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THE IMPACT OF FUTURES TRADING ON SPOT PRICE VOLATILITY:

EVIDENCE FROM TURKEY

EMRE AKÇAKMAK, 80270

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ABSTRACT

The main goal of this thesis is to investigate the effect of the introduction of futures trading on the nature of spot price volatility. Specifically, changes in volatility, speed of information flow, persistence of volatility shocks and asymmetric response are examined in Istanbul Stock Exchange (ISE) National-30 Index contracts for the period before and after the introduction of Turkish Derivatives Exchange (TurkDEX) in February, 2005. Changes in volatility, news transmission and persistence of volatility are tested using a GARCH (1,1) model, and changes in volatility and asymmetric response are tested using an E-GARCH (1,1) model. Statistically insignificant weak evidence of decrease in volatility is found using the both models. In addition, an increase in the speed of news transmission but no change in the persistence of volatility shocks or asymmetric response are found for the period examined.

Tutor	: Joel RENEBY
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Venue	: Room 343
Discussants	: Jonatan FORSBERG (19178)
	Georgios MONOKANDYLOS (80320)

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1. Introduction

Futures markets provide producers, investors and speculators the opportunity to exchange a variety of assets; from commodities such as onions and cotton to financial instruments such as currency, stock indices and interest rates, on a specified date in the future by offering standardized contracts for the trade today. These contracts generally specify the futures transaction details such as the underlying asset, contract size, and settlement method and settlement date. In addition, by setting financial requirements such as margin levels and minimum price fluctuation limits, futures exchanges offer the traders security in their transactions. For these and other reasons[1], policymakers tend to encourage futures trading which can be traced back to Ancient Greece and to the introduction of world's first futures exchange, Chicago Board of Trade, in 1848.

Following the need and interest for such standardized exchanges, several futures markets have been introduced all over the world especially during the second half of 1980's. Since then, a great deal of debate has taken place concerning the effects of futures markets on their underlying spot markets. Although this new type of market activity gained immediate popularity for several reasons, futures trading have met by skepticism of the market participants, academicians and the policymakers concerning their potential impacts on the underlying markets. In particular, some observers feel that futures trading was the main cause of the famous so-called Dutch Tulip Mania economic bubble[2], and ban of onion futures trading in 1958[3] and the stock market crash of October 1987 due to its destabilizing effects.

It has been argued that lower costs of futures trading attract additional traders to the market and this leads to an increase in the level of public information available to market participants and enhances market efficiency by reducing information asymmetries in the markets. These effects are believed to stabilize the market by decreasing spot market volatility. By contrast, it has been claimed that the futures markets encourage the investors to make riskier decisions than they otherwise would[4] and additional traders –informed and uninformed alike- are also encouraged to take speculative positions because of the considerably smaller amount of initial investment required in futures markets. These activities supposedly result in market destabilization by increasing volatility in the underlying spot market. Several authors have attempted to highlight the relationship between the futures markets and spot price volatility through empirical studies with different results. However, there is still no theoretical consensus as to whether futures markets increase or decrease the volatility of underlying spot markets.

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[1] See Carlton, D. W., (1984) for further discussion of the futures markets.

[2] Dutch Tulip mania took place in the early 17th century in Netherlands. The enormously high demand for tulip bulbs drove the prices up to extremely high levels until the economic bubble burst and harmed many investors. See, Peter M. Garber, *The Journal of Political Economy*, Vol. 97, No. 3. (Jun., 1989), pp. 535-560.

[3] Trading in onion futures on United States exchanges was prohibited in 1958. Commodity Exchange Act Amendment of 1958, Public Law No. 85-839, 72 Stat. 1013 (1958).

[4] Newbery, D. M., (1987), "When Do Futures Destabilize Spot Prices?", International Economic Review, 28(2), 291-297.

The purpose of this study is to provide new empirical evidence in the ongoing debate about the impacts of futures trading activity on various dimensions of the nature of spot market volatility by investigating this relationship in an emerging market, Turkey. Specifically, this paper attempts to determine if the introduction of the Turkish Derivatives Exchange in February 2005 has had any impact on the nature of volatility of the Istanbul Stock Exchange by examining the National-30 Index before and after the futures trading activity. This question is important for policymakers who are trying to stabilize the fragile Turkish economy, for futures and spot markets regulators who aim for higher level of efficiency and academicians who have been investigating this relationship through their empirical studies.

TurkDEX was the newest national derivatives exchange in the world as of the date this research is conducted. Although there has been a great deal of research in this subject with regard to developed markets, this study investigates a large, dynamic emerging market and, to the author's best knowledge, it is the first attempt to investigate the effect of the recently opened Turkish Derivatives Exchange (TurkDEX) on Istanbul Stock Exchange (ISE) volatility. Furthermore, the investigation has implications for the other TurkDEX futures contracts such as government bond futures contracts, currency futures contracts, and wheat and cotton contracts.

Formal hypotheses are developed as to the effects of futures trading on spot price volatility, speed of news transmission, persistence of volatility shocks and changes in asymmetric response to new information. In order to model the formal tests, Generalized Autoregressive Conditional Heteroscedastic (GARCH) family of statistical techniques is employed. The results suggest that the introduction of futures trading has had no significant effect on the spot price volatility, caused statistically significant increase in the speed of news transmission, had no effect on the persistence of volatility shocks and caused no difference in the nature of asymmetric response to the news. In addition, weak evidence was found to suggest that futures trading results in price stabilization by causing a decrease in the spot volatility.

The rest of this paper is organized as follows. The next section discusses some opposing theoretical arguments regarding the expected effects of the introduction of futures trading on the spot market volatility. These theoretical findings are followed by the results of previous empirical studies. The third section gives brief information about the Istanbul Stock Exchange and Turkish Derivatives Exchange. The fourth section introduces the data and outlines the methodologies used in this study. The hypotheses and expected outcome are presented in the fifth section. The sixth section presents the results. The tests of robustness and investigation for some other models are also presented in this section. The seventh section of the study concludes the discussion and a few suggestions for future research are given. The references are provided and some of the explanations, tables and graphs are given in the following reference and appendix sections.

2. Literature Review

2.1. Speculation and Futures Markets

It has been argued that the introduction of futures trading increases speculation by providing new means of speculative activity and by encouraging speculation due to lower costs. Thus, the effect of speculation[5] on the price volatility debate provides the basis of the ongoing futures trading stabilization-destabilization argument. The view that speculation is stabilizing can be traced back to John Stuart Mill (1921)[6]. Mill observed that by buying low and selling high, speculators improve the allocation of resources in the economy while dampening the seasonal price fluctuations due to their profitable activities. Kaldor (1939), on the other hand, argued that although some speculators gain from speculative activity, speculators may end up with a net loss of speculators while destabilizing the market.

Supporting Mill's view, Friedman (1953) suggested that profitable speculation leads to stabilization and that destabilization is equivalent to saying that speculators lose money. He argued that since unprofitable speculation cannot persist, destabilization cannot exist when there is speculation. In response to Mill and Friedman, Baumol (1957) attempted to demonstrate a model where speculation is destabilizing. Baumol constructed two main market models; market in the absence of speculators and market with speculative behavior. He concluded that by accelerating both upward and downward price movements, speculative behavior increased the frequency of price fluctuations. Telser (1959), showing that mean-reverting futures price reflects the expectations of speculators, point out the drawbacks of Professor Baumol's results and supported Mill and Friedman's view that speculation stabilizes the prices. The subject of speculation and price stabilization was further investigated by several other authors. Among these authors are Kemp (1963), Farrell (1966), Hart (1977) and Hart and Kreps (1986) and many others.

When it comes to the effects of futures trading on the spot markets, the debate of speculation extends to the relationship between information and volatility. Current market prices depend on the current available information and any change in present information can affect the current level of prices. Therefore any change in the information flow associated with futures trading is expected to change the spot prices. Cox (1976) argued that there are at least two reasons that futures trading can alter the amount of information reflected in expected prices. First, organized futures markets attract an additional set of traders: speculators who acquire and evaluate information in order to predict the prices. Second, because of low cost of transaction, futures trading may increase the number of market participants by encouraging individuals to communicate their *otherwise worthless expectations* to the market. Indeed,

[5] Kaldor (1939) defines speculation as "The purchase (or sale) of goods with a view to re-sale (re-purchase) at a later date, where the motive behind such action is the expectation of a change in the relevant prices relatively to the ruling price and not gain accruing through their use, or any kind of transformation effected in them or their transfer between different markets".
[6] John Stuart Mill (1921), Book IV, Chapter II, Sections 4-5.

Danthine (1978) concluded that futures markets improve market depth and reduce volatility because of decreased transaction costs, enabling informed traders respond to spot prices.

The specific relationship between futures markets and spot market prices have also been deeply investigated by several authors. Peck (1976) modeled commodity price movements by investigating the storage decisions in the long run and concluded that futures have a stabilizing effect on prices. Peck, however, argued that the derived effects of futures trading depend upon the characteristics of the commodity being considered. Peck added that pricing performance should not be isolated from commodity characteristics and hence all markets are not expected to perform in the same manner. Turnovsky (1979) analyzed the effects of futures market on both the long-run average spot price and the variance of a storable commodity. While Turnovsky avoided drawing any definitive conclusions, the implicit conclusion was that futures market stabilize spot prices in all the cases considered in the study. In addition, Kawai (1983) and Turnovsky (1983) predicted that futures stabilize the spot market.

As presented here, there has been no theoretical consensus whether futures trading stabilizes or destabilizes the spot prices. Instead of building up this issue on the theoretical level, several authors attempted to examine the effects of futures trading through empirical studies.

2.2. Empirical Evidence

The first step in investigating the effects of futures markets on spot price volatility has been examining the descriptive statistics before and after the introduction of futures trading and looking for clues by performing graphical analyses of the time-series. This method, however, could only give insights to the question without providing any systematic statistical inferences. The simplest generally accepted method has then been to compare the pre- and post-futures volatility by establishing a model that isolates general price movements from the underlying spot market's movements by including a proxy variable(s). The proxy variable is expected to have no related futures contract so that its volatility is unrelated to the introduction of futures trading on the spot asset under investigation. In addition, a dummy variable which takes 0 for pre-futures period and 1 for the post-futures period is included in the regression model. If the coefficient of the dummy variable is significant, then the impact of futures trading on the spot market is significant. Although these kinds of Ordinary Least Squares regression models used to be popular among researchers, the introduction of the GARCH family of models by Engle (1982) made a revolutionary change in studies investigating volatility changes. However, regardless of the model employed, there has not been any consensus as to the effects of futures markets on spot volatility as the results have been limited by the sample at hand or the models used.

In early studies, Powers (1970) investigated the effects of futures trading of pork bellies and beef on the random element of spot price returns. He concluded that the variance of the random element in spot prices was significantly lower when futures trading occurred. He added that, although there seems to be a significant reduction in price fluctuations after the onset of futures trading, this change may not be solely due to futures trading but may also be due to other changes in macroeconomic variables. Powers' findings were followed by several other authors' studies. Among others, Taylor and Leuthold (1974) observed lower volatility after the introduction of cattle futures, Cox (1976) stated that futures trading lead to greater efficiency and stabilization in the spot markets by providing accurate informational signals, Edwards (1988a, 1988b) investigated stock market volatility before and after the introduction of futures trading and found decreased volatility for S&P 500 but no significant change for Value Line Index and Skinner (1989) found a reduction in unconditional volatility after the introduction of options listing.

Froewiss (1978) attempted to identify the relationship between U.S. Government National Mortgage Association (GNMA) futures market and spot market by relating weekly GNMA price changes to the price behavior of 10-year government bonds. He concluded that although the efficiency and performance of the spot market had increased after the introduction of futures trading, it is not possible to certainly attribute these changes to futures market. However he concluded that futures trading in GNMA certificates had not definitely led to destabilization in spot prices. Similarly, Ireland and Simpson (1982) found no clear impact of futures trading on U.S. Treasury Bills. They found that although futures trading caused temporary decrease in volatility initially, this "positive benefit" vanished and even possibly resulted in increased volatility after futures trading increased substantially.

Figlewski (1980) investigated the U.S. GNMA futures market for a second time after Froewiss (1978). Figlewski constructed a model including several explanatory variables such as volatility in related markets, liquidity of cash GNMA, level of GNMA spot prices and futures market activity. He concluded that futures trading in GNMA securities led to increased volatility in the spot market. This conclusion was partly attributed to the actions of additional traders. Figlewski (1980) also pointed out the possibility of reverse causation, i.e. if increased instability in cash markets cause increase in hedging, there can be positive association between cash price volatility and futures activity, but concluded that this possible reverse causation is not overly important in the regression models he employed. Harris (1989) found a small increase in daily S&P 500 stock volatilities after the introduction of futures trading.

More recently, Antoniou and Foster (1992) studied the effects of Brent Crude Oil futures in the U.K. using GARCH techniques. They found no significant effect on the price volatility but concluded that oil futures market changed the "nature" of spot market volatility by improving pricing efficiency and providing a new hedging vehicle. Lee and Ohk (1992) studied the effect of stock index futures trading on spot price volatility in Australia, Hong Kong, Japan, U.S. and U.K. and found no significant distinct effect in Australia and Hong Kong but increase in Japan, U.S. and U.K. Later, Antoniou and Holmes (1995) investigated the effects of FTSE-100 Stock Index Futures trading on the volatility of the spot market. They employed GARCH techniques and found evidence of increased volatility while no change in the nature of volatility.

Pericli and Kaoutmos (1997), on the other hand, studied the S&P 500 Index futures and options employing E-GARCH model and found no structural changes on either conditional or unconditional variance. Antoniou et al. (1998) examined the impact of stock index futures in Germany, Japan, Spain, Switzerland, U.K. and U.S., considering also the issue of asymmetries and market dynamics; asymmetries were significantly diminished after the introduction of futures trading but there was not any strong evidence of a change in spot market volatility after the introduction of futures markets. This meant that futures trading has had major effect on market dynamics instead of price volatility itself. Perhaps one of the studies with largest scope has been Gulen and Mayhew (2000)'s study. Gulen and Mayhew investigated the effects of introduction of futures trading in twenty-five countries using various models and found either no significant effects or volatility-dampening effects in countries other than U.S. and Japan. An increase in conditional volatility was observed in U.S. and Japan. Recently, Ryoo and Smith (2004) also found that futures trading on Korea Stock Price Index increased spot price volatility by increasing the speed of information flow and reducing the persistence of information and volatility shocks.

In summary, several studies have attempted to examine the impact of futures trading on the nature of the spot price volatility. These researchers found ambiguous results regarding the impact on spot price volatility; some of them found increases, some decreases and some found no significant change in spot price volatility. Additionally, in a dominant number of studies, significant evidence was found suggesting that the speed of news transmission increased, persistence of volatility shocks decreased and asymmetric response decreased after the introduction of futures trading.

3. Istanbul Stock Exchange and Turkish Derivatives Exchange

This section gives brief information about the Istanbul Stock Exchange and the Turkish Derivatives Exchange. Additional tables and charts of basic statistics such as total trading volume, daily average trading volume and open interest are provided in the Appendix.

3.1. Istanbul Stock Exchange (ISE)

The Istanbul Stock Exchange was established to provide trading in equities, bonds and bills, revenue sharing certificates, private sector bonds, real estate certificates and foreign securities under the supervision of the Capital Markets Board (CMB). Stock trading started on January 3, 1986. Following the increasing liberalization in the Turkish economy, the Exchange started to gain importance among the investors especially in the early 90's.

ISE is currently one of the largest stock exchanges in the Balkans and Middle East. The trading on the ISE National Market takes place in two sessions and the trading hours are 09:30-12:00 for the first session and 14:00-16:30 for the second session on workdays. A fully computerized trading system which enables the ISE members to trade in stocks and right coupons was completed in mid-November 1994. This system significantly improved the speed of execution and increased the daily trading capacity. The ISE Stock Market was comprised of 304 companies and the publicly held capitalization amounted to USD 162,812 million as of December 30, 2005.

3.2. Turkish Derivatives Exchange (TurkDEX)

There have been two attempts to establish futures trading in Turkey. The first one was the Istanbul Gold Exchange's (IGE) introduction of gold futures contracts on August 15, 1997 and the second one was Istanbul Stock Exchange's introduction of U.S. dollar futures contracts on August 15, 2001. In both exchanges very few contracts were traded; the IGE gold futures market has been inactive since 2002 and ISE dollar futures market was halted after the opening of TurkDEX in 2005. Given the two unsuccessful attempts, the introduction of TurkDEX was met by skepticism.

Turkish Derivative Exchange (TurkDEX), having 11 shareholders and 57 exchange members started its operations as the first private exchange in Turkey. It was established in order to provide financial instruments that would help individuals and institutions to manage their risks effectively against abrupt price swings of volatile business environment. Trading started in February 2005 and the opening of the exchange was considered to be the "beginning of a new era for the Turkish economy"[7].

[7] See, for example, speeches of Mr. Sureyya Serdengecti (Governor of the Central Bank of the Republic of Turkey), (2005), on the occasion of opening of the Turkish Derivatives Exchange, and of Mr. Hamdi Bagci, Chief Executive officer of Turkish Derivatives Exchange from TurkDEX's webpage.

TurkDEX provides trading in ISE-30 Index, ISE-100 Index, 91-Day T-Bill, 365-Day T-Bill, Anatolian Red Wheat, Aegean Cotton, Dollar and Euro futures contracts. The trading on TurkDEX takes places in two sessions like the ISE. Although the trading hours were between 10:00 and 15:00 in the beginning, there have been attempts in order to synchronize the trading hours of TurkDEX with ISE. At the moment, the trading hours for the first session are 09:15-12:00 and 13:00-14:00 for the second session. The trading activities are performed on a remote, fully computerized trading platform: TurkDEX Exchange Operators System (TEOS). Clearing is handed by Custody Bank Inc. (Takasbank). The total trading volume increased from USD 12,484 million in February 2005 to USD 160,628 million in June 2005 and to USD 397,891 million in November 2005. The percentage of ISE-30 futures trading volume to total trading volume in the Exchange was 17% in November 2005 and 38% in December 2005.

4. Data and Methodology

4.1. Data and Preliminary Analysis

Daily closing prices for ISE National-30 Index on which the futures contracts are traded, eleven ISE sub-sector indices in order to form the artificial proxy ISE National Index and numerous others indices which will serve as proxy(s) for the alternative models and were collected for the period from January 2, 2002 to January 23, 2006 from the Istanbul Stock Exchange web page and Datastream. The pre-futures period which is from 2 January 2002 to 3 February 2005 consists of 769 observations and the post-futures period which is from 4 February 2005 to 23 January 2006 consists of 243 observations, 1012 observations in total. Non-trading days are excluded from all time-series. The returns of the foreign indices were adjusted to account for the holidays in home country i.e. if there is no matching return for the day, the missing DAX returns were replaced with their three-day moving-average returns. The beginning of pre-futures period was determined as January, 2002 for two reasons. First, two serious crises which were represented by periods of extraordinarily high volatility in Turkish economy took place in November 2000 and February 2001. Second, the length of pre- and post-periods are matched while keeping the pre-period in the optimum level i.e. pre-futures period was kept as long as possible while keeping the number of observations as close as possible to the one of one-year post-period.

The daily continuously compounded returns are calculated as:

$$R_{s,t} = Log(P_t / P_{t-1})$$

where $R_{s,t}$ is the daily return, *Log* stands for the natural logarithm, P_t is the closing value on day t and P_{t-1} is the closing value on day $t-1$. The descriptive statistics of the ISE National-30 Index return data for the pre- and post-futures period and the entire period are given in Table 1 below.

The preliminary results from the descriptive statistics suggest that the average daily return have been 0.1% from January 2, 2002 to January 23, 2006. This corresponds to an annualized return of 33.6%, compounded daily, for the period. The average daily return of the period before the introduction of futures trading was somewhat less than the one during the post-futures period, being 0.1% (25.3% annually) for the pre-futures and 0.2% (63.8% annually) for the post-futures periods. Besides, the standard deviation was substantially reduced from 0.025 in pre-futures period to 0.017 in post-futures period suggesting that the introduction of futures-trading may have led to reduction in price volatility per se. However, a concluding decision concerning the change in volatility cannot be made without further analyzing the data with an appropriate model.

Table 1. Descriptive Statistics of ISE National-30 Return Series data.

	Entire Period	
Number of Observations	1012	
Minimum Daily Return	-0.136	
Maximum Daily Return	0.122	
Mean	0.001	
Standard Deviation	0.023	
Skewness	0.068	
Kurtosis	6.699	
Jarque-Bera	577.805 (0.000)**	
	Pre-Futures	**Post-Futures**
Number of Observations	769	243
Minimum Daily Return	-0.136	-0.048
Maximum Daily Return	0.122	0.050
Mean	0.001	0.002
Standard Deviation	0.025	0.017
Skewness	0.116	-0.293
Kurtosis	6.411	3.212
Jarque-Bera (Probability)	374.467 (0.000)**	3.933 (0.140)

*The descriptive statistics of Istanbul Stock Exchange National-30 Index Daily Return Series data.The ** sign indicates Statistical significance at the 1% level.*

The pre-futures period and entire period show evidence of fat tails as can be seen from the kurtosis statistics exceeding 3 and evidence of positive skewness, i.e. that the right tail is extreme. The resulting Jaque-Bera proves departure from normal distribution for both of these periods. On the contrary, the kurtosis of the post-futures period is close to 3 and the time series is left skewed. The Jarque-Bera test of normality cannot be rejected at 5% level. All these results suggest that the behavior of return series may have changed after the introduction of futures trading. Therefore particular emphasis is given to this property while establishing the appropriate model.

4.2. Methodology

As stated above in the literature section, the earliest studies concerning the volatility change either simply compared pre-period volatility with post-period variance or employed conventional regression analysis by including a dummy variable taking on 0 pre-futures and 1 post-futures and testing for its statistical significance. For example, Froewiss (1978) performed graphical analysis, regression analysis and Box-Jenkins time-series analysis as a check on the regression results. These early methodologies, however, failed to recognize *heteroscedasticity* (see Mandelbrot (1963), Fama (1965) and the review of Bollershev et al., 1992) in stock returns. Heteroscedasdicity is associated with *volatility clustering* which can be defined as the tendency of large (small) changes in prices clustering together and resulting in persistence of the amplitude of price changes. Furthermore, the relationship between information and volatility was not taken into account in the early studies. In his famous work Ross (1989) states that, in the absence of arbitrage opportunities, the volatility of the price equals the volatility of the information flow. Thus any change in information flow after the futures trading implies a change in the volatility of spot prices. The equivalency of information volatility and price volatility points out the importance of *volatility clustering* presence in stock returns.

Engle (1982) proposed the linear Autoregressive Conditional Heteroscedasticity (ARCH) process in order to develop an explicitly formal model for time-varying second-order moments. The process accounts for heteroscedasticity and volatility clustering in price series variance by allowing the conditional variance to vary over time while leaving the unconditional variance constant. This revolutionary model was later extended to linear Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model by Bollerslev (1986). The GARCH family of models was proved to be superior to ARCH models[8] and this family was frequently used in similar studies (see for example, Antoniou et al. (1995) and Antoniou, A., et al. (1998) among the others).

The GARCH (p , q) model can be defined as follows:

First, the *mean-equation* is formed as, e.g.:

$$X_{s,t} = a_0 + \sum_{i=1}^{m} X_{i,t} + \varepsilon_t \tag{1}$$

where $X_{s,t}$ and $X_{i,t}$ are the dependent variable and m independent variable(s), respectively, at time t and a_0 is a constant,

Then the formal definition of the GARCH (p , q) process *variance-equation* is given as:

$$\varepsilon_t \mid \psi_{t-1} \sim N(0, h_t) \tag{2}$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \cdot \varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i \cdot h_{t-1} \tag{3}$$

where ε_t, error term, is a real-value discrete-time stochastic process, ψ_t is the information set of all information through time t, h_t is the conditional volatility which is given as the variance at time t, a_0 is a constant, a_i is a coefficient that relates the past value of the squared residuals to current volatility and β_i is a coefficient that relates current volatility to the last period's volatility. In equation (3), squared lagged errors, ε_{t-1}^2, stand for ARCH effects, lagged variances, h_{t-1}, stand for GARCH effects. And where:

[8] see Akgiray (1989)

$p \geq 0, \qquad q \geq 0$

$\alpha_0 > 0, \qquad \alpha_i \geq 0, \qquad i = 1,2,....., q,$

$\beta_i \geq 0, \; i = 1,2,...., p.$

As can be seen from the above formulas, GARCH process models the conditional variance as a linear function of lagged squared errors and past error variances.

Before deciding on which process to chose, we start by checking our sample to see if volatility clustering is existent and that the sample can actually be modeled with an ARCH/GARCH process.

4.2.1. Tests for ARCH effects

4.2.1.1. Plot of ISE National-30 Index over time

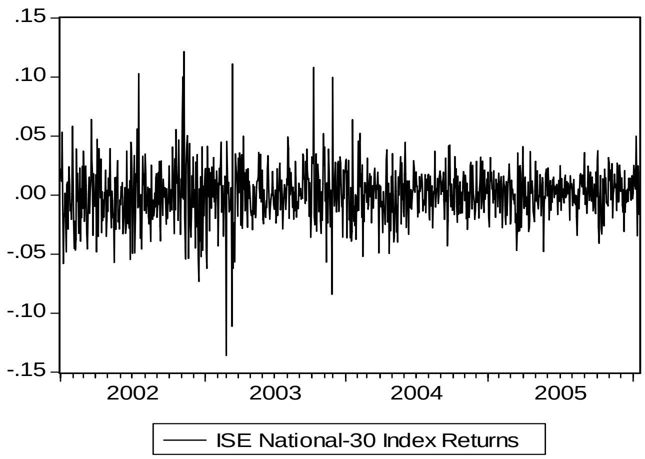

Figure 1. Plot of ISE-30 daily returns vs. years.

If there is volatility clustering in daily returns we expect to see periods of high (low) persistent volatility. As can be seen from Figure 1 above, the amplitude of returns appears to vary over time. The clustering of high volatility can be observed especially during the period before the introduction of futures trading. The second half of 2002 and the second half of 2003 demonstrates times of persistent high volatility whereas the second quarter of 2003, second half of 2004 and third quarter of 2005 shows times of low volatility. Therefore the graphical examination of returns suggests ARCH effects for the period from 2002 to the beginning of 2006.

4.2.1.2. Examination of Autocorrelations - Ljung-Box Q-statistics

Table 2. Autocorrelations and Q-Statistics of Squared OLS Residuals

	Pre-Futures Period			Post-Futures Period			Entire Period		
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.173	23.179	0.000	0.189	8.788	0.003	0.184	34.512	0.000
2	0.117	33.843	0.000	0.182	16.988	0.000	0.131	51.853	0.000
3	0.072	37.823	0.000	0.089	18.939	0.000	0.085	59.222	0.000
4	0.022	38.182	0.000	0.053	19.645	0.001	0.037	60.580	0.000
5	0.076	42.620	0.000	0.069	20.853	0.001	0.089	68.631	0.000
6	0.024	43.063	0.000	0.074	22.238	0.001	0.039	70.163	0.000
7	0.033	43.925	0.000	-0.010	22.261	0.002	0.045	72.263	0.000
8	0.020	44.232	0.000	0.030	22.491	0.004	0.034	73.452	0.000
9	0.013	44.372	0.000	0.004	22.495	0.007	0.026	74.167	0.000
10	0.184	70.782	0.000	0.054	23.229	0.010	0.193	112.180	0.000
11	0.147	87.693	0.000	0.049	23.843	0.013	0.156	137.130	0.000
12	0.064	90.877	0.000	0.030	24.081	0.020	0.076	143.080	0.000
13	0.024	91.312	0.000	0.093	26.297	0.016	0.038	144.570	0.000
14	0.084	96.853	0.000	-0.007	26.311	0.024	0.094	153.700	0.000
15	0.058	99.514	0.000	-0.050	26.972	0.029	0.070	158.700	0.000

Note: The OLS model is obtained by regressing the ISE National-30 returns on a constant.

A possible indication of ARCH effects is that the residuals of a simple Ordinary Least Squares model are uncorrelated but the squared residuals of the same model have significant autocorrelation. Table 2 above shows evidence, of possible ARCH effects, for the traditional 15 lags, as judged by the autocorrelations and Ljung-Box Q statistics of the squared residuals of simple OLS model which is estimated by regressing the ISE National-30 Index on a constant. There is evidence of high, non-linear dependence in the squared residuals shown by declining autocorrelations and significant Q-Statistics which are represented by high probabilities. Similarly, the residuals are examined for autocorrelation and no significant autocorrelation is found as expected.

4.2.1.3. Lagrange Multiplier (LM) test for ARCH effects

The Lagrange Multiplier (LM) test is the formal test for the presence of ARCH effects where the hypothesis of "no ARCH effects" is tested against "ARCH effects"[9].

For the ISE National-30 returns OLS model as given above, the F-Statistics of ARCH LM tests along with their probabilities for the lags lengths of 1, 4, 8 and 12 are represented in Table 3. The hypothesis of "no ARCH" is rejected for all lag levels for all periods, expect for the lag length of 12 for the post-futures period. Again these results suggest that an ARCH family of model will be a good fit for the sample at hand.

[9] Breusch, T. S. and A. R. Pagan (1980), Engle, R. F., (1984).

Table 3. Lagrange Multiplier (LM) test results for ARCH effects

Lag Length	Pre-Futures	Post-Futures	Entire Period
1	23.656	8.906	35.529
	(0.000)**	(0.003)**	(0.000)**
4	7.895	3.905	12.181
	(0.000)**	(0.004)**	(0.000)**
8	4.405	2.125	6.859
	(0.000)**	(0.034)*	(0.000)**
12	5.729	1.431	8.438
	(0.000)**	(0.153)	(0.000)**

*Note: The F-statistics for the corresponding number of lags are given in the table. The values in parenthesizes are the probabilities, ** indicates statistical significance at the 1% level, * indicates statistical significance at the 5% level.*

4.2.2. Models

Having confirmed the presence of heteroscedasticity in variance, this thesis will analyze the effects of futures trading on spot markets by employing GARCH family of models by addressing two main questions following a similar study to Antoniou et al. (1995) and Antoniou, A., et al. (1998). First, if the futures trading itself had any direct effect on spot volatility will be determined. The usual way of doing this involves solving two separate equations simultaneously. The mean-equation is formed in order to isolate any world-wide influences on price changes, day-of-the-week effects (Engle, R. F. and Ng, R. K. (1993), Pagan A. R. and Schwert W. G. (1990) and Balaban, E. (1995)) and any market-wide effects from the underlying spot market return series. The resulting error term, $\varepsilon_{t,}$, is what is left; it captures the impact of factors specific to the spot market. A dummy variable which takes the value of 0 for pre-futures and 1 for post-futures is included to the variance-equation. Then, these two equations are jointly solved. If the coefficient on the dummy is statistically significant, we conclude that the introduction of future trading has an impact on the spot market volatility: a significant positive coefficient suggests an increase in spot price volatility and a negative coefficient suggests a decrease.

Second, the relationship between information and volatility following the introduction of futures trading is investigated. The asymmetric response of volatility to good and bad news is one of the features that the simple GARCH model does not cover. The discussion of this effect can be traced back to findings of Black (1976) and was put forward formally by Nelson (1990). Nelson's study basically says that bad, negative, news in markets increase volatility more than good, positive news. This asymmetric response is due to *leverage effect* of the negative news i.e. negative news may be a sign of further financial distress for the shareholders by causing the firm's debt-to-equity ratio to increase. To verify if the existence of futures trading has led to changes in asymmetric response of volatility, the data will is divided into the pre-futures and post-futures sub-groups and comparison of the E-GARCH model estimates is made.

The coefficient of the error term in the variance-equation, a_i, relates today's price changes to yesterday's price changes isolated from market-wide movements. This relation naturally stems from arrival of yesterday's information to today's markets. Therefore, a_1 can be seen as a "news coefficient". If there is an increase in this news coefficient between the periods, we can say that yesterday's information is reflected in today's prices more rapidly. Although this rapid information flow may lead to either increase or decrease in volatility, it suggests an increase in market efficiency.

Since the post-futures period sample is limited to a year, the results are found to be very sensitive to the model employed. Therefore, several different mean-equations and GARCH family of models were established and the results and performances of these models were compared. Among the different models, the results of the two most parsimonious ones are represented to ensure that the results are not radically changed when the other models with marginally different performances are used. Please note that the same notation as the equations (2) and (3) will be used for the following variance-equations unless the otherwise stated.

4.2.2.1. Model A

Model A is nothing but the widely-used simple GARCH (1,1) model. The mean-equation is specified as follows:

$$R_{30,t} = a_0 + a_1 \cdot R_{A,t} + \sum_{j=2}^{5} a_j \cdot DAY_j + \varepsilon_t \qquad (4)$$

where $R_{30,t}$ is the daily return on the ISE-30 National Index calculated as the first difference of the natural logarithm of the index, $R_{A,t}$ is the daily return on the *market proxy variable* and the DAY_j are day-of-the-week dummy variables for Tuesday to Friday.

The market proxy variable should control for the market-wide fluctuations yet its composition should be independent of the ISE National-30 companies. Since the ISE National-30 Index covers more than 70% of total market capitalization and there was not any ready alternative, a market proxy was established from the sub-sector indices. The artificial index, ISE National-A, is composed of the 11 sub-sector indices which no related futures contracts are traded[10]. Other proxy variable(s) is included in order to further explain the world-wide movements as ISE-30 companies have broader global relationships than the artificial ISE National-A companies in additional models.

The variance-equation is:

$$h_t = \alpha_0 + \alpha_1 \cdot \varepsilon_{t-1}^2 + \beta_1 \cdot h_{t-1} + \gamma \cdot D_f \qquad (5)$$

where ε_t, h_t, a_0, and β_i are defined in the same way as the variance-equation above in section 4.2 and D_f is a dummy variable taking 0 for pre-futures period and 1 for post-futures period.

[10] See Appendix for the composition of the artificial index.

4.2.2.2. Model B

Model B is formed in order to test for the asymmetric response argument. If news have asymmetric effect on volatility then a negative shock to financial time series is likely to cause volatility to rise by more than a positive shock of the same magnitude. These asymmetries, bad news causing more changes in volatility than good news, are attributed to the *leverage effect* which can be described as the effect of loss of shareholder value and increased financial risk of the firm in the presence of bad news.

Several extensions of the simple GARCH model have been developed as attempt to account for possible asymmetries. Among the others (see, for example, T-GARCH or GJR model following independent studies of Zakoian (1990), and Glosten, Jagannathan and Runkle (1993)), Nelson (1991) proposed exponential GARCH, E-GARCH model to account for asymmetries. In this model, the logarithm of the conditional variance is modeled instead of the conditional variance itself. This property helps to remove the non-negativity constraints of the variance-equation coefficients as the h_t could still be positive even if the parameters are negative. Using the same mean-equation as Equation (4), the *variance-equation* of the E-GARCH model is as follows:

$$\log(h_t) = \psi + \theta \cdot \left(\left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| \right) + \lambda \cdot \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta \cdot \log(h_{t-1}) + \gamma \cdot D_f \qquad (6)$$

In this model the errors, ε_t from the mean-equation are assumed to follow Normal Distribution structure[11]. For E-GARCH, asymmetric response arises from the $\lambda \cdot \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ term. In an E-GARCH (1,1), if $\lambda < 0$, then a negative shock, $\varepsilon_{t-1} < 0$, increases the value of h_t. In other words, the presence of leverage effects can be noted if the λ coefficient is found to be statistically different from zero and in this case the λ coefficient is expected to be negative since the relationship between the returns and volatility is negative i.e. if the returns become negative, the volatility will increase. This model is used both to account for any possible asymmetric effects while testing if the introduction of futures trading has an impact on spot volatility, and to compare the asymmetric response of the market for the pre- and post futures trading periods.

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[11] Please note that the statistical software used for this thesis, EViews, has two differences from the formal E-GARCH model developed by Nelson(1991). First, EViews assumes normal distribution of the error term instead of the generalized distribution. Second, the $\sqrt{\frac{2}{\pi}}$ term from the model is dropped and Nelson's original model is as follows:

$$\log(h_t) = \psi + \theta \cdot \left(\left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| - \sqrt{\frac{2}{\pi}} \right) + \lambda \cdot \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta \cdot \log(h_{t-1}) + \gamma \cdot D_f$$

5. Hypotheses

In this section, formal hypotheses will be developed in order to conduct formal tests as to the effects of futures trading.

First, we check if the introduction of futures trading itself had any impact on spot price volatility[12]. Since there is no consensus as to the direction of the futures trading effects, the null hypothesis of "no futures trading effects" is set against "the presence of futures trading effects". In other words, the null hypothesis is that the coefficient of the futures dummy is equal to zero will be tested against the alternative hypothesis suggesting that the futures dummy is significantly different from zero. In case the null hypothesis is rejected, the coefficients are investigated and a decision will then be made concerning the direction of such change. Due to differing theories and previous empirical evidence an attempt will be made to explore whether there has been any change without making any presumptions concerning the direction of the change, if there is any. Hence, the first hypothesis is as follows:

Hypothesis 1:

H_0: Futures trading has no impact on the spot price volatility

H_1: Futures trading has an impact on the spot price volatility

Second, the change in the speed of news transmission, the speed which the new information is reflected into spot prices, and the persistence of volatility shocks, whether the previous level of volatility is persistent, are investigated. To see if there has been a change in the speed of news transmission and the persistence of volatility shocks, two hypotheses are developed. A dummy is added to the variance-equation to see if there has been a change in the relevant parameters which are described in sections 6.1 and 6.2. In line with the previous theories of more information flow with the introduction of futures trading, an increase in the speed of news transmission and a decrease in the persistence of volatility shocks are expected. The two hypotheses are as follows:

Hypothesis 2:

H_0: Futures trading has no impact on the speed of news transmission

H_1: Futures trading has an impact on the speed of news transmission

Hypothesis 3:

H_0: Futures trading has no impact on the persistence of volatility shocks

H_1: Futures trading has an impact on the persistence of volatility shocks

[12] Please note that, although there are several technical definitions of volatility we stick to the traditional definition of volatility, which is the standard deviation of the price movements, from now on.

Then, we seek for evidence if the existence of futures trading has led to changes in asymmetric response of volatility using a model allowing for asymmetric response. In addition to establishing this model which accounts for asymmetric information to see if there has been a change in volatility by inserting a dummy for the post-futures period, the test for possible changes in asymmetric volatility will be done by establishing models for pre- and post-futures periods separately and testing for the significance of the coefficients to see if they are different than zero. If both of the coefficients are found to be different than zero for any of the periods, further examination of the changes in asymmetric response will be made. Otherwise, we will conclude that there were no signs of asymmetric response for the two periods. Therefore, it will not be meaningful to test the coefficients against each other. The formal hypothesis to test if there has been an asymmetric response for the pre- and post-futures periods is as follows:

Hypothesis 4a, 4b (for pre- and post-futures):

H_0: Asymmetric response is not present for pre-futures/post-futures period

H_1: Asymmetric response is present for pre-futures/post-futures period

If both of the above Hypotheses are rejected, in other words if an evidence of asymmetric response is found for both of the periods, a further test will be performed to see if there has been a change in the magnitude of asymmetric response. In this case, the following hypothesis will be tested on the condition that Hypothesis 4a and 4b are rejected:

Hypothesis 5 (conditional):

H_0: Futures trading has no impact on the asymmetric response

H_1: Futures trading has an impact on the asymmetric response

6. Results

The results of the regression models and the relevant test results will be given in this section. In section 6.1 the first, second and the third hypotheses regarding the changes in volatility, news transmission and persistence of volatility shocks will be discussed, whereas the first and fourth hypotheses regarding the changes in volatility allowing for asymmetric response and the changes in the asymmetric response will be discussed in section 6.2. In section 6.3, alternative models will be given to further investigate the nature of volatility before and after the introduction of futures trading.

6.1. Volatility, News Transmission and Persistence of Volatility Shocks

Before examining the nature of volatility by the GARCH model, a Chow test was applied to the mean-equation in order to see if there has been any structural change in the relationship between the ISE National-30 returns and independent variables relationship. A significant structural change may indicate the impact of futures trading as well as other macroeconomic factors such as the currency rates, interest rates, etc. The sample is divided into two subgroups; pre-futures period from January 1, 2002 to February 3, 2005 and post-futures period from February 4, 2005 to January 23, 2006. The *F*-statistic of the Chow test was found to be statistically significant suggesting a possible change in the relationship between the returns on ISE National-30 and the artificial index and weekday dummies. However, it should be kept in mind that the Chow test was conducted under the basic assumption of the normal distribution of the error terms thus the test result is far from providing any definite outcome. Although this information does not affect the GARCH model used or gives any clear-cut idea as to the effects of futures trading on price volatility, it gives some insight to the possible other reasons of a change in price volatility, if there is any.

The mean and variance equations which were defined in section 6.2 are jointly estimated by *quasi-maximum likelihood* method using Bollershev-Wooldridge Heteroscedasticity Consistent Covariances. This method was first described by Bollerslev and Wooldridge (1992) to account for any departure from the normal distribution assumption of standardized error terms and provide robustness. Indeed, the Jarque-Bera test statistic for the standardized error terms of the maximum-likelihood estimation is found to be statistically significant, suggesting that the standardized errors are not normally distributed. Nevertheless, it should be kept in mind that in the absence of the Heteroscedasticity Consistent Covariances method, the coefficient estimates are still the same and consistent however; the standard errors may be erroneous if the conditional normality of residuals does not hold.

The coefficients of the mean-equation and variance-equation of Model-A is given in the following table. All the following calculations are made using EViews statistical software[13].

[13] EViews® Quantitative Micro Software.

Table 4. The coefficients from the Model A regression

Coefficients	a_0	a_1	a_2 (Tue)	a_3 (Wed)	a_4 (Thu)	a_5 (Fri)
Entire Period	-0.000	1.09895	-0.001	0.000	0.001	0.002
***n*= 1012**	(0.666)	(0.000)**	(0.465)	(0.905)	(0.543)	(0.158)
Pre-Futures	-0.000	1.162	-0.001	-0.000	0.000	0.003
***n*= 769**	(0.900)	(0.000)**	(0.463)	(0.823)	(0.986)	(0.057)
Post-Futures	-0.000	0.874	-0.001	0.001	0.002	-0.000
***n*= 243**	(0.858)	(0.000)**	(0.679)	(0.763)	(0.291)	(0.799)

Coefficients	α_0	α_1	β_1	γ
Entire Period	0.000	0.049	0.898	-0.000
	(0.170)	(0.014)*	(0.000)**	(0.352)
Pre-Futures	0.000	0.036	0.913	
	(0.288)	(0.133)	(0.000)**	
Post-Futures	0.000	0.059	0.892	
	(0.405)	(0.040)*	(0.000)**	

Entire Period	
Log-Likelihood	3037.55
Schwarz Criterion	-5.93
Akaike Criterion	-5.98
Adjusted R-squared	0.72

Result for Model A from the GARCH (1,1) model estimation . The mean-equation is:

$$R_{30,t} = a_0 + a_1 \cdot R_{A,t} + \sum_{j=2}^{5} a_j \cdot DAY_j + \varepsilon_t$$

Variance-equation is:

$$h_t = \alpha_0 + \alpha_1 \cdot \varepsilon_{t-1}^2 + \beta_1 \cdot h_{t-1} + \gamma \cdot D_f$$

*where $R_{30,t}$ is the daily return on the ISE-30 National Index calculated as the first difference of the natural logarithm of the index, $R_{A,t}$ is the daily return on the market proxy variable artificial ISE National Index and the DAY_j are day-of-the-week dummy variables for Tuesday to Friday in the mean-equation. In the variance-equation, ε_t, error term, stands for ARCH effects, h_t is the conditional volatility and stands for GARCH effects, futures dummy, D, is the dummy variable taking 0 for pre-period, 1 for post-period.. Z-Statistics are shown in parentheses with ** indicating statistical significance at the 1% level and * indicating statistical significance at the 5% level.*

The results of the mean-equations for suggest that the coefficients of artificial ISE-National Index are positive and statistically significant for all time periods. While the day-of-the week dummy coefficients are statistically insignificant for all periods, there is weak evidence of positive returns for Fridays for pre-futures period. Besides, although not statistically significant, Monday and Tuesday dummy coefficients suggest negative returns for ISE National-30 Index for all periods. These outcomes for the weekday effects will not be discussed in detail here but it should be noted that they are mostly in line with the findings of Balaban (1995)[14].

Both the ARCH and GARCH effects, as given by the a_1 and a_2 coefficients, are significant for the entire-period. All the GARCH (1,1) model variance-equation coefficients but the a_1 coefficient of pre-futures period are significant at the 5% level suggesting no important change in the nature of volatility. Indeed, when the Heteroscedasticity Consistent Covariance method is not employed, all the coefficients become significant. Although this issue was further investigated using several GARCH specifications as well as OLS models, the GARCH (1,1) proved superior the other models indicated by the evidence which is presented in section 6.3.

[14] For further information on the weekday effects on Istanbul Stock Exchange, see Balaban, E. (1995).

The estimated coefficient on the futures trading dummy variable is negative but not statistically significant. This implies that, although there may have been an increase in spot price volatility, the sample at hand with this model provides no significant statistical evidence regarding this impact. Therefore, Hypothesis 1, no change in volatility after the introduction of futures trading can not be rejected. The unconditional variances the unconditional variances which are given by a_0 / (1- a_1 - a_2) formula are also examined. The annualized unconditional variances are found to be 4.08% for the pre-futures period and 2.79% for the post-futures period. This decrease in unconditional variance for the post-futures period is consistent with the negative sign of post-futures dummy variable.

Another issue regarding the effects of futures trading is the change in the speed of news transmission and the persistence of volatility shocks. As mentioned in Models section, a_1 relates today's price changes to yesterday's price changes isolated from market-wide movements and it can be seen as a "news coefficient". An increase in this coefficient suggests an increase in the pace of information transmission in the spot market. The news coefficient for the pre-futures period is 0.036 whereas it is 0.059 for the post-futures period. The increase suggests that the information is reflected in spot prices more quickly during the period after the introduction of futures trading. The increase in information volatility, on the other hand, provides weak evidence that the price volatility increased as measured by the increase in the speed of news transmission, assuming there are no-arbitrage opportunities (Ross, (1989)). When a dummy is included for the post-futures period to formally test Hypothesis 2, significant positive change in the news coefficient is confirmed. The coefficient for the news coefficient dummy is found to be very close to zero, however positive and statistically significant at the 1% level. Thus hypothesis 2 is rejected leading a conclusion that there has been a change in the speed of news transmission.

The a_2 coefficient, on the other hand, is the lagged variance term. It relates the current variance to the previous level of variance which reflects the news before the previous day. Thus, the term stands for the "old news". An increase in the speed of news transmission which can be signaled with an increase in a_1 is expected to result in a decrease in the persistence of old news thus a decrease in the persistence of old volatility shocks. Indeed, the a_2 coefficient decreases from 0.913 to 0.892 while a_1 coefficient increases from pre- to post-futures period, suggesting that the old news has had less impact on today's prices. Hypothesis 3 is also tested by adding an "old news" dummy for the post-period. Although the coefficient is found to be slightly positive, it is not found to be statistically significant thus the hypothesis 3, that there has been no change in the persistence of old news, can not be rejected.

6.2. Volatility and Asymmetric Response

The simple GARCH models have been extended to account for any leverage effects of the equity returns. As mentioned above in the models section, leverage effects cause asymmetric response of volatility when negative information causes the volatility to increase by more than positive information of the same magnitude. The exponential GARCH, E-GARCH, model which was proposed by Nelson

(1991) is utilized to account for possible asymmetries for the entire period in order to examine the volatility changes and to see if there has been a change regarding the asymmetric response between pre- and post-futures periods.

Table 5. The coefficients from the Model B regression

Coefficients	a_0	a_1	a_2 (Tue)	a_3 (Wed)	a_4 (Thu)	a_5 (Fri)
Entire Period	-0.000	1.098	-0.001	0.000	0.001	0.002
***n*= 1012**	(0.613)	(0.000)**	(0.494)	(0.858)	(0.519)	(0.123)
Pre-Futures	-0.000	1.160	-0.001	-0.000	-0.000	0.003
***n*= 769**	(0.878)	(0.000)**	(0.459)	(0.820)	(0.978)	(0.040)*
Post-Futures	-0.001	0.856	0.000	-0.000	0.003	-0.000
***n*= 243**	(0.578)	(0.000)**	(0.942)	(0.988)	(0.207)	(0.971)
Coefficients	Ψ	θ	λ	β	γ	
Entire Period	-0.466	0.108	0.002	0.956	-0.011	
	(0.109)	(0.008)**	(0.945)	(0.000)**	(0.505)	
Pre-Futures	-0.489	0.091	0.006	0.952		
	(0.190)	(0.066)	(0.779)	(0.000)**		
Post-Futures	-17.879	-0.031	0.139	-0.933		
	(0.000)*	(0.709)	(0.090)	(0.000)**		

Result for Model B from the E-GARCH (1,1) estimation. The mean-equation is:

$$R_{30,t} = a_0 + a_1 \cdot R_{A,t} + \sum_{j=2}^{5} a_j \cdot DAY_j + \varepsilon_t$$

Variance-equation is:

$$\log(h_t) = \psi + \theta \cdot \left(\left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| - \sqrt{\frac{2}{\pi}} \right) + \lambda \cdot \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta \cdot \log(h_{t-1}) + \gamma \cdot D_f$$

*where $R_{30,t}$ is the daily return on the ISE-30 National Index calculated as the first difference of the natural logarithm of the index, $R_{A,t}$ is the daily return on the market proxy variable artificial ISE National Index and the DAY_j are day-of-the-week dummy variables for Tuesday to Friday in the mean-equation. In the variance-equation, λ stands for asymmetric response, futures dummy is the dummy variable, D, taking 0 for pre-period, 1 for post-period. Z-Statistics are shown in parentheses with ** indicating statistical significance at the 1% level and * indicating statistical significance at the 5% level.*

Table 5 shows the parameter estimates of the E-GARCH(1,1) model. The mean-equation employed is the same as the first model above. When asymmetric response to the news is allowed only the Friday dummy for the post-period is significant at the 1% level, showing positive returns on Friday for this period.

The coefficient of the dummy for futures trading, γ, is negative thus it indicates a decrease in price volatility for the post-futures period. However, similar to the GARCH model above, this coefficient is not statistically significant. Therefore, Hypothesis 1 can not be rejected when we allow for asymmetric response.

The coefficient of the asymmetric response, *λ,* is positive and not statistically significant indicating no asymmetric response to the new information during the sample period. Indeed, the graphical examination of the news impact curve[15], which can be seen in Figure 2 below, does not provide any evidence of asymmetric response for the entire period similarly. The lagged volatility shocks of the same magnitude, regardless of their signs, have almost symmetrical effects on conditional variance for the entire period.

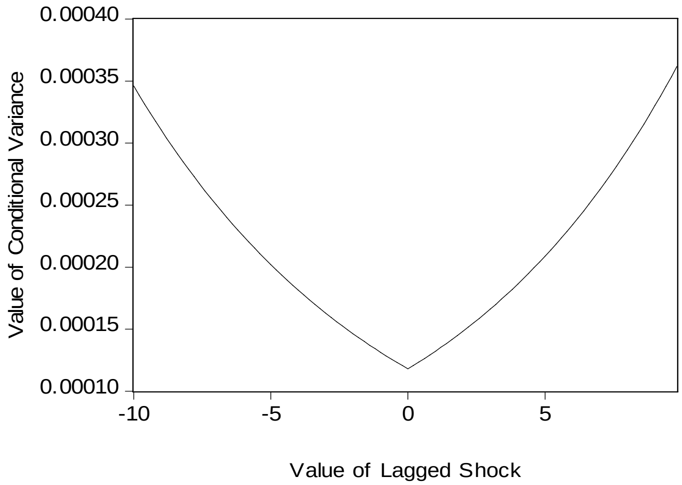

Figure 2. News Impact Curve derived from the E-GARCH(1,1) model.

Table 5 above also provides the E-GARCH model results for the pre- and post-periods. The asymmetric news coefficients are not found to be statistically significant for the pre- and post-futures periods. This suggests that there is no asymmetric response of conditional volatility to the new information for the two periods under consideration. Therefore, Hypotheses 4a and 4b, in which the null are no presence of asymmetric response for the pre- and post-futures periods respectively, can not be rejected. Since asymmetric response is not present for both of the periods, any change in the magnitude of asymmetric response coefficient will provide no further meaningful evidence. Therefore, Hypothesis 5 is not tested.

The two models above are further examined for robustness. Tests for autocorrelations in squared residuals using Ljung-Box (LB) Q-statistics performed. Unlike the OLS model results given in Table 2, none of the lags for the GARCH family of models above provided significant autocorrelation in squared residuals up to 36th lag. The Lagrange Multiplier (LM) statistics are also examined for further ARCH effects for the 1st, 4th, 8th and 12th lags. Similarly, no further significant ARCH effects were found for the two above models. The results of the LB and LM tests are presented in the Appendix.

[15] Engle, F. R., Ng, V. K. (1993), Measuring and Testing the Impact of News on Volatility.

6.3. Additional Models

Since the results are found to be very sensitive to the independent variables of the mean-equation and (p,q) combinations of the variance-equation, several other models with different mean- and/or variance-equations are established in order to investigate the change in volatility.

First, the GARCH (1,1) variance-model is identified with several different explanatory variables in the mean-equation. The coefficients of the futures dummy variable and their significance levels are provided in Table 6 below.

As can be seen from the probabilities, none of the models above provided any statistically significant evidence of a change in volatility after the introduction of futures trading. However, all the models along with the main model given above suggest weak evidence of decrease in volatility after the introductions of futures trading.

Table 6. The coefficients of the futures dummy and probability values for alternative models.

Explanatory Variables	D_f Coefficient	Probability
Weekday Dummies, Artificial ISE National-30 Index, DAX-30 Performance Index	-0.000002	0.388
Weekday Dummies, Artificial ISE National-30 Index, FTSE-100 Index	-0.000002	0.381
Weekday Dummies, Artificial ISE National-30 Index, S&P-500 Composite Index	-0.000002	0.354
Weekday Dummies, Artificial ISE National-30 Index, FTSE All World Index	-0.000002	0.371
Weekday Dummies, Artificial ISE National-30 Index, FTSE Emerging Markets Index	-0.000002	0.351
Weekday Dummies, Artificial ISE National-30 Index, FTSE Emerging Markets Europe Index	-0.000003	0.304
Weekday Dummies, DAX-30 Performance Index, FTSE Emerging Markets Index	-0.000003	0.420
Weekday Dummies, DAX-30 Performance Index, FTSE Emerging Markets Europe Index	-0.000008	0.275
Weekday Dummies, FTSE-100 Index, FTSE Emerging Markets Index	-0.000003	0.396
Weekday Dummies, FTSE-100 Index, FTSE Emerging Markets Europe Index	-0.000009	0.229
Weekday Dummies, S&P-500 Composite Index, FTSE Emerging Markets Index	-0.000004	0.342
Weekday Dummies, S&P-500 Composite Index, FTSE Emerging Markets Europe Index	-0.000009	0.199
Weekday Dummies, Artificial ISE National-30 Index, DAX-30 Performance Index, FTSE Emerging Markets Index	-0.000002	0.368
Weekday Dummies, Artificial ISE National-30 Index, FTSE-100 Index, FTSE Emerging Markets Index	-0.000002	0.366
Weekday Dummies, Artificial ISE National-30 Index-B, S&P-500 Composite Index, FTSE Emerging Markets Index	-0.000002	0.349

Note: The data for several world indices was collected from Datastream. Most of the above indices above are established by institutions such as FTSE and Datastream and the author does not accept any responsibility regarding the composition of the above 3rd party artificial indices.

Second, the variance-equations of Model A is estimated for all combinations of p = 1, 2, 3 and q = 1, 2, 3. The Log-Likelihood ratio, Akaike info criterion, Schwarz criterion and Adjusted R-Squared statistics of GARCH models with the same mean-equation as Model A are given below in Table 7.

Table 7. The coefficients from the variations of Model A variance-equation.

Log-Likelihood	ARCH Order		
GARCH Order	**1**	**2**	**3**
1	3037.549	3038.787	3038.836
2	3038.295	3038.802	3038.895
3	3042.825	3042.164	3043.148

Schwarz criterion	ARCH Order		
GARCH Order	**1**	**2**	**3**
1	-5.935	-5.930	-5.924
2	-5.929	-5.923	-5.917
3	-5.931	-5.923	-5.918

Akaike info criterion	ARCH Order		
GARCH Order	**1**	**2**	**3**
1	-5.983	-5.984	-5.982
2	-5.983	-5.982	-5.980
3	-5.990	-5.986	-5.986

Adjusted R-squared	ARCH Order		
GARCH Order	**1**	**2**	**3**
1	0.722	0.722	0.721
2	0.722	0.721	0.721
3	0.721	0.721	0.721

As can be seen from the table above, all the statistics are very close to each other. Although the log-likelihood of our GARCH (1,1) model is the lowest, its Schwarz Criterion and Adjusted R-Squared statistics are the best among the others which indicate the superiority of Model A employed here. Besides, the coefficients of the other order models are generally either insignificant or they violate the assumption of non-negativity. LM tests also showed that there are no further significant ARCH effects in ISE National-30 return series. For the purpose of this study, the coefficients of the futures dummy are examined. The coefficients of the futures dummy are found to be negative but statistically insignificant for the all combinations given above.

6.4. Summary of Results

To sum up Section 6, the outcomes of hypotheses are evaluated in the order the results are given, in the table below.

Table 8. The summary of the results.

Hypothesis	Section	Tested against	Method	Outcome
Hypothesis 1	6.1	Change in volatility	GARCH (1,1) Dummy	No change in volatility, weak evidence for negative change
Hypothesis 2	6.1	Change in the speed of news transmission	GARCH (1,1) Pre-Post Evaluation and Dummy	Positive change in the speed of news transmission
Hypothesis 3	6.1	Change in the persistance of news	GARCH (1,1) Pre-Post Evaluation and Dummy	No change in the persistance of the news
Hypothesis 1	6.2	Change in volatility	EGARCH (1,1) Dummy	No change in volatility, weak evidence for negative change
Hypothesis 4a	6.2	Presence of asymmetric response (pre-futures)	EGARCH (1,1) Pre-Period Significance	No asymmetric response in pre-futures period
Hypothesis 4b	6.2	Presence of asymmetric response (post-futures)	EGARCH (1,1) Post-Period Significance	No asymmetric response in post-futures period
Hypothesis 1	6.3	Change in volatility	GARCH (1,1) Mean-Equation Models with Dummies	No change in volatility, weak evidence for negative change
Hypothesis 1	6.3	Change in volatility	GARCH (p,q) Variance-Equation Models with Dummies	No change in volatility, weak evidence for negative change

7. Conclusion

The purpose of this thesis has been to investigate the effects of the introduction of futures trading on the Istanbul Stock Exchange National-30 Index. The main hypothesis that *the volatility of the spot market is changed after the introduction of futures trading* is investigated along with the others such as *a change in news transmission speed*, *a change in persistence of volatility shocks* and *a change in asymmetric response to the new information* after the introduction of futures trading. The preliminary analysis was conducted by the graphical analysis and unconditional volatilities then the hypothesis was tested formally on the data from the Istanbul Stock Exchange for the period January 2002 – January 2006.

The main finding of this investigation is that there has not been any significant change in the spot price volatility after the introduction of futures trading. However, a weak reduction in volatility for the post-futures period was found indicated by the graphical examination of daily volatility, unconditional variances and insignificant but negative coefficients of futures dummies of our two formal models along with the alternative models. The power of the first test in section 6.1 and the power of the second one in section 6.2 are found to be 0.847 and 0.848 respectively[16]. In other words, the ability of the tests above to detect an effect when the effect actually exists is over the 0.80 which is the conventional limit to conclude that a test is statistically powerful. Regarding Hypothesis 1, the fact that no statistically significant change in spot volatility was found is in line with most of the different theories and empirical research in the subject.

In addition, Hypotheses 2 and 3, the changes in the speed of news transmission and the persistence of volatility shocks were investigated. An increase in the speed of news transmission which is considered to be typical after the introduction of futures trading is found. Furthermore, evidence was found suggesting that the persistence of volatility shocks was decreased after the introduction of futures trading. However, this effect was not found to be statistically significant. These results are in line with the expectations and they comply with the dominant theories.

The asymmetric response of volatility was also examined for the pre- and post-futures periods for Hypotheses 4a and 4b. In addition to the model established to account for asymmetries in response to new information, no evidence of such behavior was found by the examination of the news impact curve. Besides, futures trading have not affected the nature of response to new information as there has not been any change in asymmetric response between the pre- and post-periods.

Although the models presented here provide an insight to the effects of futures trading on the spot price volatility, the results should be evaluated with caution. The fact that no significant change is found as to the futures trading impact on volatility in this paper can be misleading and/or insufficient alone. This is

[16] Lenth, R. V. (2006). Java Applets for Power and Sample Size [Computer software]. Retrieved March 07, 2006, from http://www.stat.uiowa.edu/~rlenth/Power.

because it is almost impossible to isolate the specific impact of futures trading from the effects of other changes in the economy. Indeed, the Turkish economy has had a relatively less volatile period especially during 2004 and 2005 after the financial crisis, elections and some other important international political events. Furthermore, the recovery of the economy was boosted especially after dropping six zeros from the currency at the beginning of January, 2005. Considering that the post-futures period begins in February, 2005, the difficulty of telling the specific effects of futures trading will be more obvious. Futures trading itself may well have increased the spot price volatility and its effect might be offset by the stabilizing effect of some other macroeconomic change as mentioned or it may have led to price stabilization although the destabilizing macroeconomic changes led us to conclude that there has been no change in spot price volatility.

Moreover, the Turkish Derivatives Exchange is still in its very early periods and it was not possible to collect further data for the post-period sample. In addition to the low number of observations for the post-period, it should be noted that the trading volume has been at low levels especially during the first few months of futures trading. The Exchange still witnesses important changes such as the introduction of ISE National-100 contracts in November, 2005 and the recent change in trading hours to synchronize with the ISE trading hours.

8. Suggestions for Further Research

Three main areas are identified for further research. First, this thesis can be enriched with the additional data in a few years. By this way not only the GARCH models will better fit and will give better results for longer post-futures period, but also the additional data will help to eliminate the short-term changes caused by other events than the introduction of TurkDEX. Second, an investigation which relates the trading and open position volume in the Turkish Derivatives Exchange contracts to the volatility in the relevant spot asset could be performed. This would allow to see if increased unexpected trade volume in TurkDEX leads to increase in volatility of the spot market. Third, the changes in the Istanbul Stock Exchange Indices that are attributed to the introduction of futures trading could be compared to the changes caused by the relatively new and similar derivatives markets such as Taiwan Futures Exchange, Korean Exchange – Futures Division, Athens Derivatives Exchange and Mexico Derivatives Exchange.

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Web Pages

www.ise.org (Istanbul Stock Exchange homepage)

www.turkdex.org.tr (Turkish Derivatives Exchange homepage)

www.tcmb.gov.tr (Central Bank of the Republic of Turkey homepage)

www.deutsche-boerse.com (Deutsche Börse Group homepage)

Databases

Datastream®

10. APPENDIX

10.1. TurkDEX ISE National-30 Futures Contract Specifications

Underlying Asset Istanbul Stock Exchange 30 Index (ISE 30)

Contract Size 100 TRY times the value of the ISE 30 Index/1,000 (Contract Size = 100*34.445 = 3,442.5 TRY)

Price Quotation Istanbul Stock Exchange 30 Index with the three digits. (ISE 30)/1,000 (Sample quote = 34.425)

Daily Price Limit % ±10 above or below the prior day's settlement price

Minimum Price Fluctuation (Tick) 0.025 = 2.5 TRY

Contract Months 3 nearest months out of February, April, June, August, October and December (like February, April, June or April, June, August)

Final Settlement Day Last business day of the contract month

Last Trading Day Last business day of the contract month

Settlement Method Cash Settlement

Final Settlement Price Arithmetic mean of random 10 ISE-30 index values during the last 15 minutes of trading at TURKDEX on the last tading day. When the trading at the ISE is over before TURKDEX, arithmetic mean of random 10 ISE-30 index values during the last 15 minutes of trading at ISE (the time interval between the random values must be higher than 30 seconds).

Daily Settlement Price Daily Settlement Price calculated as mentioned below:

- Weighted average of all prices during the last 10 minutes of trading at TURKDEX.
- If there are insufficient trades (less than 10) during the last 10 minutes of trading, weighted average of last 10 prices during the day.

If daily settlement price can not be calculated through above methods or Settlement Price Committee determines that the settlement price doesn't reflect the market very well, daily settlement price is calculated through the methods as mentioned below:

- Weighted average of all prices during the session,
- Prior day's settlement price,
- Mean of the best bid and ask quotations,
- Theoric future price calculated by the Settlement Price Committee.

10.2. The Evolution of Istanbul Stock Exchange and Turkish Derivatives Exchange

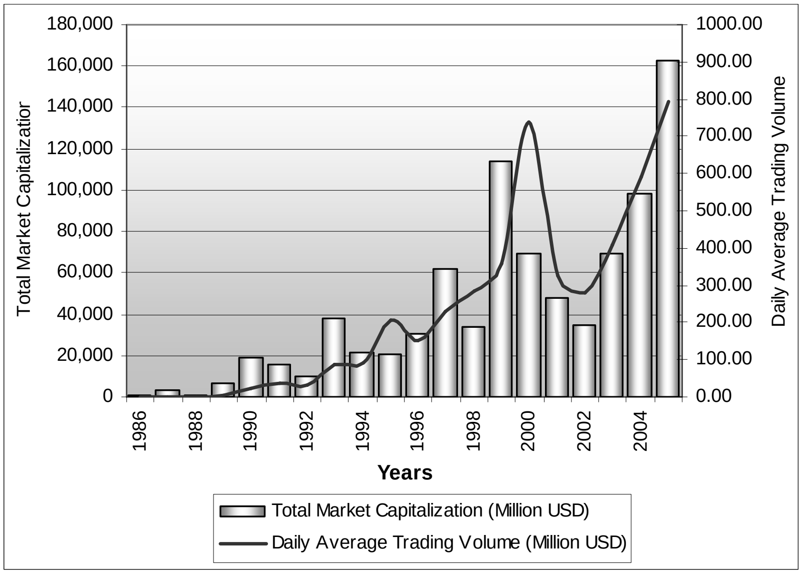

Figure 3. Evolution of Istanbul Stock Exchange from 1986 to 2006.

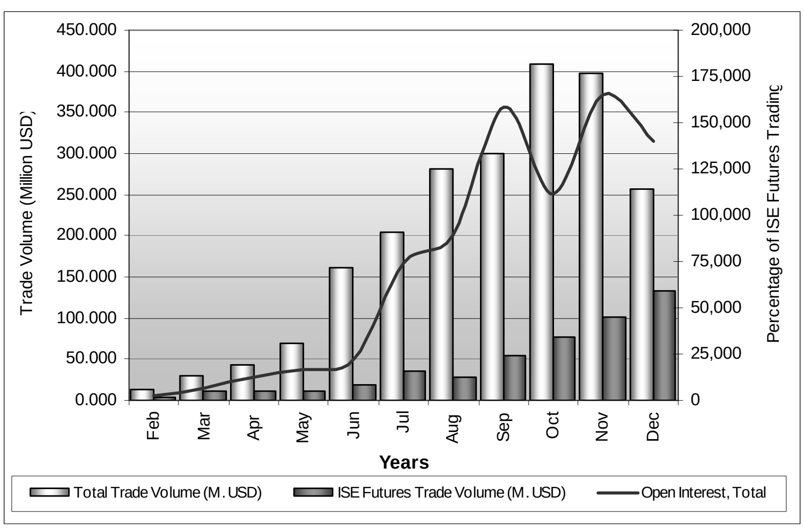

Figure 4. Evolution of Turkish Derivatives Exchange since February, 2005.

10.3. ISE National-30 Index vs. Artificial ISE National Index

Table 9. The List of Sub-Sector Indices which form the ISE National Artificial Index

CODE	INDICES	BASE DATE AND VALUE
XU030	ISE NATIONAL-30	Dec.27, 1996=976
XTEKS	TEXTILE, LEATHER	Dec.27,1996=1,046
XTAST	NON-METAL MINERAL PRODUCTS	Dec.27,1996=1,046
XELKT	ELECTRICITY	Dec.27,1996=1,046
XULAS	TRANSPORTATION	Dec.27,1996=1,046
XTRZM	TOURISM	Dec.27,1996=1,046
XSGRT	INSURANCE	Dec.27, 1996 = 914
XFINK	LEASING, FACTORING	Dec.27, 1996 = 914
XYORT	ISE INVESTMENT TRUSTS	Dec.27, 1996 = 976
XBLSM	INFORMATION TECHNOLOGY	June 30, 2000 = 14,466.12
XSVNM	DEFENCE	June 30, 2000 = 14,466.12
XIKIU	ISE SECOND NATIONAL	Dec.27, 1996 = 976

Note: The National-30 Index and the sub-sector indices which are used to form the Artificial ISE National-30 Index (ISE National-A) are given. The National-A is calculated by taking the arithmetic average of the 11 sub-sector indices above.

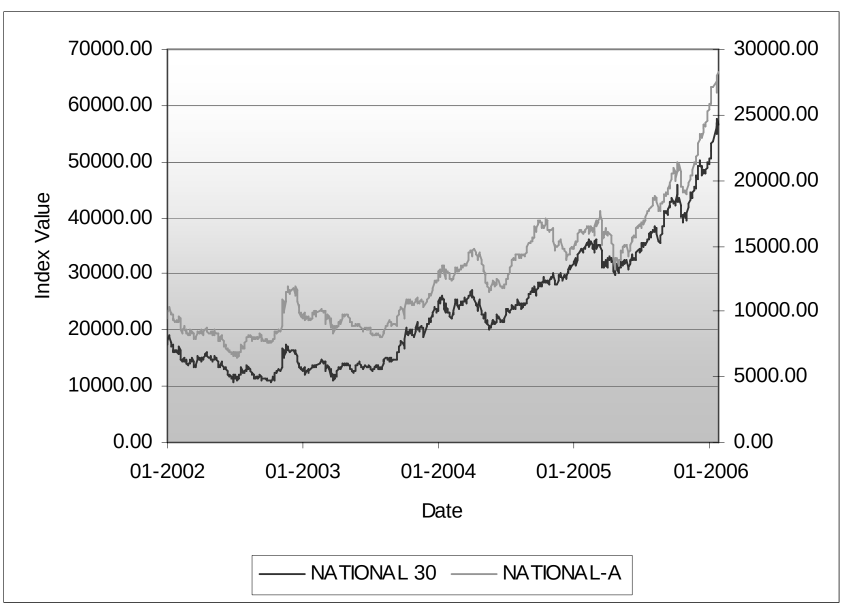

Figure 5. Time series of ISE National-30 Index and the Artificial ISE National Index.

10.4. Residuals, Actual and Fitted Returns from Model A and Model B, Further Tests

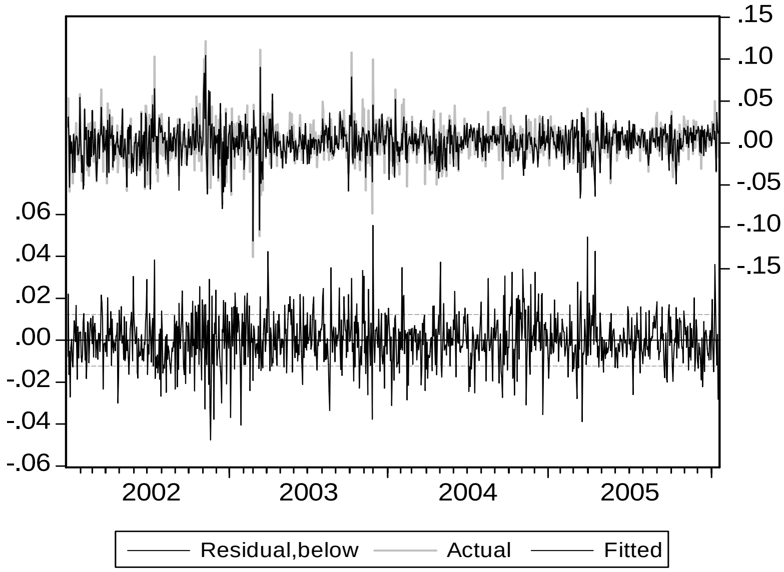

Figure 6. Residuals, Actual and Fitted Return from Model A, GARCH(1,1).

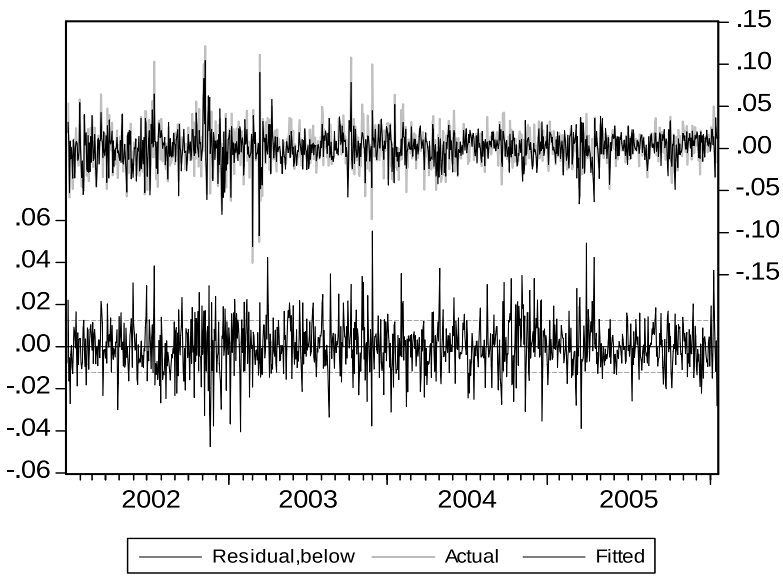

Figure 7. Residuals, Actual and Fitted Return from Model B, E-GARCH(1,1)..

Table 10. Autocorrelations and Q-Statistics of Squared Residuals for Model A and Model B

	Model A			Model B		
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.036	1.335	0.248	0.040	1.584	0.208
2	-0.006	1.374	0.503	-0.006	1.618	0.445
3	-0.035	2.586	0.460	-0.032	2.671	0.445
4	-0.058	5.998	0.199	-0.061	6.500	0.165
5	-0.025	6.660	0.247	-0.029	7.386	0.193
6	-0.032	7.678	0.263	-0.033	8.501	0.204
7	0.014	7.875	0.344	0.016	8.778	0.269
8	0.079	14.229	0.076	0.080	15.256	0.054
9	-0.015	14.455	0.107	-0.015	15.483	0.079
10	0.006	14.491	0.152	0.003	15.490	0.115
11	-0.002	14.495	0.207	-0.001	15.492	0.161
12	0.059	18.017	0.115	0.057	18.871	0.092
13	0.036	1.335	0.248	0.040	1.584	0.208
14	-0.006	1.374	0.503	-0.006	1.618	0.445
15	-0.035	2.586	0.460	-0.032	2.671	0.445

Note: None of the Q-Staticstics for the models found significant.

Table 11. Lagrange Multiplier (LM) test results for further ARCH effects

Lag Length	Model A	Model B
1	1.236	1.471
	(0.267)	(0.225)
4	1.520	1.623
	(0.194)	(0.166)
8	1.577	1.650
	(0.127)	(0.107)
12	1.450	1.493
	(0.138)	(0.121)

The F-statistics for the corresponding number of lags are given in the table.
The values in parenthesizes are the probabilities.