therefore, receiving information in a sequential, random fashion requirement is satisfied.

2.4. Heterogeneous Beliefs

In this part, market agents that have heterogeneous beliefs, preferences and strategies are taken into consideration in order to explain theoretical relation between return and trading activity. Differences in Opinion Model (Harris and Raviv, 1993) and Rational Expectations Model (Wang, 1994) can be considered as important models in this sense.

2.4.1. Differences of Opinion Model

One striking fact about the financial markets is the presence of a great variety of traders with their various beliefs. Harris and Raviv (1993) developed a model which is grounded to the differences of opinions between traders in order to explain the trading in speculative markets. They assume that the traders receive the common information while sharing prior common beliefs about the market state. However, they differ in interpretation of the received information. In their model, trading takes place for only speculative purposes therefore producing trading volume (Harris and Raviv, 1993:481). Although investors have the same information, they use their own models in which can be updated regarding to the relation between returns and the data.

There are two types of risk neutral investor in the market: responsive and unresponsive. These investors are indifferent whether given the information is favorable or unfavorable but differ the extent to which the information is important. As the favorable information becomes available, responsive traders increase their probability of high returns more than those in unresponsive groups. Thus, the asset will be valued highly as long as the cumulative past information is favorable. Also, the asset will be valued highly by the unresponsive traders as the cumulative past information is unfavorable. As a result, trading is generated as the cumulative information switches from favorable to unfavorable or vice versa and positive correlation will occur between absolute value of the price changes (i.e. return) and the volume. Moreover, trading volume is expected to be positively autocorrelated (Harris and Raviv, 1993:475).

2.4.2. Rational Expectations Model

Rational Expectations Model, which can be defined based on Muth's (1961) reputed work that is rested on rather strong assumptions referring the amount of information available to individual financial parties and their ability to exploit this information.

Concerning to financial markets, there are two types of investors including informed and uninformed. The informed traders have the perfect private information whereas uninformed traders have only the noisy signals (Shalen, 1993; Wang, 1994). Under the symmetric information investors have the same information about the future cash flows whereas regarding to the asymmetric information, investors are heterogeneous and they differ about the information they have. According to the model, trade of investor depends upon investor's demand for liquidity. Under the asymmetric information uninformed traders rationally deduce information about for example futures cash flows based upon realized dividends (Wang, 1994:131-132).

When a group of investor shorts to shares in order to rebalance their portfolios, price of stocks must go down. The reason is, as the information asymmetries grow uninformed traders require higher discount in prices in order to compensate the risk of trading against private information, when they buy stocks from those informed traders. Indeed, the price changes are associated with the trading, since the investors are risk – averse. Hence, there is a positive correlation between absolute price changes and trading volume. This correlation becomes higher as the information asymmetries increase (Wang, 1994:148).

3. LITERATURE REVIEW

This section is fundamentally forming the literature review part of this thesis. In this part, the early empirical studies are given in fourfold. Firstly, previous researches on the relation between return and trading volume are reviewed. Secondly, studies on the relation between volatility and trading activity are evaluated. Thirdly, causal relations among the volatility, trading volume and open interest are inspected. Finally, prior researches which have been conducted on Turkish Stock Market are detailed.

3.1. Price Changes (Return) and Trading Volume Relation

Ample of studies have sought to explain the relationship between trading volume and price changes (i.e. return) in different countries and in various asset markets. Researchers hypothesized that the trading volume would drive the price variability and this is supported by several empirical studies. While the contemporaneous relation between volume and return (per se) or absolute value of return is based on Mixture of Distribution Hypothesis, Differences of Opinion Model and Rational Expectations Model, causal relation between these variables depends on Sequential Information Arrival Hypothesis.

Having looked at the early literature, Granger and Morgenstern (1963) investigate the relation between price change and volume by using New York Stock Exchange data. They apply spectral methods, where a discrete time series has no trend and therefore stationary. They conclude that there is no relation between aggregate volume and composite price index. Godfrey, Granger and Morgenstern (1965) find no relation between volume of transactions and the price. Contrarily, Crouch (1970) questions the relation by employing Dow Jones price index and the corresponding volume of transactions. He finds a positive correlation between absolute level of price change and the volume of transactions. Copeland (1976) develops a model which is known as Sequential Information Arrival model (as explained in section 2.3.2.), for asset trading and reports a positive relation between absolute price change and volume. A paper from Epps and Epps (1976) suggest a positive contemporaneous relation running from trading volume to absolute price change. Rogalski (1978) focuses his scope on individual securities by using monthly observations and finds a positive interrelation between price change and volume indicating that security prices and volume are dependent.

Since the investors take position concerning to transaction costs, Jennings, Starks and Fellingham (1981:157) modify the SIAH model by including margin requirements which is actually imposition of a cost for traders. They report a positive causal relation in either direction between price change *per se* and trading volume. Wood, Mclnish and Ord (1985), questions the return-generating process along with the features of trading (size, frequency and level of transaction), and behavior of returns for NYSE stocks. They report a direct relation between absolute value of price change and trading size and also absolute value of the price change and trading frequency.

Moosa and Al-Lougnahi (1995) examine the price - volume relation for emerging Asian stock markets. They find causality from volume to absolute price changes which also supports SIAH (Copeland, 1976) as indicating that positive price changes lead to higher transactions for Malaysia, Singapore and Thailand. They also report causality from price changes per se to volume for the same countries.

Saatcioglu and Starks (1998) try to explain the price-volume (turnover) relation in emerging Latin American Markets. By using monthly value weighted total index return in local currency and U.S. dollars covering period from 1986 to 1995, they find a positive relation between return and volume, and also absolute returns and volume (Saatcioglu and Starks, 1998:205). Chen, Firth and Rui (2001), examine nine of the largest and well established stock markets including New York, Tokyo, Paris, Toronto, London, Milan, Zurich, Amsterdam and Hong Kong by using daily data from 1973 to 2000. They report a positive contemporaneous relation between trading volume and absolute value of stock changes for all markets. However, they find a positive contemporaneous relation between price changes and volume for only Japan, Switzerland, Hong Kong, Netherland and France.

Lee and Rui (2002) question the relationship by using daily data of the Tokyo, New York and London stock exchanges. A positive contemporaneous relation is found between trading volume and returns in all markets supporting the MDH (Clark, 1973). Furthermore, they also test causal relation between variables and report that trading volume does not cause returns meaning that in the presence of current and past returns, trading volume is not able to predict future returns (Lee and Rui, 2002:61).

A paper from Deo, Srinivasan and Devandhen (2008:64 - 65) focuses on the dynamic relation among trading volume, volatility and price changes in Asia-Pacific stock market over the period 2004 to 2008. They obtain a significant contemporaneous relation between trading volume and absolute value of stock returns. Alongside of finding significant contemporaneous relationship, they also reported a causal relation between returns and volume indicating a feedback system for Hong Kong, Indonesia, Malaysia and Taiwan stock markets. Their findings support both MDH (Clark, 1973) and SIAH (Copeland, 1976).

Table 1. Previous studies on trading volume and return relation

Authors	Price –Volume Change *Per se*	Absolute Price - Volume
Granger & Morgenstern(1963)	No correlation	
Godfrey, Granger & Morgenstern (1965)	No correlation	
Crouch (1970)		Yes positive

Table 1. Continued

Copeland (1976)		Yes positive
Epps & Epps (1976)		Yes positive
Rogalski (1978)	Yes positive	
Jennings,Stark & Fellingham (1981)	Yes positive	
Wood, Mclnish &Ord (1985)		Yes positive
Gallant, Rossi & Tauchen (1992)		Yes positive
Moosa & Al Lougnahi (1995)	Yes positive	Yes positive
Saatcioglu & Starks (1998)	Yes positive	Yes positive
Chen, Firth &Rui (2001)	Yes positive	Yes positive
Lee & Rui (2002)	Yes positive	
Deo,Srinivasan &Devandhen (2008)	Yes positive	Yes positive

3.2. Volatility Persistence and Trading Volume

The positive relationship between volatility and trading volume is well documented by many studies (Lamoureux and Lastrapes, 1990; Gallant et al., 1992; Kim and Kon; 1994, Gallo and Pacini, 2000). The notion is, presence of Autoregressive Conditional Heteroscedasticity (ARCH) of daily price movements are positively related to trading volume which is a stochastic mixing variable reflecting the rate of daily information flows to the market. Trading volume is thus, assigned as a good proxy for unobservable information arrival to the market by early studies (Phylaktis, Kavussanos and Manalis, 1996; Pyun Lee and Nam, 2000; Chen, Firth and Rui, 2001; Bohl and Henke, 2003; Lucey, 2005; Girard and Biswas, 2007; Deo, Srinivasan and Devandhen, 2008).

Lamoureux and Lastrapes (1990) investigate the trading volume and stock return volatility for the U.S. market by using 20 actively traded stocks. They conclude that persistence of volatility substantially decreases by the inclusion of serially correlated contemporaneous trading volume. Gallant, Rossi and Tauchen (1992) examine the relationship by using S&P composite index daily returns from 1928 to 1987. They document a relation between asymmetric response of volatility and high stock returns with high volumes and show that leverage effect is removed with the introduction of conditioning lagged trading volume with past returns.

The work of Lamoureux and Lastrappes (1990) can be thought as a micro level, because the study just focuses on actively traded shares. However, the study of Gallant et al. (1992) comprises the whole index, therefore can be thought as a macro level.

Phylaktis, Kavussanos and Manalis (1996) use lagged daily trading volume and value as proxies for information flow in order to explain the generalized autoregressive conditional heteroscedasticity (GARCH) property of stock returns in the Athens Stock Exchange for data period from 1988 to 1993. Their study uncover that both the value of transaction (trading value) and volume of transaction (trading volume) reduce the GARCH effect by being good proxies for information flow therefore providing evidence of mixture of distributions hypothesis. Furthermore, they obtain a greater reduction in the GARCH effect when they assign the value of transaction rather than volume of transaction. They also report a positive conditional volatility and trading volume/value relation in Athens Stock Exchange.

Pyun, Lee and Nam (2000), doubt whether the ARCH effect is generated by the flow of information in the Korean equity market. By using weekly returns of individual securities on Korean Stock Exchange, they test the effect of current volume on conditional volatility. They find that trading volume, reflecting the information arrival, generates the ARCH effect in this emerging market. On one more step further, they test the effect of lagged volume however they do not obtain any significant relation. Therefore, their study supports the MDH in favor of contemporaneous relation between trading volume and conditional volatility.

Chen, Firth and Rui (2001) examine the dynamics among stock returns, trading volume and volatility by using nine national stock markets including, U.S., Japan, U.K, France, Canada, Italy, Switzerland, Netherland and Hong Kong. They report that 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).

By employing daily returns and trading volume data for stocks listed in Warsaw Stock Exchange, Bohl and Henke (2003) provide evidence that inclusion of current volume into conditional variance equation reduce the volatility of many individual securities. Hence, their study supports to MDH (Clark, 1973) to a large extent in Polish stock market.

Arag´o and Nieto (2005) analyze the volume-volatility relationship in the whole market level by focusing on world main stock markets including U.S., Germany, France, Italy, Spain, U.K, Switzerland and Japan by splitting up the volume as expected and unexpected component over period from 1995 to 2000. Their findings suggest that unexpected volume affects the volatility more than total volume. However, the GARCH effect is not reduced at all by the inclusion of either total volume or the expected and unexpected volume. The relationship is questioned for individual securities in Dublin Stock Exchange by Lucey (2005). The effect of the inclusion of trading volume to the conditional variance does not reduce the persistence in Irish stock market by providing no favorable evidence for MDH.

Girard and Biswas (2007) examine the relationship between trading volume and volatility in emerging and developed stock markets by utilizing Threshold GARCH (TGARCH) model. Addition of total volume does not reduce the persistence in both markets. However, when they split up the trading volume as expected and unexpected components, their results state a reduction in volatility for both developed and emerging markets.

Naregadu and Nowbutsing (2009), using Stock Exchange of Mauritius (SEM) data, examine the relationship among trading volume, stock returns and volatility. They find no evidence that supports both MDH (Clark, 1973) and SIAH (Copeland, 1976) in this thin emerging market considering the very weak positive relationship between these variables.

Pati and Rajib (2010), investigate the relationship for NSE Nifty index futures. They obtain a more substantial reduction in volatility persistence after the inclusion of contemporaneous trading volume than inclusion of lagged trading volume in conditional volatility equation in Indian stock market. Their findings suggest that, current trading volume as a good proxy for information arrival to the Indian stock market.

The following table summarizes the empirical literature that has been reviewed in a chronological order.

Table 2. Literature review on the relationship between conditional volatility and trading volume.

Author(s)	Country/Period	Method	Mixing Variable	Support for Reduced Persistence?
Lamoureux & Lastrapes (1990)	The U.S/1990	GARCH	Current Trading Volume	Yes
Gallant,Rossi &Tauchen (1992)	The U.S/1928-1987	Semi-non parametric	Lagged Trading Volume	Yes
Phylaktis ,Kavussanos & Manalis(1996)	Greece/1988-1993	GARCH	Current Trading Volume/Value	Yes
Pyun, Lee & Num (2000)	Korea/1990-1994	GARCH	Current Trading Volume	Yes
Chen,Firth & Rui (2001)	9 national stock markets[2]/1973-2000	EGARCH	Current/Lagged Volume	No
Bohl & Henke (2003)	Poland/1999-2000	GJR-GARCH	Current Trading Volume	Yes
Aragò &Nieto (2005)	7 National stock markets[3]/1995-2000	GARCH	Current Expected/Unexpected Volume	No
Lucey (2005)	Ireland/2000-2003	GARCH	Current Trading Volume	Yes
Girard & Biswas (2007)	Developed & Emerging Markets/ 1980-2005	TGARCH	Lagged Expected/ Unexpected Volume	Yes

[2] The U.S., Japan, U.K, France, Canada, Italy, Switzerland, Netherland and Hong Kong
[3] U.S., Germany, France, Italy, Spain, U.K., Switzerland and Japan

Table 2. Continued

Neragadu& Biswas (2009)	Mauritus/2002-2008	GJR-GARCH	Current Trading Volume	No
Pati & Rajib (2010)	India/2004-2008	EGARCH/ GARCH	Lagged/Current Trading Volume	Yes

3.3. The Relationship between Volatility and Measurement of Trading Activity

Considerably less research has been conducted on the volatility, trading volume and open interest relationship. Open interest only includes open positions whereas trading volume consists of both open and closed positions in a trading day. Hence their effects on volatility may differ from each other.

Figlewski (1981) examine the relationship between GNMA (Government National Mortgage Association) pass through futures and related cash market volatility determinants including trading activity, price level, the amount of futures issues, number of secondary market transfers and also near and cash future volatilities. In his study, open interest and trading volume are assigned in order to gauge to size of the futures market and measure the current trading activity, respectively. Findings of his study suggest a positive relation between each of the trading activity and the futures market volatility. In addition, there is a causality that exists from futures market activities to price volatility in the cash market. Chen, Cuny and Haugen (1995) propose a theoretical model in order to investigate the effects of volatility on open interest and the basis[4]. While they report a negative relation between the basis and S&P 500 Cash Index volatility, positive relation is obtained between open interest of S&P 500 futures and S&P 500 Cash Index volatility. The latter relation suggests that investors are not

[4] Market futures price minus fair futures price (as given by the current spot price of the cash index grossed up by the interest rate and adjusted for expected dividends).

willing to sell stocks in order to decrease their market risk exposure. Instead, they sell S&P 500 futures therefore increasing open interest. Watanabe (2001:653) investigates the dynamics of trading activity and volatility by taken into consideration the OSE[5] regulation for the Nikkei 225 Stock index futures where both margin rates and minimum requirement are decreased. He divides the each trading activity as expected and unexpected components and provides evidence of positive relation between unexpected component of trading volume and volatility. Notwithstanding he does obtain a significant negative relation between expected component of open interest and volatility after the OSE deregulation for trading of Nikkei 225 futures.

Ferris, Park and Park (2002), using S&P 500 index futures data, explore the dynamic interaction and causal relationships between volatility and trading activity by including arbitrage opportunities, such as pricing error. In order to forecast, relations they apply Vector Autoregression model by using the natural logarithm of open interest, trading volume and pricing error. Their findings suggest that open interest is caused by its own lags, trading volume and pricing error, and trading volume is caused by its own lags, open interest and pricing error. However, no relation is found between either trading volume and volatility or open interest and volatility. Motladiile and Smit (2003) question the relation between open interest of the future contract, basis and volatility of the underlying index of by using the data from South African Futures Exchange during the period from 1998 to 2001. By applying cost of carry model, while they provide evidence of a positive relation between open interest and volatility, negative relation is obtained between basis and volatility of the underlying index. Regarding to the positive relation between open interest and volatility, they suggest that as volatility increases traders would be willing to hedge their positions by buying more future contracts.

Kim et al., (2004) investigate the contemporaneous relationship among open interest, trading volume and current market stock volatility by employing KOSPI[6] 200 Derivatives intra-day data for both futures and options from 1996 to 2002. They apply simultaneous equation model based on three stages least squares method and suggest a

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[5]Osaka Security Index.
[6]Korea Stock Price Index.

positive contemporaneous relation between stock market volatility and unexpected trading volume that is consistent with Watanabe's (2001) study. However they report a negative relation between unexpected open interest and stock market volatility.

Yang, Balyeat and Leatham (2005) examine the lead-lag relationship between trading activity and cash price volatility by concentrating on futures agricultural commodity market. They find a unilateral causality from unexpected trading volume to volatility. However, no strong causality is found between open interest and volatility.

Yen and Chen (2009) analyze the Taiwan futures market by using lagged logarithmic values of total open interest (TOI) and trading volume (TVOL). Vector Autoregressive model results for the out of sample suggest that there is no lead-lag association between log of TOI and TVOL. The lagged log of TOI is not associated with the volatility whereas log of TVOL have an impact on the volatility (Yen and Chen, 2009:126). Ripple and Moosa (2009) test the effect of maturity, open interest and trading volume on volatility by using contract-by-contract and time series analysis. By employing NYMEX[7] crude oil futures data their findings unveil that although trading volume has a greater impact on volatility, the explanatory power of open interest is significant prevailing the effects of maturity on the volatility. Moreover, as the maturity date approaches, open interest tends to decrease and lead to increase volatility.

3.4. Evidences from Turkish Stock Market

The research that has been made on the specific area of return, trading activity and volatility relation is very limited for Turkish stock markets. Actually, this is a common feature for emerging markets. While, much of the research has focused primarily on the relationship between price changes and trading volume, few have examined the causal relation between these variables. It should be noted that emerging markets are different from the developed markets when the specification of stock markets are taken into account in terms of loose standards and the information content that is not available to

[7] New York Mercantile Exchange.

all investors therefore leaving a room for speculative movements. In this context, Basci, Ozyildirim and Dogan (1996) propose a model that market participants are subjective about value of the stock. Furthermore, there is no short selling or borrowing money in the proposed model due to the existence of parties that have unlimited demand for stock or money. They argue that the presence of *equilibrium price – allocation pair* depends upon the restriction on short sales. By employing weekly data series for 29 individual stocks that are traded in Istanbul Stock Exchange, they find a positive correlation between trading volume and return. On one more step, using ISE composite index daily return data from 1992 to 1998, Salman (2002) applies Generalized Autoregressive Conditional Heteroscedasticity in Mean (GARCH-M) model in order to investigate relation between return, volume and volatility. He finds a positive and contemporaneous relation between volume and returns. Besides his findings suggest a positive risk-return-volatility relation, when the volume is taken as a proxy for the information arrival into market and incorporated both into mean and variance equation.

Yuksel (2002) employs intraday volume and intraday return data of ISE National – 30 Index so as to examine the impact of structural changes on information arrivals during 1998 Russia Crisis. His study reports a contemporaneous relation between volume and the absolute value of returns in Turkish stock market for pre - crisis, crisis and post – crisis periods. In addition, the price effect of trading increases during the crisis time and cannot get back to the pre-crisis level after the crisis by confirming that information arrivals become a major issue with the structural change (Yuksel, 2002:95). Additionally, he tests the effect of volume on conditional variance by including one period lag value of trading volume into variance equation. Although the lag value of trading volume is found to be significant for pre – crisis period, it is not able to reduce GARCH effect. Sabri (2004) investigates the various predicting factors of stock return volatility by using monthly data of five different areas of emerging markets including Turkey, Mexico, Korean, South Africa and Malaysia. His findings reveal a strong positive correlation between trading volume and price changes that causes to increase in price volatility in emerging markets. As reported in his study, trading volume can be assigned as a major factor that predicts return volatility in Turkey (Sabri, 2004:71).

On one more step, Lokman and Hatemi (2005) examine the causal relationship between trading volume (or turnover) and stock price changes in Central & Eastern Europe (Czech Republic, Poland, Hungary), Turkey and Russia stock markets therefore comparing developed and emerging economies. Their study reveals a unilateral causality from stock price to trading volume and market turnover in Turkish stock market. It can be said that it is possible to forecast future price of stocks by looking at trading volume or market turnover data. Further implication refers an evidence against weak form of market efficiency in accordance with this relation, since it is not possible to predict future price by analyzing prices from past. Baklaci and Kasman (2006), using daily return and trading volume of 25 individual stocks listed in Istanbul Stock Exchange (ISE) and applying GARCH (1, 1) model, uncover that when the contemporaneous value of trading volume is included in variance equation, just 6 stocks exhibited a decrease in volatility persistence. Although the positive contemporaneous relation between volume and return exists, validity of MDH (Clark, 1973) is rejected for Turkish stock market. Okan et al. (2009) investigate the volume-volatility relationship by using ISE-30 Index Futures data. They obtain a substantial reduction in volatility persistence after the inclusion of trading volume into the Exponential GARCH model. In addition, applying Vector Autoregressive analysis, they find a bilateral relation between volatility and trading volume. Their findings are consistent with the SIAH (Copeland, 1976) by suggesting a lead lag relation between volume and volatility. In a more recent study, Kiran (2010) analyze the relation between volatility and volume by employing Istanbul Stock Exchange Composite Index (ISE-100) data and applying various GARCH models. Findings of this study suggest a significant negative relation between volume and volatility which is contradict with the previous studies by suggesting evidence against both MDH (Clark, 1973) and SIAH (Copeland, 1976).

4. DATA AND EMPIRICAL RESULTS

4.1. Data

The data[8] of ISE-30 Index futures contract series with daily settlement prices, trading volume and open interest are sourced from the TurkDEX. The sample period extends from 1 September 2005, to 30 September 2010 including 1280 observations.

4.1.1. Turkish Derivatives Exchange ISE – 30 Index Futures Contracts

Turkish Derivatives Exchange (TurkDex, henceforth) is a self-governing joint stock corporation which is one of the fastest – growing derivatives exchanges in recent years to become a top 25 global exchange. Trading at the TurkDex began in 4 February 2005. TurkDEX ranked number 24 in 2009 in the Futures Industry Association's (FIA) global list of top 53 derivatives exchanges measured by volume, up 45.8% on 2008[9]. There are four class of assets available to the investors namely, equity, commodity, interest rate and forex. All TurkDex products are available to international investors without any regulation constraints. Furthermore, TurkDex is tax-free for both local institutional and foreigner investors and there is no short sales restriction.

The Istanbul Stock Exchange 30 Index Futures (henceforth, ISE-30 Index Futures), is a very broad-based index which accounts for almost 70% of capitalization and market volume on the Istanbul Stock Exchange (ISE). The prices of futures reflect expectations about the spot price on a particular delivery day which is fixed and not changes as time passes. Investors are able to invest on the direction of whole economy with the ISE-30 Index Futures. They can also make use of leverage effect by depositing 10% of the equity index contract value, which gives them a chance to have a greater position.

[8]The data are obtained from the TurkDEX website:
(http://www.turkdex.org.tr/VOBPortalEng/detailsPage.aspx?tabid=329).

[9] 2009 Annual Volume Survey: FIA magazine. Retrieved on September 21, 2010

Furthermore, ISE-30 Index Futures are usually used for hedging purposes by hedge funds. Features of ISE-30 Index Futures Contracts are shortly given as follows:

Underlying asset is based on the stock prices of the companies comprised in ISE National-30 stock price index. *Cash settlement* is specified for settlement method. Last business day of each contract month is determined for both *last trading day* and *final settlement day*. Generally, *daily settlement price* is computed by taking the weighted average of all the transactions performed within the last ten minutes before the closing of the trading session based on the quantity. If the number of transactions performed is less than 10, weighted average of the last 10 transactions before the closing session can be calculated[10]. *Contract size* of the futures is calculated by dividing the index value by 1.000 and multiplying this value by TRY[11] 100.

The Commodity Futures Trading Commission approved the sale of ISE-30 Index based contract by the 19th of August, 2010. Since therefore, TurkDEX are able to sell and distribute its flagship index contract in the U.S. Consequently, increase in trading activity is expected for TurkDEX.

4.2. Empirical Methods

Monitoring the price behavior frequently come into prominence in order to predict and understand price movements, since the large price movements in financial markets direct the researchers' attention. One might investigate the price behavior by applying different statistical methods. Since the tomorrow's price is uncertain, it is very desirable to understand future distribution of returns. By doing so, participants of financial markets may be able to take better decisions. The assumption of normal distribution, which places independent and identical distributions of asset prices, was refuted by Mandelbrot (1963) and Fama (1965).

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[10] For further information: http://www.turkdex.org.tr/VOBPortalEng/
[11] ISO 4217 code for Turkish Lira.

Asset returns have well documented distribution characteristics such as non-stability and departures from normality. Different statistical characteristics of stock returns dates back to the leading work of Fama (1965) and Mandelbrot (1965). Although Cootner (1964) found the longer tail asset distribution in his study, Mandelbrot (1963) was the first questioned the normal distribution of stock returns. The daily returns display autocorrelations for short lags. Considering the future stock price activities, mathematical models become important to predict the future behavior of stock prices In this study P_t is denoting the daily settlement price at time t and continuously compounded returns series of interest is denoted by:

$$(3) \qquad R_t = 100 * \ln\left(\frac{P_t}{P_{t-1}}\right)$$

The logarithm of price changes (i.e. return) diminishes the effect of price-level non-stationarity on the estimated return volatility. A tendency for the price level to revert to its trend path over time occurs as long as asset prices follow a mean- reverting process. Therefore financial market participants do forecast future returns by utilizing the information of previous returns (Chaudhuri and Wu, 2003).

4.2.1. Trend and Tests for Unit Roots

Many economic or financial time series have been dominated by trend. It is a very common feature arising from steadily rising population. Previous studies indicate strong evidence of linear and non-linear trends in trading volume series (Gallant et al., 1992; Chen et al. 2001; Lee and Rui, 2002; Deo et al.2008). Here, TurkDEX is one of the emerging derivatives exchange market that has been growing substantially, since the beginning date of trading in 2005. Along with this growth, the trading volume may suffer from trend and this behavior lead to the series to be non-stationary. Taken this into the consideration, the linear, t, and non-linear or *quadratic* trend, t^2, are introduced. Hence the following regression is run for trading volume:

(4) $V = \delta_0 + \delta_1 t + \delta_2 t^2 + \varepsilon_t$,

where *V,* is the trading volume of raw data. Coefficients of linear and quadratic trends are found statistically significant. Residuals from above equation will be used as detrended volume (DV) thereafter.

Here, the author runs the same regression for open interest that is based on Watanabe's (2001) model, since there is an upward trend in the open interest (see, Appendix 6). The regression for the open interest is given as follows:

(5) $OI = \theta_0 + \theta_1 t + \theta_2 t^2 + \varepsilon_t$

where, *OI* is the open interest and, *t* and t^2 denote linear and non-linear or *quadratic* trend respectively. Residuals from this regression will be used as detrended open interest (DOPI), thereafter.

When the mean and the second moment of the underlying process are not constant, non-stationary time series occur. Non-constant means, μ_t, non-constant variance, σ_t^2, or both of these features may cause non-stationary time series (Wei,1990:67.) Since the second moment, variance, of price varies with the time, statistical analysis becomes burdensome. Besides, it is necessary to check possible effects of trend in time series which lead series to be non-stationary.

As suggested by random walk hypothesis (RWH) that dates back to work of Bachelier (1900), price changes are in some way random and so wander in a completely unpredictable way. The best forecast of tomorrow's price requires today's price but not previous prices. Large stock markets support the random walk hypothesis whereas small stock markets show deviations from random walk. A random walk process says that any shock to stock price is permanent and there is no tendency for the price level to return to a trend path over time. Hence, it is necessary to check whether the return series of futures market have unit root or not. The stationarity of return, trading volume and open interest series are tested by applying three different tests including Augmented Dickey Fuller (Dickey and Fuller, 1979), Phillips-Perron (Phillips and Perron, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (Kwiatkowski, Phillips, Schmidt and Shin, 1992). Theoretically, three tests are given as follows:

(6) Augmented Dickey Fuller (ADF) regression

$$\Delta x_t = \rho_0 + \rho x_{t-1} + \sum_{i=1}^{n} \Delta x_{t-i}$$

(7) Phillips-Perron (PP) regression

$$x_t = \alpha_0 + \alpha x_{t-1} + u_t$$

(8) Kwiatkowski- Phillips-Schmidt-Shin (KPSS)

$$y_t = \xi t + r_t + \varepsilon_t$$
$$r_t = r_{t-1} + u_t$$

ADF and PP tests are used for testing a null hypothesis that observable time series has unit root indicating a series is non- stationary where $\rho = 0$ and $\alpha = 1$, whereas KPSS tests a null hypothesis that observable time series is stationary around a deterministic trend, t , if $\xi \neq 0$. Testing unit root becomes essential since the following analysis for the influence of trading volume on volatility may be invalid if the trading volume series is non-stationary (Baklacı and Kasman, 2006:120).

4.2.2. ISE-30 Index Futures Return and Trading Volume Relation

MDH (Clark, 1973) proposes a positive price change (i.e. return) - volume relation. According to MDH, both trading volume and return rely on a common underlying variable. As a result, trading volume and return change contemporaneously in response to the new information arrivals (Clark, 1973; Lee and Rui, 2001). Furthermore, positive correlation is expected between absolute value of price change and trading volume with respect to Differences of Opinion Model and Rational Expectations Model.

In the current study following regressions will be applied in order to investigate contemporaneous relation between return and trading volume:

(9) $$DV_t = a + bR_t + u_t$$

(10) $$DV_t = a + b|R_t| + u_t ,$$

where DV_t , R_t , $| R_t |$ and u_t are the detrended volume, return, absolute return and random error term at time t, respectively.

4.2.3. Causal Relation between ISE- 30 Index Futures Return and Trading Volume

When dealing with financial time series analysis, it becomes essential to understand whether changes in one variable will cause a change in other variable. The ideas is, if X causes Y, then one can conclude that changes of X happened first then it followed by changes of Y, in other words X is said to Granger-cause Y, when lagged values of X provide significant information about future values of Y. (Granger, 1969.)

Causal relation between trading volume and stock price change has been tested by applying Vector Autoregression (VAR) Analysis (Chen et al. 2001).

(11) $$DV_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i DV_{t-i} + \sum_{j=1}^{n} \beta_j R_{t-j}$$

(12) $$R_t = \alpha_0 + \sum_{i=1}^{n} \gamma_i R_{t-i} + \sum_{j=1}^{n} \delta_j DV_{t-j}$$

Here, DV_t detrended trading volume and R_t is the return at time *t*. If the β_j coefficients are statistically significant, inclusion of past value of return, in addition to past history of detrended volume, yields a better estimation of future volume. Hence, it can be said that *return causes volume*. If a standard F – test does not reject the hypothesis that β_j = 0 for all *j* then returns do not cause volume. Similarly if δ_j = 0, then the causality does not exist from volume to returns. If both β_j and δ_j differ from zero, then there exists a feedback system between trading volume and return.

4.2.4. ISE-30 Index Futures Return Volatility and Trading Volume

One of the objectives of this thesis is to examine the relationship between the flow of information into the market and the persistence of ISE-30 Futures Index return volatility. Several studies have examined the volatility – trading volume relation by introducing different GARCH models (Phylaktis et al,, 1996; Pyun et al., 2000; Bohl and Henke, 2003; Arago and Nieto, 2005; Deo et al., 2008). Since the one possible explanation for the existence of ARCH effect is the foundation of a serially correlated news arrival process, trading volume is thus included as an explanatory variable in conditional variance equation.

The sign of returns play an important role in affecting volatilities. Volatilities tend to rise in case of bad news and decreases otherwise (Nelson, 1991). With Autoregressive Conditional Heteroscedasticity, ARCH, (Engle, 1982) and Generalized Autoregressive Conditional Heteroscedasticity, GARCH, (Bollerslev, 1986; Taylor, 1986[12]) models, positive and negative shocks have the same effect on volatility because conditional variance is only related to the past squared innovations and past conditional variances. Besides, ARCH and GARCH models have restrictions in order to pursue non-negativity assumptions of conditional volatility. To overcome the restrictions and drawbacks of symmetric ARCH & GARCH models, so called asymmetric models have been introduced including asymmetric ARCH (Engle, 1990), Exponential GARCH (Nelson,

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[12] GARCH model proposed by Bollerslev (1986) and Taylor (1986) independently.

1991), non-linear asymmetric GARCH (GJR-GARCH; Glosten, Jagannathan and Runkle, 1993), Threshold GARCH (TGARCH; Zakoian, 1994).

Since the ISE-30 Index Futures return data is heteroscedastic (see, Figure 1 and Figure 2) it is a candidate to fit a GARCH model. Existing empirical analyses of volume and volatility relationship has extensively investigated by numerous ARCH/GARCH specifications (see, Table 2). In this thesis, GJR-GARCH model is applied in order to examine the relation between volume and volatility, considering the asymmetries that are intensively seen in emerging markets. The restricted model, where the trading volume is excluded, is thus tested with the introduction of Autoregressive Moving Average, ARMA (p, q) GJR-GARCH (1, 1):

(13) $$R_t = \omega + \sum_{i=1}^{p} a_i R_{t-i} + \sum_{i=1}^{q} b_i \varepsilon_{t-i} + \epsilon_t$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2$$

R_t denotes the realized return of the ISE-30 Index futures. ε_{t-1}^2 denotes the ARCH term which is lag of the squared error term from the mean equation. γ represents the asymmetric effect and if $\gamma > 0$, the asymmetric effect is captured. In case of bad news, where $\varepsilon_t < 0$, d_t equals 1 and, in case of good news where $\varepsilon_t > 0$, d_t equals 0. Persistence is gauged by the coefficient of lagged conditional variance, β_1. The appropriate ARMA (p, q) specification is chosen according to Akaike Information Criterion (AIC) (see, Appendix 2).

Next, detrended trading volume is included in Equation (13) in order to investigate the relation between return volatility and trading volume. Lagged value of the trading volume is used concerning to simultaneity bias in the coefficient estimates (Najand and Yung, 1991; Kim et al., 2004; Yen and Chen, 2009).

(14) $$R_t = \omega + \sum_{i=1}^{p} a_i R_{t-i} + \sum_{i=1}^{q} b_i \varepsilon_{t-i} + \epsilon_t$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2 + \eta_1 DV_{t-1}$$

MDH (Clark, 1976) suggests that if the coefficient of the detrended trading volume, η_1 is statistically significant, then β_1 is become considerably smaller or disappear after the addition of trading volume into the variance equation. Therefore, trading volume is able to explain the GARCH effect in the unrestricted model (Salman, 2002; Watanabe, 2001; Lokman and Hatemi, 2005; Okan et al. 2009).

The results from the estimated models are said to be valid as long as the specification of the model is correct in any empirical analysis (Koutmos, 1998). The specification of the model can be tested by checking the estimated standardized residual. The estimated standardized residuals should follow independent, identically distribution (i.i.d). The linear and non-linear independence can be tested by means of the Ljung Box (LB) statistic. The model is said to be correctly specified, if the LB values are insignificant for standardized residuals (ε_t/σ_t). Besides, insignificant values of LB statistic for the standardized squared residuals, $(\varepsilon_t/\sigma_t)^2$ indicates that the volatility process is correctly specified (Koutmos, 1998:286).

In this thesis, Generalized Error Distribution (GED, henceforth)[13] is used concerning to significant excess kurtosis and skewness (Arago and Nieto, 2005; Girard and Biswas, 2007). The estimated degrees of freedom is called GED parameter, denoted by ν. If the estimated GED parameter is less than 2, then the non-normality for series is confirmed. For normal distribution, ν=2 and if ν=1 or very close to unity, then it is called Laplace distribution (Koutmos, 1998).

[13] For the functional form of GED, see Appendix 5.

4.2.5. Causal Relation between ISE-30 Index Futures Return Volatility and Trading Activity

A Vector Autoregressive model, again, can be used in order to examine the relationship between ISE-30 Index futures return volatility and the measures of the trading activity, trading volume and open interest, since all the series are stationary. The following VAR models are run:

(15) $$Vol_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Vol_{t-i} + \sum_{j=1}^{n} \beta_j TA_{t-j}$$

(16) $$TA_t = \alpha_0 + \sum_{i=1}^{n} \gamma_i TA_{t-i} + \sum_{j=1}^{n} \delta_j Vol_{t-j}$$

where *Vol* stands for volatility, which is obtained from the restricted ARMA (p, q) GJR-GARCH(1, 1) model by taking the square root of variance series; *TA* denotes the trading activity namely detrended trading volume or detrended open interest. According to SIAH (Copeland, 1976) existence of causality indicates that lagged values of trading activity may have the ability to predict current volatility, or vice versa. If the β_j coefficients are different from zero and statistically significant, inclusion of past values of volatility, in addition to past history of detrended trading volume or detrended open interest, yields a better estimation of future volatility. Hence, it can be said that either *open interest* or *trading volume causes volume*. If a standard F – test does not reject the hypothesis that β_j = 0 for all *j* then neither *trading volume* nor *open interest cause volatility*. Similarly, if δ_j = 0, then the causality does not exist from volatility to either open interest or trading volume. If both β_j and δ_j differ from zero, then there exists a feedback relation between trading activity and return volatility.

5. EMPIRICAL RESULTS

In this part, the estimated models from the statistical tests are presented. Then, the results are analyzed and compared with the previous studies. All the tests are run in Eviews5.1.

5.1. Descriptive Statistics

It is widely known that stock returns tend to display non-normal unconditional sampling distributions in the form of skewness or excess kurtosis. To adoption of conditional distribution with fatter tails rather than normal distribution is able to remove presence of this kurtosis problem (Bollerslev et al., 1992:23).

Table 3. Descriptive statistics.

	Return	Trading Volume	Open Interest
Mean	0.059	122218.7	114022.5
Median	0.030	108567.5	135934.0
Maximum	9.656	489495.0	270315.0
Minimum	-9.972	23.000	0.000
Standard Deviation	2.135	107737.8	77999.7
Skewness	-0.062	0.670	-0.1592
Kurtosis	5.496	2.7258	1.6115
Jarque-Bera	332.9	100.025	108.235
Probability	0.000	0.000	0.000

The main descriptive statistics of all three series are summarized in Table 3 in order to assess the distribution properties of return, trading volume and open interest series. As reported in the table, trading volume series is positively skewed in according to normal distribution, which has zero value, by indicating an asymmetric right - tailed distribution. On the other hand, both return and open interest series are negatively skewed by indicating that they have long left tail. Return series has excess kurtosis with respect to the normal distribution, where kurtosis is 3, referring that the distribution is peaked, namely *leptokurtic.* Asymmetric behavior of returns may be attributed to risk averse nature of the traders (Mahajan & Singh, 2009.) Jarque-Bera (JB)[14] test for normal-asymptotic distribution with 2 degrees of freedom- results are also given. Under the null hypothesis sample data are independently and identically distributed (i.i.d) normal. All the series have statistically significant JB test values with the distribution probability of 0.0000. Hence, the null hypothesis can be rejected that series have normal distribution.

Table 4. Ljung- Box Q (LB) statistics.

Series	**LB (5)**	Prob.	**LB (10)**	Prob.	**LB(20)**	Prob.
Return	5.848	(0.321)	2064.0*	(0.000)	2666.4*	(0.000)
DV	12.741	(0.239)	3111.6*	(0.000)	3732.3*	(0.000)
DOI	20.381	(0.158)	3756.1*	(0.000)	4243.6*	(0.000)

Note: * denotes the significance at 1% level. Numbers in parentheses are the *p-values.* DV and DOI denote detrended volume and detrended open interest

Table 4 reports to Ljung-Box Q statistics for all series. While the null hypothesis of no autocorrelation is rejected for detrended trading volume (DV) and detrended open interest (DOPI) series, it cannot be rejected concerning to return series. The condition of serial autocorrelation for both trading volume and open interest is, thus satisfied which is required for Information Based Models.

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[14] $\text{JB} = \frac{T}{6}\left(skew^2 + \left(\frac{(kurtosis-3)^2}{4}\right)\right)$

Figure 1 and Figure 2 show the natural logarithm of daily returns and daily squared returns of ISE-30 Index. The visual inspection of plots shows the clustering in series – high values of returns tend to be followed by high values and low values of returns tend to be followed by low values.

Figure 1. ISE-30 Index Settlement Price and Logarithmic Returns.

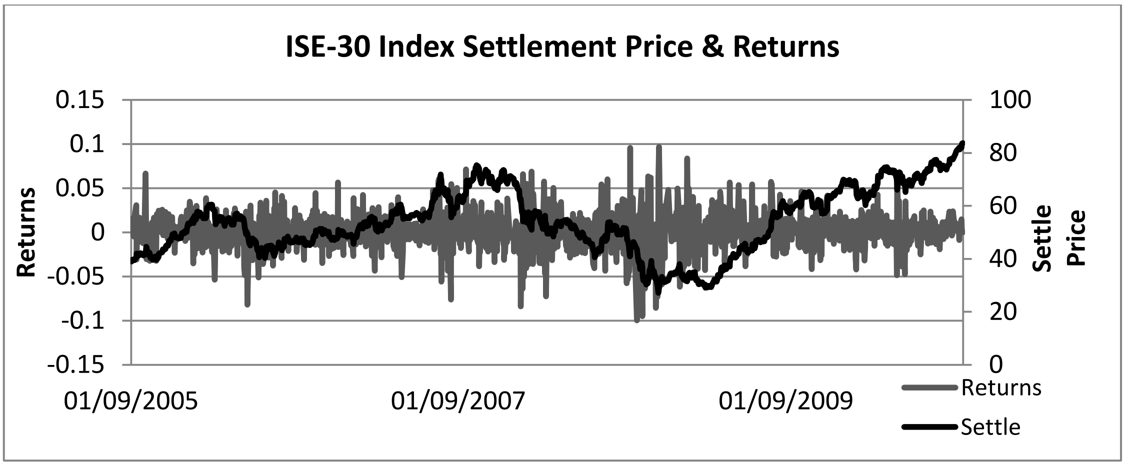

Figure 2. Squared Logarithmic Returns.

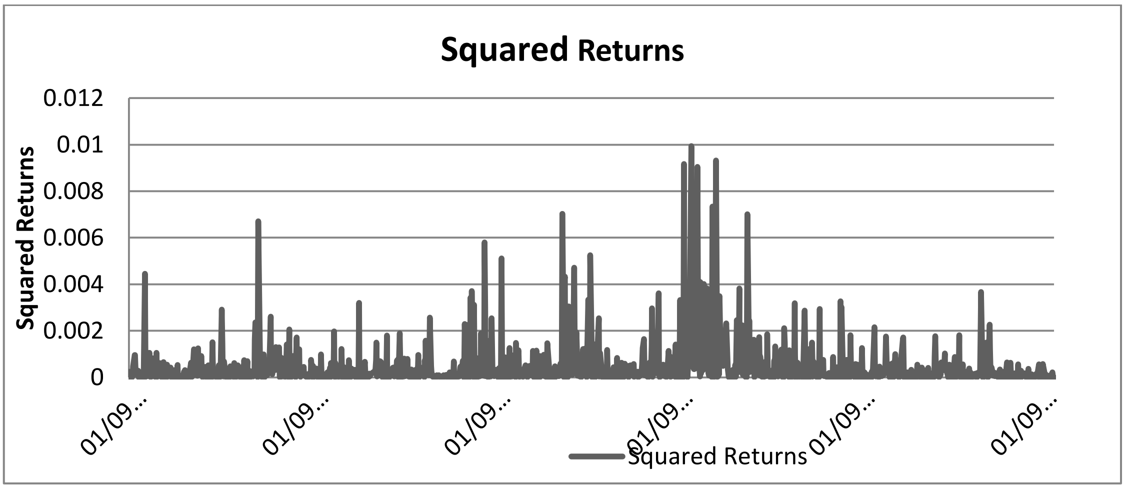

Table 5. Linear and Non-Linear Trend in Volume and Open Interest.

For trading volume, Equation (4) is specified as follows: $V = \delta_0 + \delta_1 t + \delta_2 t^2 + \varepsilon_t$,. For open interest, Equation (5) is specified as follows: $OI = \theta_0 + \theta_1 t + \theta_2 t^2 + \varepsilon_t$

Series	Linear Trend (t)	Prob.	Quadratic Trend (t^2)	Prob.
Trading Volume	328.03*	(0.000)	358.457*	(0.000)
Open Interest	-0.069*	(0.000)	-0.138*	(0.000)
R-square (R^2)	0.685		0.792	

Notes: * denotes the significance level at 1%. Numbers in parentheses are the *p-values*.

Table 5 represents the regression results of testing linear and non-linear trend in volume and open interest series. Estimated coeffieicents of both linear and quadratic trend terms are statistically significant and robustness of the model is acceptable. (Chen et al, 2001; Deo et al, 2008).

Table 6. Unit root test for Return, Detrended Volume (DV) and Detrended Open Interest (DOPI).

Series	ADF	Prob.	Phillips-Perron	Prob.	KPSS	Prob.
Returns	-34.179*	(0.000)	-34.139*	(0.000)	0.122	(1.000)
DV	-5.308*	(0.000)	-18.127*	(0.000)	0.282	(1.000)
DOPI	-9.918*	(0.000)	-12.986*	(0.000)	0.126	(1.000)

Notes: * denotes the rejected of null hypothesis of “ series has unit root ” significance level at 1%. Optimum lag, 22, is selected with respect to the Akaike Information Criterion (AIC). Numbers in parentheses are the *p-values*. DV and DOPI denote detrended trading volume and detrended open interest, respectively.

Unit test results with respect to three different tests are presented with constant and trend in Table 6. Results exhibit that return, detrended trading volume (DV) and detrended open interest (DOPI) series follow stationary process at %1 significance level for the constant and trend forms with respect to ADF and PP tests. Therefore, null hypotheses of *there is unit root* is rejected according to ADF and PP tests, whereas the null hypothesis of *series is stationary* is accepted according to KPSS test for three series. Hence, the stationarity condition is provided for all series.

Correlations between trading volume, return and absolute return are given in Table 7. The positive correlation between trading volume and absolute value of return is supported by Mixture of Distribution Hypothesis, Rational Expectations Model and Differences of Opinion Model. Regarding to MDH (Clark, 1973), this positive correlation indicates a simultaneous response to a new information arrival that is given by both trading volume and price change. With respect to Rational Expectation Hypothesis (Wang, 1994) positive correlation refers that as the information asymmetries increase, investors will demand higher discounts in stock prices. Besides, the uninformed traders only will take position on assets concerning to their expectations about the informed traders' private investment opportunity. Therefore, it can be said that volume reflects the extent of disagreement among the investors about the value of the asset which brings asymmetric information or differences of opinion (Harris and Raviv, 1993). Notwithstanding, negative correlation has been found between trading volume and return (i.e. price change *per se*). It may be attributed to no short sale constraint in TurkDex. As stated by Basci et al. (1996) and Suominen (2001), introduction of a short sale constraint leads to a positive correlation between volume and return *per se.*

Table 7. Correlations between return, absolute return and trading volume.

Variables	Return (*per se*)	Absolute Return	DV
Return	1.000		
Absolute Return	0.023	1.000	
DV	-0.021	0.219	1.000

Note: DV denotes detrended trading volume.

Correlations between the measures of trading activity and return volatility are presented in Table 8. The positive correlation between trading volume and return volatility is in line with the previous studies (Bhargova and Malhotra, 2006; Ripple and Moosa, 2009) This positive correlation can also be supported by MDH hypothesis indicating that price volatility and trading volume both response simultaneously to new information arrivals. Correlation between open interest and volume is also positive which is inconsistent with earlier studies of Watanabe (2001), Ripple and Moosa (2009); but in line with the findings of Figlewski (1981), Chen et al. (1995) and Motladiile and Smit (2003).

Table 8 Contemporaneous Correlations between volatility and trading activities.

Variables	DV	DOPI	Volatility
DV	1.000		
DOPI	0.231	1.000	
Volatility	0.065	0.427	1.000

Note: DV and DOPI denote detrended trading volume and detrended open interest, respectively.

5.2. Contemporaneous Relation between ISE-30 Index Return and Trading Volume

Table 9 reports the regression analysis of detrended trading volume against ISE-30 Index Futures returns and absolute returns. According to estimated models, there is no significant relation between daily returns per se and trading volume. This finding is inconsistent with studies of Saatcioglu and Starks (1998), Chen et al. (2001), Yuksel (2002) and, Baklaci and Kasman (2006). However, the coefficient for absolute daily returns is positive and also significant at 1% level. This result is consistent with the previous studies (Crouch, 1970; Copeland, 1976; Rogalski, 1978; Moosa and Lougnahi, 1995; Deo et al., 2008).

Table 9. Contemporaneous relationship between trading volume and daily returns. Regression of detrended trading volume (DV) on returns and absolute returns. $DV_t = a + bR_t + u_t$ and $DV_t = a + b|R_t| + u_t$, where DV_t, R_t, $| R_t |$ and u_t are the detrended volume, return, absolute return and random error term at time t, respectively.

Series	a	Prob.	b	Prob.
ISE-30 Index Futures Return	-4.708	(0.998)	588876.4	(0.458)
ISE-30 Index Futures Absolute Return	-13841.7*	(0.000)	895666.2*	(0.000)

Notes:* denotes the significance at the 1% level. *p-values* are in parentheses.

Overall, hypothesis of contemporaneous relation between trading volume and daily returns *per se*, Hypothesis 1 (a), is rejected whereas the hypothesis of contemporaneous relation of absolute returns and trading volume, Hypothesis 1 (b), is strongly supported.

5.3. Causal Relation between ISE-30 Index Futures Returns and Trading Volume

As reported in Table 10 the information criteria including Akaike's (AIC), Hanna-Quinn (HQ) information and modified likelihood ratio tests indicates to setting lag order 5 whereas Schwarz's (SIC) point to setting lag order 4. The author used 5 lags for VAR analysis, therefore circumventing the serial correlation problem in residuals of the VAR (4). (For the estimated VAR (5) model table, see Appendix 1).

Table 10. Lag order selection for VAR (p) specification of return - trading volume.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-18610.33	NA	1.68e+10	29.21872	29.22681	29.22176
1	-18166.12	886.3157	8.40e+09	28.52767	28.55192	28.53678
2	-18160.26	11.68855	8.38e+09	28.52474	28.56516	28.53992
3	-18131.67	56.86678	8.06e+09	28.48613	28.54272	28.50739
4	-18108.91	45.19693	7.83e+09	28.45668	28.52944*	28.48401
5	-18096.65	24.29862*	7.73e+09*	28.44372*	28.53265	28.47712*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion.

Table 11 reports the Granger Causality Test results for return – volume relationship. Results in Table 11 indicate that return Granger causes volume at the 1% significance level whereas volume Granger causes return at the 10% significance level. Since the volume has an impact on returns and returns have an impact on volume, it can be said that feedback system exists in TurkDex for ISE-30 Index returns. Findings suggest that trading volume adds some significant predictive powers in the presence of current and past returns.

Table 11. Granger Causality Test results for Return-Volume relation.

Null Hypothesis	Obs.	F-statistic	Prob.
DV does not Granger Cause Return	1274	2.720	0.018**
Return does not Granger Cause DV	1274	1.972	0.080***

Notes: ** and *** denote the significance at the 5% and 10% levels, respectively. DV denotes detrended trading volume.

As a result, Hypothesis 1(c) is supported by in lining with the study of Rogalski (1978), Jennings et al. (1981), Deo et al. (2008) who find causality in either direction between return and trading volume.

5.4. ISE-30 Futures Index Return Volatility Persistence and Trading Volume

Results from the estimated ARMA (2, 2) - GJR-GARCH (1, 1) model is given in Table 12. The appropriate ARMA (p, q) specification is chosen for GJR-GARCH (1, 1) model by looking for the lowest Akaike Information Criterion (see, Appendix 2). All the estimated coefficients are statistically significant at 1% significance level in restricted model where the trading volume is excluded. Volatility Persistence for ISE-30 Index futures return is high, 0.853, indicating that the persistence of past volatility is explaining current return volatility. Asymmetry effect, denoted by γ, is positive and statistically significant indicating that leverage effect exists in TurkDex. That is, bad news has a greater impact on volatility than that of good news. This asymmetry effect is inherent and, indeed it can be attributed to the existence of the futures market itself. The notion is, in futures market traders may not be able to access good information as traders in the existing cash market (Figlewski, 1981).

Table 12. Estimated models without (restricted) and with (unrestricted) trading volume.

Regression of restricted model: $R_t = \omega + \sum_{i=1}^{2} a_i R_{t-i} + \sum_{i=1}^{2} b_i \varepsilon_{t-i} + \epsilon_t$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2$$

Regression of unrestricted model: $R_t = \omega + \sum_{i=1}^{2} a_i R_{t-i} + \sum_{k=1}^{2} b_i \varepsilon_{t-i} + \epsilon_t$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2 + \eta_1 DV_{t-1}$$

Model	α_0	α_1	β_1	γ	η_1
ARMA (2, 2) GJR-GARCH (1, 1) (Restricted)	0.196* (0.001)	0.048** (0.015)	0.853* (0.000)	0.117* (0.001)	
ARMA (2, 2) GJR-GARCH (1, 1) (Unestricted)	0.211* (0.000)	0.044** (0.019)	0.851* (0.000)	0.119* (0.000)	6.5E-07 (0.158)

Note: * and ** denote the significance at the 1% and 5% levels, respectively. *p-values* are in parentheses.

The coefficients of unrestricted model are estimated after the inclusion of lagged trading volume as an explanatory variable into the conditional variance equation. All the coefficients are still statistically significant with the exception of lagged trading volume which is positive but not statistically significant. The negligible reduction in persistence is obtained, after the introduction of lagged trading volume. Therefore, Hypothesis 2 is rejected by indicating that trading volume is not an appropriate proxy for the arrival of information into the TurkDex futures market. This result is consistent with previous studies which were conducted on emerging markets (Yuksel, 2002; Salman 2002; Huang and Yang, 2001), whereas it is inconsistent with the previous studies that were conducted on again, emerging markets (Phyklaktis et al., 1996; Girard and Biswas, 2007; Pati and Rajib, 2010). One possible explanation of this finding is, although trading volume gives information on the quality of information signals, it does not indicate the signal itself (Blume, Easley and O'Hara, 1994).

Table 13. Residual Diagnostics for both restricted and unrestricted models.

Model	E (ε_t/σ_t)	E $(\varepsilon_t/\sigma_t)^2$	LB (15)	$LB^2(15)$	v
ARMA (2, 2) GJR-GARCH (1, 1) (Restricted)	0.004	1.003	18.360 (0.419)	12.024 (0.677)	1.33* (0.000)
ARMA (2, 2) GJR-GARCH (1, 1) (Unestricted)	0.006	1.004	20.052 (0.170)	14.724 (0.472)	1.361* (0.000)

Notes: * denotes the significance at the 1% level. Numbers in parenthesis are the *p-values*. v is the GED parameter.

The validity of the results is required for the correct specification of the model. Estimated residual diagnostics for both restricted and unrestricted models are given in Table 13. The means and the variances of the standardized residuals are almost zero and one respectively. Ljung Box (LB) values are insignificant for the standardized residuals, (ε_t/σ_t), supporting the null hypothesis that residuals are uncorrelated up to 15 lags. The squared standardized residuals, $(\varepsilon_t/\sigma_t)^2$ are said to be independent, identically distributed since the calculated LB^2 values are insignificant. Furthermore, insignificant value of LB for $(\varepsilon_t/\sigma_t)^2$ shows that the volatility process is correctly specified (Chen et al., 2001). GED parameter, v, presents the estimated degree freedom parameter. Since it is less than 2, which refers to normal distribution, shows that GED is suitable for the estimated models (Koutmos, 1998). Therefore, the estimated models fit the data well.

5.5. Causal Relation between ISE-30 Index Futures Volatility and Trading Activity

Appropriate lag order is chosen using Akaike Information Criterion (AIC) for the relation between volatility and measures of trading activities. Table 14 reports the lag order selection test results for trading volume – volatility relation. The information criteria including Akaike's and modified likelihood ratio tests indicates to setting lag order 10 whereas Schwarz's and Hanna Quinn's point to setting lag order 4 and 5. The author used 10 lags for VAR analysis, therefore circumventing the serial correlation problem in residuals of the VAR (4) and VAR (5). For open interest – volatility relation, as given in Table 15**,** all the information criteria point to setting lag order 2. Therefore, the author used 2 lags for VAR specification (For estimated VAR models see, Appendix 3 and Appendix 4).

Table 14. Lag order selection for VAR (p) specification of trading volume –volatility.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-17021.30	NA	1.60e+09	26.87182	26.87994	26.87487
1	-15010.90	4011.278	67585312	23.70466	23.72902	23.71381
2	-14990.62	40.39756	65870726	23.67896	23.71956	23.69421
3	-14961.20	58.51026	63280150	23.63884	23.69568	23.66019
4	-14936.62	48.81146	61257435	23.60635	23.67943*	23.63381
5	-14925.16	22.72510	60540134	23.59457	23.68390	23.62813*
6	-14918.67	12.84015	60303000	23.59065	23.69621	23.63031
7	-14912.29	12.62269	60076259	23.58688	23.70869	23.63264
8	-14906.12	12.17252	59870977	23.58345	23.72150	23.63532
9	-14902.10	7.906054	59869805	23.58343	23.73772	23.64140
10	-14893.90	16.14527*	59473469*	23.57679*	23.74732	23.64085

Table 15. Lag order selection for VAR (p) specification of open interest –volatility.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-16455.13	NA	5.81e+08	25.85566	25.86375	25.85870
1	-14186.30	4526.949	16546106	22.29742	22.32168	22.30653
2	-14166.38	39.69833*	16137204*	22.27239*	22.31284*	22.28758*
3	-14165.59	1.559544	16218946	22.27744	22.33407	22.29871
4	-14164.29	2.580094	16287915	22.28169	22.35450	22.30903

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Granger Causality test results are given in Table 16. Volatility does cause trading volume at the 10% significance level. Moreover, trading volume also does cause volatility at 10% level. This interrelation of trading volume and volatility suggests a bidirectional relation by suggesting a feedback system for ISE-30 Index Futures. While finding of bidirectional relation inconsistent with studies of Figlewski (1981), Yang et al. (2005) and Lokman and Hatemi (2005), it is consistent with Okan et al. (2009) results. On the other hand, while volatility does cause open interest at the significance level of 10%, open interest does not cause volatility. This result is inconsistent with Figlewski's (1981) study that has evidence of causality from open interest to volatility. In contrast to existence of feedback system between trading volume and volatility, causality is said to be unidirectional running from open interest to volatility.

Table 16. Granger Causality test results for trading activity - volatility relation.

Null Hypothesis	Obs.	F-statistic	Prob.
DV does not Granger Cause Volatility	1267	5.678	2.3E-08*
Volatility does not Granger Cause DV	1267	1.823	0.052***
DOPI does not Granger Cause Volatility	1275	0.013	0.988
Volatility does not Granger Cause DOPI	1275	2.509	0.082***

Notes: * and *** denote the significance at the 1% and 10% levels respectively. DV and DOPI indicates detrended trading volume and detrended open interest, respectively.

The presence of lead-lag relation in each direction between volume and volatility is supported by SIAH (Copeland, 1976) where lagged values of volatility or volume have an ability to predict current volume or volatility. Hence current study provide evidence in favor of SIAH in lining with previous studies (Jennings et al., 1981; Okan et al., 2009) On the other hand causality exists only from volatility to open interest by pointing out that changing in volatility happened first and then it is followed by changes of open interest. Hence lagged values of volatility provide information about the future value of the ISE-30 Index Futures open interest.

Overall, while Hypothesis 3 (a) is supported, Hypothesis 3 (b) is rejected.

6. SUMMARY AND CONCLUSION

ISE-30 Index Futures has been one of the most preferred and followed contracts by a wide group of both local institutional and foreigner investors as well in Turkish Derivative Exchange. The present study aims to investigate the relationship between return, volatility and trading activity of ISE-30 Index Futures contracts in the context of information based models by using daily data. The sample covers the time period from September 1, 2005 to September 30, 2010.

Testing the implications of Differences of Opinion Model (Harris and Raviv, 1993) and Rational Expectations Model (Wang, 1994) according to return- trading volume relationship concludes that daily trading volume of ISE- 30 Index Futures reflecting the extent of disagreement among the investors about the value of the asset, brings asymmetric information in TurkDex. Even though they receive the same information they interpret this information differently.

The results of the full period time series indicate that trading volume does not reduce the ISE-30 Index Futures return volatility persistence. One of the possible interpretations of this result is, although trading volume provides information about the quality of information signals, it does not represent the information signal itself. Furthermore, the trading volume has no impact on the reduction of the volatility persistence resulting conflict with the MDH (Clark, 1973). Consequently, trading volume is not an appropriate proxy for the daily information arrival to ISE-30 Index Futures market.

The presence of feedback system between volatility and volume which is supported by causal relation, suggests that changes of trading volume happened first than it is followed by changes in volatility or, vice versa. Therefore lead-lag relation between volume and volatility that is proposed by SIAH (Copeland, 1976; Jennings et al., 1981) is supported. Notwithstanding, there is only causality from volatility to open interest proposing a no feedback system between those.

This thesis points out some implications for those who buy or sell securities in TurkDex. Undeniably, as an emerging market, Turkey is actually thinly traded and highly volatile market that makes it less liquid and inefficient than other mature markets. The short term focus of trading leads investors to a myopic investment behavior and speculative trading. Having information about trading activities alone may be insufficient, due to the fact that the investors not also need to be informed about the conditions of cash markets determinants concerning to interaction between futures and cash markets but also keep in mind the differences between cash and futures markets in terms of price-trading activity.

The limitation of the study can be explained as follows: Although daily, weekly or monthly data are widely used in order to examine the return-volatility-trading activity relation in the literature, they may not be appropriate data frequencies concerning to valuable information content of intraday movements of futures markets.

The current study can be extended by allowing effect of public news on price change with using intraday data. Moreover, trading activity would be broadened by adding trading value into analysis or using trading value in lieu of trading volume. Besides, since the quasi-rational behavior of investors is obvious, it would be interesting to test implications of over or under-reaction behavior of investors in the context of trading activity – volatility relation.

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APPENDICES

Appendix 1.

VAR (5) estimation for the causal relation of Return-Volume

	Return→DV	DV→Return
RETURN(-1)	0.041	-1439.348
	(0.028)	(538.104)
	[1.475]	[-2.67485]
RETURN(-2)	0.001	100.2649
	(0.028)	(538.828)
	[0.053]	[0.18608]
RETURN(-3)	-0.022	-244.6355
	(0.028)	(538.824)
	[-0.792]	[-0.45402]
RETURN(-4)	0.030	280.6534
	(0.028)	(538.882)
	[1.075]	[0.52081]
RETURN(-5)	-0.037	825.9090
	(0.028)	(538.478)
	[-1.376]	[1.53379]
DET_VOL(-1)	-1.52E-06	0.567003
	(1.5E-06)	(0.02802)
	[-1.038]	[20.2323]
DET_VOL(-2)	1.04E-07	-0.040496
	(1.7E-06)	(0.03205)
	[0.062]	[-1.26360]
DET_VOL(-3)	-1.88E-06	0.102584
	(1.7E-06)	(0.03194)
	[-1.133]	[3.21173]
DET_VOL(-4)	-3.83E-07	0.128657
	(1.7E-06)	(0.03209)
	[-0.229]	[4.00968]
DET_VOL(-5)	4.76E-06	0.083922
	(1.5E-06)	(0.02802)
	[3.260]	[2.99542]
C	0.057	-134.9300
	(0.059)	(1148.61)
	[0.958]	[-0.11747]
R-squared	0.015	0.546
Adj. R-squared	0.008	0.543
Sum sq. resids	5734.525	2.12E+12
S.E. equation	2.131	40927.77
F-statistic	1.983	151.961
Log likelihood	-2765.994	-15331.53
Akaike AIC	4.359	24.085
Schwarz SC	4.404	24.130
Mean dependent	0.059	-234.716
S.D. dependent	2.139	60510.41

**standard errors in ( )and t- statistics in [ ].*

Appendix 2.

Akaike Information Criterion (AIC) for ARMA(p,q) GJR-GARCH(1,1) model

p/q	0	1	2	3
0	4.145	4.146	4.147	4.148
1	4.146	4.147	4.149	4.150
2	4.148	4.149	4.143	4.152
3	4.151	4.152	4.150	4.147

Appendix 3.

VAR (10) estimation for the causal relation of volatility-trading volume

	DV→Volatility	Volatility→DV
DET_VOL(-1)	0.553	9.66E-07
	(0.028)	(1.3E-07)
	[19.459]	[7.361]
DET_VOL(-2)	-0.048	-4.60E-07
	(0.033)	(1.5E-07)
	[-1.477]	[-3.045]
DET_VOL(-3)	0.094	1.28E-08
	(0.033)	(1.5E-07)
	[2.864]	[0.085]
DET_VOL(-4)	0.121	-1.26E-07
	(0.033)	(1.5E-07)
	[3.699]	[-0.832]
DET_VOL(-5)	0.102	1.82E-08
	(0.033)	(1.5E-07)
	[3.086]	[0.119]
DET_VOL(-6)	-0.060	-3.05E-07
	(0.033)	(1.5E-07)
	[-1.850]	[-2.001]
DET_VOL(-7)	-0.022	6.94E-08
	(0.033)	(1.5E-07)
	[-0.682]	[0.456]
DET_VOL(-8)	0.069	5.49E-08
	(0.033)	(1.5E-07)
	[2.109]	[0.362]
DET_VOL(-9)	-0.032	-4.55E-08
	(0.033)	(1.5E-07)
	[-0.992]	[-0.299]
DET_VOL(-10)	0.096	-9.74E-08
	(0.028)	(1.3E-07)
	[3.327]	[-0.729]
VOL(-1)	12630.14	0.893631
	(6156.90)	(0.028)
	[2.051]	[31.387]
VOL(-2)	2481.155	0.071
	(8211.12)	(0.038)
VOL(-3)	-5415.566	-0.022
	(8175.91)	(0.038)
	[-0.66238]	[-0.59003]
VOL(-4)	-8614.679	0.079
	(8173.37)	(0.038)
	[-1.052]	[2.089]
VOL(-5)	-11741.99	-0.043
	(8165.03)	(0.038)
	[-1.438]	[-1.140]
VOL(-6)	-1708.348	-0.086
	(8166.95)	(0.037)
	[-0.209]	[-2.280]
VOL(-7)	12562.66	0.010
	(8166.65)	(0.037)

	[1.538]	[0.266]
VOL(-8)	5032.324	0.123
	(8173.87)	(0.038)
	[0.616]	[3.251]
VOL(-9)	-3572.308	-0.115
	(8178.11)	(0.038)
	[-0.435]	[-3.032]
VOL(-10)	-2214.332	0.053
	(6017.91)	(0.028)
	[-0.368]	[1.889]
C	916.611	0.075
	(4041.35)	(0.019)
	[0.227]	[4.020]
R-squared	0.556	0.925
Adj. R-squared	0.549	0.924
Sum sq. resids	2.06E+12	44.019
S.E. equation	40646.60	0.188
F-statistic	78.27058	767.125
Log likelihood	-15233.46	330.628
Akaike AIC	24.07965	-0.487
Schwarz SC	24.16492	-0.403
Mean dependent	-500.056	2.044
S.D. dependent	60571.68	0.680

**standard errors in ( )and t- statistics in [ ].*

Appendix 4.

VAR (2) estimation for the causal relation of volatility – open interest.

	Volatility→Open Interest	Open Interest→Volatilty
VOL(-1)	0.916	6682.393
	(0.028)	(2999.10)
	[32.650]	[2.228]
VOL(-2)	0.045	-6604.578
	(0.028)	(2998.64)
	[1.580]	[-2.203]
DET_OPENI(-1)	3.94E-08	0.677
	(2.6E-07)	(0.028)
	[0.152]	[24.462]
DET_OPENI(-2)	-3.87E-08	0.160
	(2.6E-07)	(0.027)
	[-0.149]	[5.797]
C	0.081	-193.900
	(0.017)	(1853.65)
	[4.652]	[-0.104]
R-squared	0.919	0.662
Adj. R-squared	0.919	0.661
Sum sq. resids	47.526	5.43E+11
S.E. equation	0.193	20676.69
F-statistic	3616.421	622.682
Log likelihood	287.861	-14476.01
Akaike AIC	-0.442	22.715
Schwarz SC	-0.423	22.736
Mean dependent	2.040	-164.306
S.D. dependent	0.679	35524.86

**standard errors in ( )and t- statistics in [ ].*

Appendix 5.

Generalized Error Distribution (GED) in Functional Form

$L(\Theta) = \sum_{t=1}^{T} I(\Theta)$, where Θ denotes the set of parameters of the average and conditional variance to be estimated with:

$$I(\Theta)_t = \ln\left(\frac{\nu}{\lambda}\right) - 0.5\left|\frac{\varepsilon_t}{\sigma_t\lambda}\right|^{\nu} - (1 + \tfrac{1}{\nu})|\ln(2) - \ln\left(\Gamma\left(\frac{1}{\nu}\right)\right) - 0.5\ln(\sigma_t^2),$$

Where $\lambda = \exp(\left(-\frac{1}{\nu}\right)\ln(2) + 0.5ln\left(\Gamma\left(\frac{1}{\nu}\right) - 0.5\ln\left(\Gamma\left(\frac{3}{\nu}\right)\right)\right)),$ and ν is the GED parameter.

Appendix 6. Open interest and Trading volume series.