PRICE DISCOVERY IN TURKISH INDEX MARKETS: AN EXAMINATION OF SPOT INDEX AND INDEX FUTURES

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PRICE DISCOVERY IN TURKISH INDEX MARKETS: AN EXAMINATION OF SPOT INDEX AND INDEX FUTURES

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ABSTRACT

PRICE DISCOVERY IN TURKISH INDEX MARKETS: AN EXAMINATION OF SPOT INDEX AND INDEX FUTURES

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This thesis analyzes the price discovery process among spot index and index futures in Turkey using daily closing prices. The empirical results from the application of Johansen cointegration method, based on Vector Error Correction Model, indicate that the markets are cointegrated and share a common trend in the long-run. According to the results of the model, there is a bi-directional relationship between index futures and spot index. Results further show that when there is a discrepancy from the long-run equilibrium, it is the spot index that adjusts more to that discrepancy. That is index futures is the dominant market, meaning that it has the lead on spot index in registering the new information into the prices. Results are consistent with the overall literature on price discovery that support the role of derivatives markets used as a price discovery vehicle.

Keywords: price discovery; futures markets; cointegration; VECM

ÖZET

TÜRK SERMAYE PİYASASINDA FİYAT OLUŞUMU: SPOT ENDEKS VE VADELİ ENDEKS ÜZERİNE BİR ÇALIŞMA

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Bu çalışma günlük getiri serileri kullanarak Türkiye spot piyasa ve vadeli piyasaları arasındaki fiyat oluşum mekanizmasını incelemektedir. Yöney hata düzeltme modeline dayanan Johansen eştümleşme metodu uygulanarak bulunan sonuçlar, iki piyasa fiyat serilerinin eştümleşik zaman serileri olduğunu ortaya koymaktadır. Dolayısıyla iki market arasında uzun dönemli bir denge ilişkisi vardır. Bu dengeden sapmalara iki piyasa da tepki vermektedir. Ancak, spot endeksin uzun dönemli ilişkiden sapmalara karşı daha fazla düzeltme gösterdiği ortaya çıkmıştır. Sonuç olarak fiyat oluşum sürecinde vadeli endeksin dominant piyasa olduğu, başka bir deyişle piyasaya yeni ulaşan bilgi setinin vadeli endeks tarafından daha hızlı bir şekilde fiyatlara yansıtıldığı saptanmıştır. Bu çalışmadan elde edilen bulgular, vadeli piyasaların fiyat belirleme aracı olduğunu ortaya koymaktadır ve bu alanda yapılan önceki çalışmalarla paralellik göstermektedir.

Anahtar Kelimeler: fiyat oluşumu; vadeli piyasalar; eştümleşme; Yöney Hata Düzeltme Modeli

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Chapter 1

Introduction

For centuries, equity trading all over the world has been an important instrument for companies to raise capital, for households to appreciate their savings and for financial institutions to manage their portfolios. Having relatively a short history, futures markets have become a popular tool used by investors both for hedging purposes and speculation. Financial liberalization and globalization, the increasing need to manage risks going along with financial innovation have led these markets to grow substantially, especially over the last thirty years. Following the rapid expansion of developed and emerging financial markets in recent decades, the relationship between the spot markets and futures markets has been an area of intense study in the literature.

Since stock index futures and their underlying spot indices are affected by the same set of information, the prices of both markets are expected to move simultaneously under the assumption of an efficient market environment. According to the efficient market hypothesis, new information should be impounded promptly in the prices of both markets. Thus, there should not be any difference between the capabilities of the markets to register the impacts of new information into the prices. In other words, there should not be any lead-lag relation between spot and futures markets. In reality, due to market frictions, a lead-lag pattern is observed in price movements of spot and futures markets making one of these markets as the leader in price discovery process. Mainly, the differences in trading costs (commissions and bid-ask spreads) and leverage effects, the type of new information coming to the market (market-wide or firm specific), short-selling constraints in spot markets, possible nonsynchronous trading in spot markets and lower trading in one market have been presented as market frictions that affect the speed of information reflection. In literature, the stock index future is generally disclosed as having the lead behavior on spot index. This may reflect the greater speed with which investors' views are reflected in futures markets. As stated in Stoll and Whaley (1990), if investors have a strong belief about the direction of the complete market, they may trade in the futures market because of the lower transaction costs and the higher degree of leverage. Put differently, they may not choose the spot index unless they have a belief on a trend in the price of an individual stock. To realize a complete portfolio of stocks that mimics the spot index is not an easy task and it may have unbearable transaction costs. The choice of investors to trade in futures market over the spot market moves futures prices first, and then pulls prices of spot market due to the index arbitrage responding to the deviations from the cost-of carry relation.

In addition, volatility spillovers between markets have been an area of interest in the extant literature as another indicator of the relationship between futures markets and their underlying spot market indices. The examination of the rate of flow of information from one market to the other measured by the variance of the price changes has revealed results that support the premise of unequal price discovery roles of markets.

Although the linkage between spot and futures market have been investigated by many studies in the literature, stock market of Turkey is worth studying. First of all, the Turkish stock exchange namely Istanbul Stock Exchange (ISE) is one of the emerging markets with an increasing role in international financial environment along with other emerging markets. It is included in Morgan Stanley Capital International (MSCI) Emerging Markets Index. In fact, there is a difference between the investor profiles of the spot market and futures market of Turkey that is named as Turkish Derivatives Exchange (TurkDex). Considering last three years, international investors account about 60-70% of trading activities in ISE whereas only 10% of investors are international investors in TurkDex. Therefore, empirical evidence from futures market, its characteristics and the relationship with the spot market may give useful information to international investors, also to domestic investors and may encourage them to trade more actively in TurkDex. Secondly, the index futures market of Turkey introduced only four and a half years ago should be tested in its price discovery role. Knowing results of this role coming from a newly established market will give the ability to compare them with the results from well-established futures markets.

The objective of this study is to contribute to the existing literature of price discovery relationship between the spot index and futures index by examining the stock markets of Turkey which is an emerging market. Previous studies regarding Turkish markets deals only with the impact of futures market on the spot market volatility. The examination of lead-lag relationship in returns of index futures market and spot index market studied in the current study is a new issue and open as well to future research.[1] In addition, a limited data was available for the previous studies because of the newly established index futures market. The first years of index futures market of Turkey experienced a thin trading volume. However, in the last two and a half years trading volume soared. This study provides further evidence with extended data. Understanding the price discovery process that reveals the speed of markets in reflecting the new information into the prices will provide informed investors the ability to decide to use which one of the markets as price discovery vehicle. Thus, investors will have a useful tool for both hedging and speculation purposes.

A Vector Error Correction Model is used to examine the relationship among the futures market and the spot market. This model based upon the existence of cointegration allows exploration of both the short-run and long-run price discovery relationship. By exploring components of the common factor, this model also allows defining the roles of the cointegrated markets in the price discovery process. Specifically, the error correction term in the model reveals the adjustment process of the markets to the long-run equilibrium being perturbed in the short-run. Therefore, the results from the model enable to determine the leader market that contributes most to the price discovery process.

The results show that Istanbul Stock Exchange 30 index and Turkish Derivatives Exchange ISE-30 index futures have a cointegration relationship and common factor with each other. Moreover, results indicate that both of the markets are

[1] As an exception, Kasman and Kasman (2008) deals with the long-term causal relationship between index futures and spot index and provides evidence of one way causality having the direction from spot index to the index futures.

effective in the price discovery process pointing to a bi-directional relationship. However, futures market is found to have superior ability to process the information and to be the dominant market.

The following parts of this study are organized as follows. Chapter 2 covers the literature regarding the price discovery mechanisms on the spot and futures index markets. Empirical evidences from the previous studies are also presented. Chapter 3 provides the institutional details of both markets. A brief history of the markets, their place in both domestic and international financial system and trading specifications of the markets are included to compare the markets structurally. The following chapter 4 introduces the methodology and presents the concepts and models used in the study. Chapter 5 begins with a description of the data used in the analysis and then reports the results suggested by the tests. And finally, the conclusions are summarized in Chapter 6.

Chapter 2

Literature on Price Discovery

Since the establishment of the futures markets, the relationship between the futures market prices and the underlying spot market prices has been investigated by several empirical studies within the literature. More recently, studies have focused on the concept price discovery which refers to the speed of new information incorporated into the market. This premise attracts attention from academicians and practitioners because the same or similar securities are traded in more than one market. For instance, the same security may be traded in different markets in the same country or in different countries. Thus, it becomes important to know whether the prices of different markets reflect new information regarding a single asset simultaneously or one of them reflects the information firstly.

An investor can take a long position by purchasing a basket of stocks in the spot market that mimics the overall market or the index or by buying a contract in the futures market that represents the spot index. In this framework, where the new information is impounded into the prices first, in other words the process of price discovery between the futures markets and their underlying spot markets have become a popular subject examined intensely in the extant literature. Using alternative models and econometric techniques, results of the previous studies suggest that futures markets dominate the spot markets in the price discovery process.[2]

Primarily, the term price discovery referred to the use of futures prices for pricing cash market transactions as stated in Working (1948). It is referred as the lead-lag relationship between the futures price and the spot price connected with Granger causality in the later studies.

Garbade and Silber (1983), Finnerty and Park (1987), Kawaller, Koch and Koch (1987) and Harris (1989) commonly demonstrate a significant lead from futures returns to spot returns and a weak lead from spot to futures.

By using a vector autoregressive (VAR) model with one period lag, Garbade and Silber (1983) show that about 75% of new information is incorporated first in futures prices in their study regarding commodity futures and spot markets. They assume that the prices in different markets trading similar assets share a common implicit efficient price. They attribute the linkage of the prices between different markets to the arbitrage activities and state that futures markets lead the spot markets.

The studies following Garbade and Silber (1983), particularly studies regarding index futures and spot index, used regression analysis to determine the lead-lag relationship between the returns of the markets. One market's return is regressed

[2] Garbade and Silber (1979) suggest the terminology of "dominant" and "satellite" markets. Prices in the dominant market include the new information before the prices in the satellite market; thus, dominant market is more influential in the price discovery process.

on the leads and lags of the other market. To conclude which market leads the other one, the coefficients of the lead and lag terms are used.

Kawaller, Koch and Koch (1987), with the help of time-series regression analysis, investigate the price discovery function of futures prices for spot prices and the character of the spot/futures price relationship both on expiration and non-expiration days in the S&P 500 index and futures markets. They observe a lead from futures to cash prices extends for twenty to forty-five minutes, while the lead form cash prices to futures prices rarely extends beyond one minute. Their results indicate no significant difference between the lead length of expiration and non-expiration days. The authors suggest the infrequent trading of component stocks in the spot market and the leverage effect of futures market as the explanation of the lead of futures market. In their following paper, Kawaller, Koch and Koch (1993), imply that with the increase in volatility of futures prices, the lag of spot prices becomes smaller in length. Larger price moves in the futures prices strengthens the price relation between two markets.

The study of Stoll and Whaley (1990) finds that S&P 500 and MM index futures returns tend to lead stock returns by approximately 5 minutes. The reason of the lead of futures market may be due to the effects of non-synchronous trading and stock bid/ask spread. Using an autoregressive moving average (ARMA) process, they adjust for these microstructure effects. The authors conclude that the superior role of futures market in the price discovery lies in that the investor’s view is reflected in the futures market faster because of lower transaction costs and higher leverage.

Nonsynchronous trading as a possible reason for lead-lag relation between MM cash index and MMI and S&P 500 futures is examined by Chan (1992). Chan examines effects of different conditions like bad news/good news, the relative intensity of trading activity and the extent of market wide movement on lead-lag pattern. His findings suggest that a lead from futures market to cash market does not completely depend on infrequent trading. Chan shows that the lead is faster when stocks move together, pointing market wide information.

The options market, one of the derivatives markets is also included in some studies regarding their potential role in price discovery. The study by Fleming, Ostdiek and Whaley (1996) investigate the intraday price discovery process among S&P 500 index and index futures and S&P 100 index and index options. The results show that S&P 500 index futures lead the cash by just over five minutes with no evidence of feedback and S&P index options lead cash index about five minutes. They demonstrate that this result is consistent with the trading cost hypothesis that they put forward. Trading cost hypothesis proposes that informed traders choose derivatives markets because of lower costs of taking position in these markets.[3] If market frictions exist and the trading costs differ among related markets, there will be arbitrage profit due to the premise that market with lower trading cost reflects the new information faster than the other markets.

[3] Glosten and Milgrom (1985) and Easley and O'Hara (1987) suggest the concept of using trades as signals of information. They put forward that new information is revealed after the trading of informed traders. Thus, trades may affect the behavior of prices.

De Jong and Donders (1998) use the cross-correlations and lead-lag regression method to analyze the relationship between the index, futures and option returns on the Amsterdam European Options Exchange. In their study, they adjust for irregular trading intervals. Their findings, parallel to the previous literature, show that futures, options and cash indices have asymmetrical relation between each other. Based on their empirical results, futures market has a lead over both the cash and options markets however there is no significant lead-lag relation between cash and options markets. They attribute the cause of lead-lad relations between these markets to the transaction costs, effects of infrequent trading and leverage.

With the development of regression techniques examining the lead-lag relationship between the returns of the markets, the cointegration analysis with error correction models has been used widely. The use of cointegration and error correction models enables to determine long-run equilibrium relationship between the two time series and to distinguish the short-run deviations from that equilibrium. In addition to the use of cointegration and error correction models, some researchers used information sharing techniques to determine the contribution of the markets to the price discovery process.

By using German markets data, Booth, So and Tse (1999) find that index futures is dominant and has the largest shares of information rather than the spot index and index options. To reach this conclusion, authors use a multivariate Vector Error Correction Model (VECM), proposed by Engle and Granger (1987), which allows exploration of both short and long-run price discovery relationships.

VECM is able to capture the premise that the prices of closely-related assets do not move away from each other for long periods. By using this model, authors determine the information share of each index security, which is used as a measure of the contribution to the price discovery.

As in the above study by Booth, So and Tse (1999), information sharing techniques, relatively a new approach, are applied in a significant number of studies to examine the price discovery process across markets that are linked by arbitrage conditions. Co-integrated markets typically share the implicit efficient price as the common stochastic factor. This common factor driven by news is used to investigate how information is impounded into the prices of different markets. The permanent-transitory (PT) model of Gonzalo and Granger (1995) and the information shares (IS) model of Hasbrouck (1995) are the two popular common factor models that are used in the extant literature.

The paper by Baillie, Booth, Tse, and Zabotina (2002) reveals the close relationship between these common factor models. They disclose that Gonzalo and Granger (1995) model deals with error correction process and the components of the common factor, while Hasbrouck (1995) explains the price discovery with a model that measures each market's relative contribution to the variance of innovations to the common factor. The two models give similar results when the residuals between markets are uncorrelated, when correlated results can be different. Harris, McInish and Wood (2002), De Jong (2002), Lehmann (2002) and Hasbrouck (2002) also study the relationship between these models and demonstrate the differences between the two approaches.

The study by Chu, Hsieh, and Tse (1999) investigates the price discovery function in S&P 500 index, futures and depository receipt markets. By using Johansen's maximum likelihood estimator (1988), they determine a long-run stochastic trend that reveals the co-integration of these three markets. Application of the Gonzalo and Granger's (1995) model gives the results claiming that the leverage hypothesis and the uptick rule hypothesis explain the primacy of S&P 500 futures market's contribution into the process of price discovery.

Booth, Lin, Martikainen, and Tse (2002) manifest that price discovery occurs in the downstairs market rather than in the upstairs market of Helsinki Stock Exchange via using both of the common factor models. The authors state that this result is expected induced by the fact that it is more advantageous to informed traders to trade in downstairs market.

So and Tse (2004) investigate the Hong Kong Hang Seng Index markets to shed light on the information transmission process by using three different methods: Gonzalo and Granger (1995) and Hasbrouck (1995) common factor models and the multivariate generalized autoregressive conditional heteroskedasticity (M-GARCH) model. The rationale behind the use of a GARCH model is its functionality to measure the effect of trading not only on price of an asset but also on its volatility. The market structure of Hang Seng Index allows creating a portfolio tracking the index easily, which provides a suitable environment to test the trading cost hypothesis. Common factor models indicate similar results and suggest that it is the index futures market that prevails other markets. Volatility spillover, the impact of volatility disturbance from one market to the other, from futures market to other markets is strong according to the results of GARCH models consistent with the common factor models. Overall results report that trading cost hypothesis is acceptable pointing the futures market as the leader in information processing and the spot market as the laggard.

Instead of regression and cointegration analysis and the error correction models, information transmission and volatility spillover, which examine the second moment relationship between the spot and futures markets, are used by researchers recently as an approach to reveal the price discovery process. The use of volatility spillover is important because the volatility changes reflect the new information arrival at the market and the evaluation and assimilation process of it by the market. Specifically, the understanding of how the volatility of one market affects the volatility of the other one discloses the information transmission process in the markets.

Shown by Ross (1989) volatility of prices is directly related with the rate of flow of information to the market. French and Roll (1986) consider three different explanations for the volatility difference between trading hours and non-trading hours and find the private information as the source of this difference. Thus, as another approach in the clarification process of price discovery, the examination of volatility spillovers between markets is widely used by researchers like in the following studies.

The findings of Kawaller, Koch and Koch (1990) propose no lead-lag behavior between the volatility of S&P 500 futures prices and the volatility of the S&P 500 index using intraday data.

Chan, Chan and Karolyi (1991) also focus on the intraday volatility of the cash and futures price changes because these volatilities may vary over time and it is functional to use volatility to define the lead-lag pattern when considered as the source of the rate of flow of information to the market. They study the S&P index and futures market. By using GARCH models, they uncover bidirectional dependence in the intraday volatility of the cash and futures markets. Results are robust even after controlling for the nonsynchronous trading. Price innovations in both markets predict the other markets' volatility. According to their evidence, the price discovery process occurs in both markets not only in the futures market.

Koutmos and Tucker (1996) claim that innovations in the stock market have no impact on the volatility of futures market, in contrast to Chan, Chan and Karolyi (1991). The data they use in their research is S&P index and futures markets' daily closing prices. Findings demonstrate that innovations originating in the futures market increase volatility in the stock market. They also show that bad news increases volatility more than good news in both markets by using a bivariate error correction EGARCH model.

In a more recent study, Tse (1999) examines the intraday price discovery and volatility spillover between the DJIA cash and futures markets using minute-by-minute data. Results of Hasbrouck (1995) model and VECM both support the primacy of futures market in price discovery process. Tse also reports that spillovers from futures market to index are more significant than the reverse direction. He states that further research can be done in order to investigate the role of inherent leverage, low transaction costs and the lack of short selling restrictions in the futures market as possible reasons for the results of his study.

Other studies reporting spillover effects between spot and futures markets in different countries are the following ones by Iihara, Kato, and Tokunaga (1996) reporting a spillover effect mainly from the futures market to the spot market in the case of the Nikkei Stock Average Index, by Bhar (2001) stating volatility spillover effects for the Australian spot and futures markets, also by Booth and So (2003) for German markets, by Lafuente (2002) for Spanish markets and by Alexakis, Kavussanos, and Visvikis (2007) for Greece markets.

Having a short history, Turkish Derivatives Exchange (Turkdex) is investigated by only three papers regarding the examination of its linkage with the spot market. Baklaci and Tutek (2006) use the Istanbul Stock Exchange 30 (ISE 30) Index Futures data to study its impact on spot volatility. They find that the introduction of the futures market reduces the volatility in underlying spot market, resulting in improved efficiency. In the subsequent paper, Baklaci (2007) examines currency futures under the same objective. He suggests that currency futures augments the volume of information that flow into the spot market and declines the speed of information process. He also notes that futures market is the one that serves as the price discovery vehicle with its ability to impound the information into prices faster than the spot market.

Parallel with the previous two papers on Turkish stock markets, Kasman and Kasman (2008) by using an EGARCH model provide evidence that futures market has a decreasing effect on the volatility of spot market. Therefore, it makes a stabilizing effect on the spot market. Furthermore, they show that there is a significant long-run relationship between stock index futures and spot index. In contrary to the most of the previous research, results indicate that the direction of the causality is from the spot market to the futures market. Thence, they conclude that spot market is the leader in the price discovery process.

As a conclusion, most of the previous studies regarding both developed and emerging markets agree on the result that futures markets are the dominant markets in the price discovery process. Three techniques are particularly used to investigate the relationship of closely related assets; regression methods focusing on the lead-lag relationship, GARCH models for the examination of volatility spillovers and the Gonzalo and Granger (1995) and Hasbrouck (1995) common factor models aiming to measure the contribution of different markets to information share.

Chapter 3

Institutional Details

3.1 Turkish Derivatives Exchange

Turkish Derivatives Exchange (TurkDex) is the first and only exchange for derivatives trading in Turkey. It is established in 2001 and the first transaction took place on 4^{th} February, 2005. Thereafter, it experienced a rapid growth by increasing the number of its members, which are authorized to make transactions in the exchange both for their own account and for their clients' accounts. As of April 2009, TurkDex has 87 members. Both domestic and international investment and intermediary institutions involve in transactions in TurkDex, but the big part of the investors are domestic country citizens.[4] With an increasing trend in trading volume since the first day of operation, TurkDex has experienced its highest trading volume on April 21, 2009. The trading volume totaled 1.739.145.908 TRY that accounts over 1 billion USD by value and 513.281 by number of contracts by the end of the trading session. TurkDex is a fully electronic exchange. The volume report published by "Futures Industry Association" states that Turkish Derivatives Exchange is the 28th largest exchange ranked by the number of futures and options traded and/or cleared in

[4] For March 2009, 93.23 % of the transactions measured by volume are carried out by home country citizens and the remaining 6.77% by international investors based on the data provided by TurkDex.

2008 with 54,472,835 numbers of contracts.[5] The total number of futures contracts traded on TurkDex rose 119.1% over 2007.

TurkDex Exchange Operations System (TEOS) is used for trading activities. During the normal session held between 9.15 a.m. and 5.15 p.m. computerized system matches automatically buy and sell orders on a price and time priority basis which is called continuous auction trading method. Trading system supports various types of orders including limit, market, keep remainder and market contingent (stop-loss) orders. Custody Bank Inc. (Takasbank) is in charge as clearing house for TurkDex, which is also the clearing house for Istanbul Stock Exchange. It is accepted as an 'Approved Depository' and 'Approved Bank by Securities Futures Authority (UK SFA). Custody Bank also manages a guarantee fund in order to protect the members against defaults.

Regulation barriers are at the minimum for trading in TurkDex. For the safety of investors, Capital Markets Board of Turkey (CMB) is the governing and auditing body for exchange traded derivatives contracts. One of the most distinctive features of trading in TurkDex is the tax advantage. There is no income tax for the gains from trading activities both for foreign and domestic investors.[6] Two main types of products are currently traded in the exchange. First one is financials; equity index futures (ISE-30 and ISE-100), interest rate futures (T-benchmark) and currency futures (US Dollar /TRY and Euro/TRY). Second type of products is commodities; wheat futures, cotton futures and gold futures. Currently no option

[5] www.futuresindustry.org

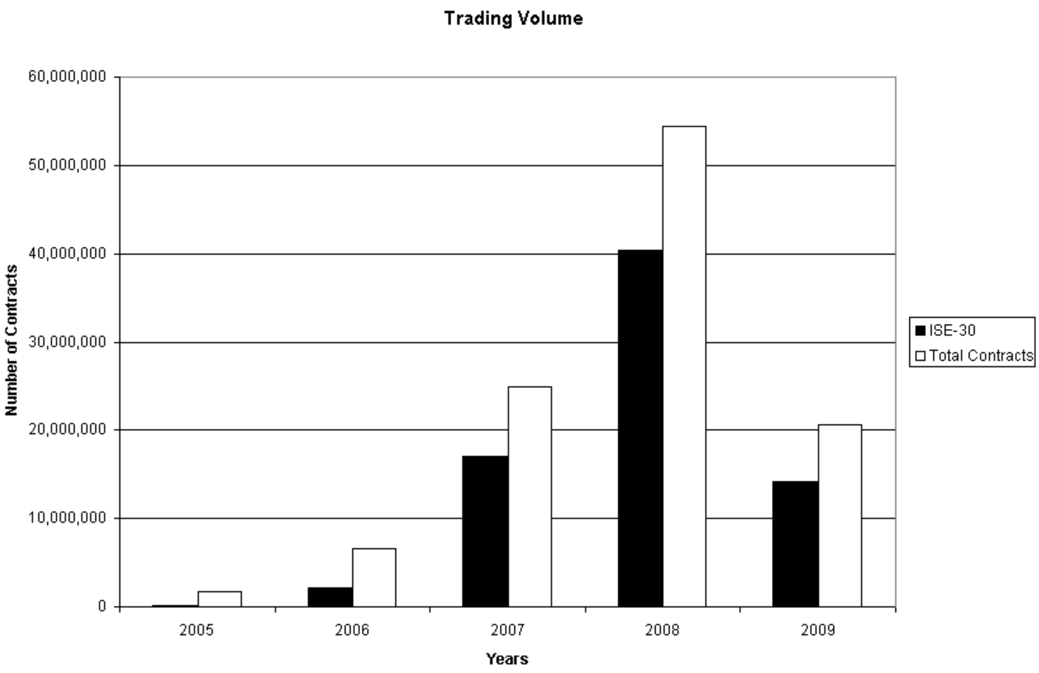
[6] August 2008 report "A Guide to the Taxation of TurkDex Futures" by PricewaterhouseCoopers gives detailed information regarding taxation of income generated from the transactions in TurkDex.

contracts are listed. But it is planned to launch options and single stock futures for trading in the near future. Equity index futures, particularly ISE-30 Index Futures dominates the trading activity in TurkDex with an approximately 75% share in the total trading volume in terms of the number of contracts. Figure 1 exhibits this relationship clearly.

3.2 TurkDex-ISE 30 Futures

Since its introduction, ISE-30 Index Futures contract (ISE-30 futures) has been used as an effective tool for both the speculation and hedging purposes by investors. With the ease and low cost of trading, it has become the most liquid financial instrument in the financial system of Turkey and one of the most active equity index futures contract in the world. It continuously attracts an increasing number of investors year over year. Initial margin for ISE-30 futures contract is currently 500 TRY and the maintenance margin is 75% of the initial margin. The biggest number of contracts one account is allowed to hold is 20.000 for each contract month. If it is over 20.000, the percentage limit of 10% total open interest for the related contract month is valid as the position limit. Contract specifications of the ISE-30 futures are given in Table 1.

Figure 1
Trading Volume of ISE-30 Index Futures and Total Contracts



Notes: Data for 2009 covers the first three months.

3.3 Istanbul Stock Exchange

As a result of a considerable improvement in the Turkish capital markets in 1980s, Istanbul Stock Exchange (ISE) was formed in 1986 as the first organized stock exchange. Tradable securities in ISE include equities, bonds and bills, revenue-sharing certificates, private sector bonds, foreign securities, real estate certificates and international securities. ISE is one of the most important emerging stock market that is open for further improvement. It is a full member of "The World Federation of Exchanges" (WFE), "Federation of Euro-Asian Stock Exchanges" (FEAS), "International Securities Services Association" (ISSA), "International Capital Market Association" (ICMA), "European Capital Markets Institute"

Table 1
Specifications of the ISE-30 Index Futures

Underlying Asset	Value calculated based on the stock prices of the companies included in ISE National-30 stock price index by using the index's calculation method.
Contract Size	Value calculated by dividing the index value by 1.000 and multiplying the quotient by TRY 100 (ISE National-30 Index/1.000)*TRY 100.
Price Quotation	ISE National-30 Index value, divided by 1.000 shall be quoted significant to three decimals.
Daily Price Limit	±%15 of the established Base Price for each contract with a different contract month.
Minimum Price Fluct. (Tick)	0,025 (25 ISE National-30 Index points) Value of one tick corresponds to TRY 2,5.
Contract Months	February, April, June, August, October and December (Contracts with three different expiration months nearest to the current month shall be traded concurrently. If December is not one of those three months, an extra contract with an expiration month of December shall be launched.)
Final Settlement Day	Last business day of each contract month
Last Trading Day	Last business day of each contract month
Settlement Method	Cash Settlement
Final Settlement Price	Arithmetic average of 10 randomly selected, not less than 30 seconds apart, ISE National-30 Index values executed at the ISE within the last 15 minutes before the closing of the trading session of the Exchange on the last trading day shall be used as the last settlement price of the futures contract. If the ISE trading session closes before that of the Exchange, calculation method being the same, calculations shall be made based on the ISE National-30 Index values executed during the last 15 minutes before the closing of the ISE trading session
Daily Settlement Price	Daily settlement price is established at the closing of each trading session as follows: 1. Weighted average price of all the transactions performed within the last 10 minutes before the closing of the trading session based on the quantity thereof shall be established as the daily settlement price. 2. If number of transactions performed within the last 10 minutes before the closing of the trading session is less than 10, weighted average of the last 10 transactions before the closing shall be calculated instead. 3. If the daily settlement price cannot be calculated using the above-explained methods, daily settlement price may be determined by using below explained methods separately or in combination.

Source: Turkish Derivatives Exchange

(ECMI) and an affiliate member of "International Organization of Securities Commissions" (IOSCO). By the end of 2008, ISE has a market capitalization of about 120 billion USD with a 60% decline in value over 2007 with the painful effect of the global crisis. Nevertheless, compared with 2002 the financial crisis year of Turkey, the market value of ISE has managed to grow about 250%. The market capitalization relative to GDP is relatively low for Turkey. According to the statistics provided by World Federation of Exchanges for 2007, ISE is the 11^{th} biggest emerging market based on market capitalization. Daily calculation of ISE Indices first began in 1987. Since 1994, computerized stock trading is fully activating in ISE. There are two trading sessions; morning session (09:30-12:30) and afternoon session (14.00-17.00). Stock market of ISE includes; national market, second national market, new economy market, watch list companies market and exchange traded funds market. By the functionality of ISE Trading System, prices are determined electronically with "multiple price-continuous auction" method. Orders both bid and ask are matched by the prices given as price ticks. Table 2 gives the relevant price tick for a stock based on its price. Only authorized members are allowed to carry out short selling activities for the allowed securities in ISE with some limitations. Investors are faced with two types of costs while trading in ISE stock market. One of them is bid-ask spread and the other one is brokerage fee. Brokerage fee is negotiable and determined between the customer and the brokerage firm, where brokerage firms are exposed to an exchange fee of 1/100,000 of traded value. Thus, brokerage fees are indirectly affected by this rate. For a comparison, exchange fee for the ISE-30 Futures contract is 4/100,000 of traded value.

Table 2
Relevant Price Tick for a stock in Istanbul Stock Exchange

Base Price Range (TRY)	Relevant Price Tick (TRY)
0.01-2.50	0.01
2.52-5.00	0.02
5.05-10.00	0.05
10.10-25.00	0.1
25.25-50.00	0.25
50.50-100.00	0.5
101.00-250.00	1
252.50-500.00	2.5
505.00 and over	5

3.4 ISE-30 Index

ISE National 30 Index (ISE-30) is an index that is weighted by market capitalization based on the 30 biggest companies listed in the ISE National Market except investment trusts. 30 companies with the highest market value and daily average traded values are ranked and chosen to the index.[7] ISE-100 index which includes ISE-30 and ISE-50 indices is the accepted main indicator of the national stock market for Turkey. Considering the last three years (2006-2009), the trading volume of ISE-30 component companies constitute about 50% of the ISE-100 trading volume. As of the second quarter of 2009, ISE-30 index comprises equities of some big banks, communication companies, insurance companies, conglomerates and some big industrial firms. There are ten banks traded within ISE-30 index with a weight of 50%. For instance, with a portfolio that includes only bank stocks, an investor can easily track the ISE-30 index. Therefore, for an

[7] Details of selection criteria and periodic adjustment of component companies can be found on www.ise.org

informed trader it’s a feasible opportunity to invest in the spot market rather than in futures market considering the trading costs.

Chapter 4

Methodology

Futures market is a tool that is used by investors mainly for three purposes; hedging; the way to provide compensation for unexpected price moves of a cash position hold by the investor, speculation; trading of futures contract for the aim of getting profit according to the expected price movements and the arbitrage; the purchase and sale of futures and stocks at the same time to exploit riskless profit from the mispricing opportunity. The third one, arbitrage trading, is generally accepted as the determinant that links the prices of stock index and index futures.

If market frictions do not exist and the markets are perfectly functioning, meaning that they are informationally efficient, the returns of the futures market index and the underlying spot market index should be contemporaneously correlated. The new information coming to the market should be simultaneously reflected to the prices of both markets. That is, there should not be any lead-lag relation between the markets. This premise arises from the existence of arbitrage opportunity. If one of the prices, for instance futures price, is above the equilibrium level stated by the cost-of-carry relation, arbitrage activities should bring the price back to equilibrium. Otherwise with the convergence of futures prices to the spot index price at the expiration or with the liquidation of the contract coming to its predicted value before expiration, the arbitrager could gather a riskless fixed income return or fixed rate of cost of borrowing by the simultaneous sale of futures contract and the purchase of stocks. Therefore, the abundance of arbitrage activities similar to the one stated above assures the correct price of both of the markets.

The intertemporal relationship between the prices of futures and spot market is represented by the above stated cost of carry model. It is used by investors to define whether futures contracts are correctly priced. The prices of index futures market, F_t, and the underlying spot index price, S_t, should not drift apart as they are linked together with the relation predicted in the cost-of-carry model. The relation is shown by the following model;

$$F_t = S_t e^{(r-d)(T-t)} \tag{1}$$

According to the model, index futures price (F_t; the theoretical futures price at time t) is tied to the spot index price ($S_{t;}$ the spot index price that is replicated by a portfolio of stocks) with the net cost of carrying rate. *R-d* is the net cost of carrying the underlying stocks in the index, where *r* stands for the riskless interest rate and *d* stands for the dividend yield accumulated for holding the stocks in the portfolio. *T* is the time that index futures contract matures and *t* is the current time. This model assumes that markets are perfect and the interest rates and dividends yields are non stochastic.

If the raw price series data of both markets for the sample period are converted to natural logarithms, following that, if return series are formed by taking the first differences of the logarithmic prices (log prices), we get equation (1) transformed into a linear model stated in (2,a),

$$R_{ft} = R_{st} + (r - d) \quad (2, a)$$

where r_{st} is the spot market return and r_{ft} is the futures market return calculated for both of the markets as:

$$R_{it} = \log(P_{it}) - \log(P_{i,t-1}) \quad (2, b)$$

where P_i is the index level at time t.

With the assumptions made for equation (1) and equation (2, a) it is suggested that; the variance of returns in both of the markets should be equal, contemporaneous rates of returns of both markets are perfectly and positively correlated and none of the markets should have a leading role in determining the equilibrium price. Nevertheless, the market frictions like trading costs, leverage effects, the type of new information coming to the market, short-selling constraints in spot markets, possible nonsynchronous trading in spot markets and lower trading in one market may cause a lead-lag relationship between the returns of futures market and the spot market.

Firstly suggested by Granger (1981) and then extended by Engle and Granger (1987), the cointegration concept has been used frequently in the literature to reveal the close relationship between the time series. Cointegrated variables should move together in the long run. Good examples for these types of variables are above stated; futures prices and spot prices. Cointegration also implies that integrated variables are driven by common factor specified as the implicit efficient price as stated in Hasbrouck (1995). There are two types of common factor models to determine the role of the common factor in the price discovery process. They are Hasbrouck (1995) and Gonzalo and Granger (1995). Particularly, Hasbrouck (1995) model deals with variance of innovations to the common factor, whereas Gonzalo and Granger (1995) model explores the components of common factor and the error correction process. Details and applications of these models are beyond the scope of this study and can be focused on in future research.

In order to define two times series to be cointegrated, the series should be non-stationary but there exists a linear combination that generates a stationary process. Simply, the linear combination can be defined as $z_t = x_t - \alpha y_t$, then z_t is stationary, where α is called to be the cointegrating vector.[8] A time series with a mean and variance not varying over time is said to be stationary. In addition, the value of the covariance between the two time periods in a time series only depends on the lag. Because of these properties, it can be said that shocks in a stationary time series will have no permanent effect. It is possible that some temporary short-run disequilibrium between price series within a limit of certain bounds can exist. However, stationarity in the linear combination of two series makes a certain long-run equilibrium, meaning, deviations from the equilibrium to be transitory.

The order of integration of the both logarithmic price series (index futures and spot index) is detected by using the Augmented Dickey-Fuller and Phillips-Perron (1988) unit root tests and is shown in Table 5.

[8] The linear combination is a basic regression equation and z_t is the error term.

To model the long-run relationship between the cointegrated series, Vector Error Correction Models (VECM) has been used widely. These types of models can demonstrate the relationship between the cointegrated time series, which do not drift away from each other in the long-run. The error correction mechanism assures that the proportion of disequilibrium in one period will be corrected in the next period. In a system of cointegrated variables, the cointegrating vectors show the long-run equilibrium, whereas error correction term reveals the short-run adjustment process. Specifically, the coefficients of error correction terms define both the direction and the magnitude of the correction adjusting the deviations from the long-run equilibrium. In other words, the cointegrating relationship between the series can be corrupted due to the differences in the abilities of the markets to process the newly arrived information. The error correction term in the VECM clearly reveals the adjustment roles of price series to restore the equilibrium.

Before the VECM can be formed, the evidence of cointegration has to be first manifested. By using a cointegration test, the existence of a long-run relationship between the series can be examined. There are some tests available for the purpose of cointegration testing, such as Engle-Granger (EG) or Augmented Engle-Granger (AEG) test, Cointegrating Regression Durbin–Watson (CRDW) Test and the Johansen Maximum Likelihood test for cointegration. Johansen (1988, 1991) method based on a VECM model is accepted to be a more powerful test than the other ones. Johansen method uses two types of tests in order to define the number of cointegrating vectors between two cointegrated series, therefore the cointegration relation. These tests are the trace test and maximal eigenvalue test.

The calculation and evaluation process of these tests are demonstrated in Johansen (1988, 1991). Lag length selection is important in Johansen tests, which can lead to inaccurate results and thus inaccurate model specification. Schwarz Information Criteria (SIC) is used to define the optimal lag length in the Vector Error Correction Model.

Chapter 5

Data& Empirical Results

This study uses daily returns of ISE-30 Index (spot index) and ISE-30 Index Futures (index futures) to reveal the price discovery role of both markets.[9] Understanding the data environment is useful. Descriptive statistics for the returns of spot index and index futures disclose functional information as a pre-diagnosis before further econometric analysis. In addition, properties of the return data for both markets can be compared with the return data of developed markets and other emerging markets for detecting structural differences.[10] Daily price series of spot index are obtained from "Matriks Information Dissemination Services Corporation", one of the licensed data dissemination companies of ISE.[11] Daily price series of index futures are from TurkDex.[12] Price series of both markets contain 584 observations starting from January 04, 2007, ending in April 29, 2009. As known, index futures contracts were introduced in February 04, 2005. First two years of index futures data is excluded from the sample with respect to relatively low levels of trading. Figure 2 shows the trade volumes of index futures and the spot index. Spot index price series are used directly in the analysis. On the other hand, for index futures a pseudo-price series is constructed. For each day on

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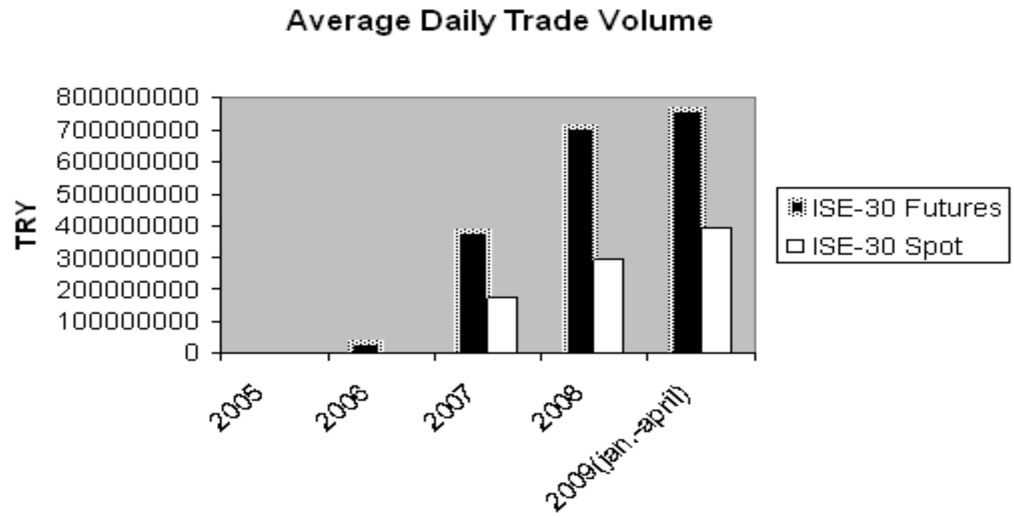
[9] Hereafter, the terms spot index and index futures will be used instead of ISE-30 Index and ISE-30 Index Futures, respectively.
[10] Bekaert and Harvey (1997) and Antoniou , Ergul and Holmes (1997) list the characteristics of emerging markets as thin trading, higher sample average returns, low correlations with developed market returns, more predictable returns, higher volatility and low liquidity. Development of emerging markets and increased integration of international markets in the following years may have apparent effects on these characteristics of emerging markets.
[11] http://www.matriks.web.tr
[12] http://www.turkdex.org.tr/VOBPortalEng/DesktopModules/QuotaHistoricMain.aspx

the sample period, there are more than one contract types for index futures traded in TurkDex. Conventionally, nearby contract is used in calculating futures returns, as accepted the most actively traded one. Upon expiration, next nearby contract supplants the former one in forming return series. In fact, on some days before expiration, next nearby contract is the more active than the nearby contract. Therefore, in this study, instead of using simply the nearby contract and rolling over it upon expiration, future return series are calculated by using the most active contract measured by number of contracts traded.

Figure 2
Average Daily Trade Volumes of ISE-30 Spot Index and Index Futures Markets



5.1 Descriptive Statistics

Descriptive statistics regarding both of the returns series calculated as in the (2, b) are provided in Table 3. Central moments including means, medians, maximums, minimums and standard deviations are quite similar for both return series. The mean returns for both series are negative reflecting the gloomy financial climate of the last two years. Other moments are skewness and kurtosis, which measure the symmetry of returns to the means and tail behaviors of returns, respectively. Being positively skewed, series are distributed non-symmetrically. Revealed by the excess kurtosis, returns series for the both markets are heavy tailed, which means they tend to include relatively more extreme values and can be named as leptokurtic. The Jarque-Bera statistic that is significant at 1% level supports the argument of non-normal distribution of both return series. In addition, there is a high level of positive correlation between the returns of both markets, which suggests that the markets are related.

5.2 Autocorrelations

A simple test of stationarity of a time series is based on autocorrelation. Ljung-Box Q-statistics tests for the null hypothesis that there is no-autocorrelation up to a certain lag. As shown in Table 4, presence of no-autocorrelation hypothesis can be rejected for both of the markets in their log prices due to the p-values given in parenthesis. However, large p-values for return series show that no-autocorrelation hypothesis cannot be rejected. This result supports the non-stationarity of log prices and stationarity of return series for both of the markets. The correlograms depicted in Figure 3 and Figure 4 also demonstrate this situation.

Table 3
Descriptive Statistics of Returns of the Spot Index and Index Futures

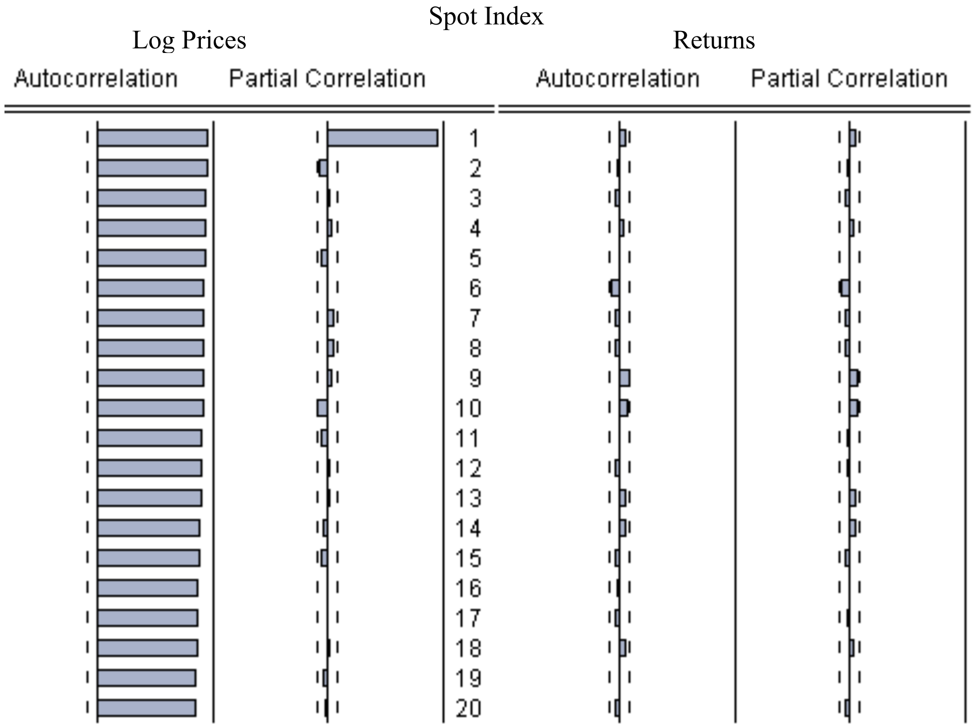
	Spot Index	Index Futures
Mean	-0.000365	-0.000386
Median	-0.001544	-0.001408
Maximum	0.127255	0.099656
Minimum	-0.097398	-0.099722
Standard Deviation	0.024901	0.025958
Skewness	0.129009	0.053069
Kurtosis	5.215036	4.868844
Jarque-Bera	121.0087	85.26015
Probability	0.000000	0.000000
Correlation of returns of spot index and index futures	0.9464	

Table 4
Ljung-Box Q-statistics of the Spot Index and Index Futures Log Prices and Returns

	Spot Index		Index Futures	
	Log Prices	Returns	Log Prices	Returns
Q_1	581.74 (0.000)	1.6334 (0.201)	581.33 (0.000)	1.0797 (0.299)
Q2	1157.3 (0.000)	1.6662 (0.435)	1156.1 (0.000)	1.0996 (0.577)
Q12	6612.2 (0.000)	16.697 (0.161)	6577.2 (0.000)	11.530 (0.484)
Q20	10567 (0.000)	23.820 (0.250)	10491 (0.000)	15.952 (0.720)

Notes: Values in parenthesis are p-values.

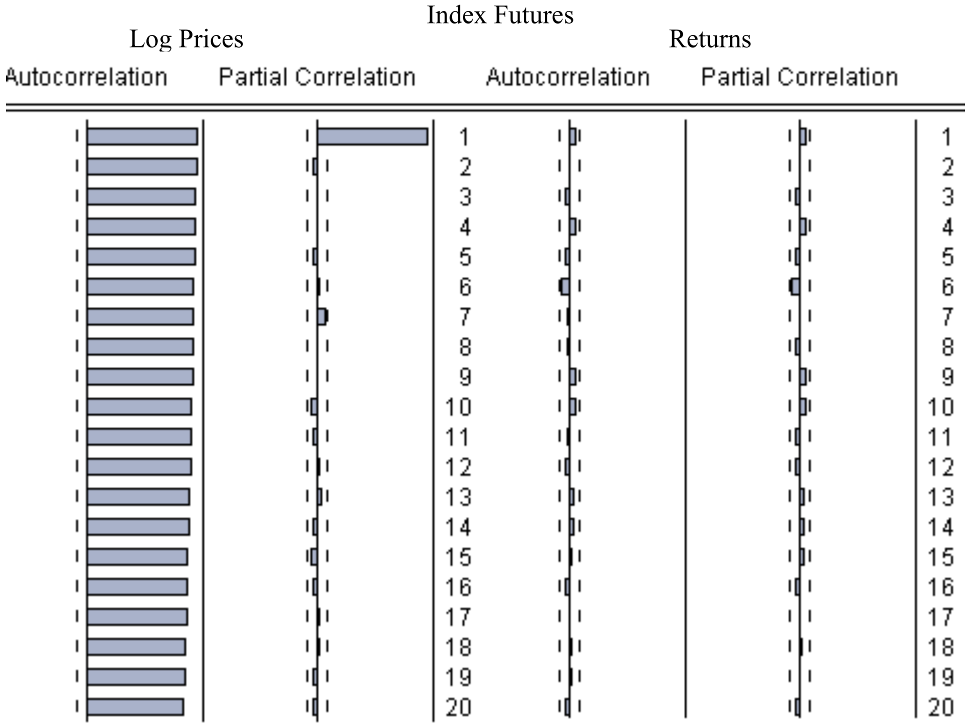
Figure 3
Correlograms for Spot Index Log Prices and Returns



5.3 Unit-Root Tests

Log prices, transformed from the raw price series and the first differences of log prices defined as returns series are both tested for the existence of unit-root by using two different methods; Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) (Phillips and Perron, 1988) . The results are given in Table 5. Results of the both tests clearly exhibit that logarithmic price series have both unit roots, which means that the log price series are integrated of order one (I (1)) variables. Consequently, their first differences (returns) are stationary.

Figure 4
Correlograms for Index Futures Log Prices and Returns



5.4 VECM and Johansen Cointegration

After testing for the stationarity and order of integration, the long-run relationship between the two price series is examined by using Johansen cointegration test. The lag length selection is based on Schwarz Information Criteria (SIC). The lag length giving the minimum SIC is used in the cointegration test and in the VECM.

Table 5
Unit Root Tests of the Spot Index and Index Futures Log Prices and Returns

	Spot Index Log Prices/ Return	Index Futures Log Prices/ Return
ADF		
Intercept	-0.990494/ -22.76360**	-0.937525/-22.99385**
Intercept and Trend	-2.442468/-22.76607**	-2.364719/-22.99332**
PP		
Intercept	-1.026140/ -22.76349**	-0.970879/ -22.98105**
Intercept and Trend	-2.472940/ -22.76591**	-2.393850/ -22.97961**

Notes: An ** indicates statistical significance at the 1% level. Lags are selected using Akaike's Information Criteria (AIC). Probabilities are based on MacKinnon (1996).

After computing for the cases including one to six lag terms, model with two lag terms gives the minimum SIC as shown in Table 6 below. Therefore, with two lag terms the following VECM is estimated:

$$\Delta F_t = a_f + \alpha_f(EC_{t-1}) + \sum_{i=1}^{2} \beta_{f1i} \Delta F_{t-i} + \sum_{i=1}^{2} \beta_{s1i} \Delta S_{t-i} + \varepsilon_{ft}$$
$$\Delta S_t = a_s + \alpha_s(EC_{t-1}) + \sum_{i=1}^{2} \beta_{f2i} \Delta F_{t-i} + \sum_{i=1}^{2} \beta_{S2i} \Delta S_{t-i} + \varepsilon_{st} \quad \text{(3a, 3b)}$$

where ΔF_t and ΔS_t are the returns for index futures and spot index respectively; a_f and a_s are constants. EC_{t-1} is the error correction term where $EC_{t-1} = f_{t-1} - s_{t-1}$.

Johansen cointegration test provide two separate tests in order to show the existence of cointegration within a system of equations, which are Johansen trace test and the Johansen maximum lambda test. Table 7 reports both of the test statistics.

Table 6
Selection of lag based on Schwarz Information Criteria (SIC)

	lag1	lag2	lag3	lag4	lag5	lag6
SIC	-11.32	-11.39*	-11.37	-11.34	-11.31	-11.27

*minimum SIC

Both of the test statistics in Table 7 exhibit that two price series are cointegrated with one cointegrating vector. The Johansen trace statistics, the null hypothesis that there is no cointegrating vector which is r≤0 is rejected since its value is higher than the critical value at 1% level. However, the null hypothesis that there is at most one cointegrating vector that is r≤1 is not rejected. Similar results can be observed from the Johansen maximum lambda statistics. At 1% level it is accepted that there is one cointegrating vector. So, test results clearly states that two markets share a common long-run trend between each other.

Table 7
Results of Johansen Cointegration Tests

H_0	Eigenvalue	λ_{trace}	critical values at 1% level	λ_{max}	critical values at 1% level
$r \leq 0$	0.069833	43.28807	20.04	42.05956	18.63
$r \leq 1$	0.002112	1.228517	6.65	1.228517	6.65

Notes: H_0 is the null hypothesis that the system contains at most r cointegrating vectors. Critical values are from Osterwald-Lenum (1992).

Other results of the Johansen cointegration test can be observed from Table 8, which gives the unrestricted cointegrating coefficients and their normalized values. The cointegrating coefficients in the Table 8 represent the empirical long-run relationship between the index futures and spot index. The following equilibrium error relationships can be demonstrated as;

$$z_t = -92.35550 \log f_t + 92.80627 \log s_t \quad (4)$$

and with normalized coefficients as;

$$z_t = \log f_t - 1.004881 \log s_t \quad (5)$$

where "futures" is the index futures logarithmic price and "spot" is the spot index logarithmic price. If z_t is set to 0 for the equation (4), it is easily seen that long-run equilibrium relationship can be derived as futures $\cong$ spot.

Table 8
Unrestricted Cointegrating Coefficients and Normalized Cointegrating Coefficients

	Index Futures	Spot Index
Unrestricted Cointegrating Coefficients	-92.35550	92.80627
Normalized Cointegrating Coefficients	1.000000	-1.004881

The estimation results of the Vector Error Correction Model (3a, 3b) are given in Table 9. First of all the long-term relationship between the index futures and spot index can be seen from the error correction coefficients. If we state the null hypothesis as the coefficients to be equal to zero, we reject the null hypothesis at 5% level for both of the coefficients or we can say that they are both statistically significant at 5% level. Signs of the error correction coefficients are negative confirming the existence of long-run relationship. Thus, both of the markets, index futures and spot index adjust towards each other.

Table 9
Vector Error Correction Estimates

	Dependent Variables	
	Index Futures	**Spot Index**
Constant	-0.000129 [-6.29528]*	-0.000368 [-2.36470]*
Futures lags		
$\beta_{f,1}$	-0.319536 [-8.04929]*	0.241970 [1.82563]
$\beta_{f,2}$	-0.025403 [-2.11869]	-0.054728 [-1.36711]
Spot lag		
$\beta_{s,1}$	0.811585 [25.5304]*	-0.181238 [-1.70761]
$\beta_{s,2}$	0.327814 [7.90954]*	-0.252240 [-1.82286]
Error Correction Terms	-0.179264 [-6.29528]*	-0.224823 [-2.36470]*

Notes: t-statistics are in parenthesis. * denotes significance at 5%.

It means that if there is a discrepancy from the long-run equilibrium, stated as z_t, both the index futures and the spot index corrects the error. However, the magnitude of the error correction is different for the markets. Index futures corrects the error by shifting 0.179%, while spot index market corrects it by shifting 0.224% of the discrepancy in the last period. Therefore, spot index adjusts toward index futures more than the index futures' adjustment toward the spot index. This result indicates that index futures lead its underlying spot index in the reflection process of new information to the prices. With the help of the error correction terms both of the markets stay on the long-run equilibrium. In addition coefficients of lagged spot price series in the futures equation are individually significant, whereas the coefficients of lagged futures series in the spot equation are individually non-significant. According to both of these results, it can be said that index futures lead the spot index in the price discovery process.

Chapter 6

Conclusion

In this study, the contribution of the index futures and spot index markets to the price discovery process is investigated using the data over the sample period of January 2007 through April 2009. Since low levels of trading in the index futures market for the first two years may cause biased results in the lead-lag relation, it is not included in the sample period. The cointegration relation between two price series is explored and the degree of the price discovery role of each individual market is examined.

Using Johansen cointegration method that is based on Vector Error Correction Model, we find a cointegration relationship between the markets. Both of the tests used by Johansen cointegration, the trace test and the maximum lambda statistics, indicate that two price series are driven by one common implicit efficient price. This shows that both of the indices move to the equilibrium between each other, albeit short-run deviations due to the market frictions. The estimates of the vector error correction model disclose the error correction process by stating the adjustment behaviors of each market for reestablishing the long-run equilibrium. Both of the markets are found to be significant in the error correction process, which shows that there is a bi-directional relationship in the price adjustment process. However, the spot index having a bigger coefficient of estimate in the error correction term indicates that futures market has the leading role in price discovery.

This result is consistent with the literature that generally points the futures market to be the dominant market. In a perfectly efficient financial market, no lead-lag relation should exist between the markets that are based on the same asset and thus share the same set of information. However, the findings here suggest a difference in price discovery role, which can be attributable to the transaction cost hypothesis. Transaction cost hypothesis asserts that new information is reflected faster in the market with less transaction costs. Therefore, it can be said that structural differences and trading procedures that make the index futures market to have lower trading costs and the leverage characteristics of the futures market are the main reasons of price discovery role of index futures market.

REFERENCES

Antoniou, Antonios, Nuray Ergul and Phil Holmes. (1997). *Market Efficiency, Thin Trading and Non-linear Behaviour: Evidence from an Emerging Market.* European Financial Management, Volume 3 Issue 2**,** Pages 175 – 190.

Akaike, Hirotugu. (1981). *Likelihood of a Model and Information Criteria.* Journal of Econometrics , 16 ,3-14.

Alexakis,Panayotis, Manolis G. Kavussanos and Ilias Visvikis. (2008). *The Lead-Lag Relationship between Cash and Stock Index Futures in a New Market.* European Financial Management, Vol. 14, Issue 5, pp. 1007-1025.

Baillie, Richard T and et al. (2002). *Price discovery and common factor models.* Journal of Financial Markets, Volume 5, Issue 3, Pages 309-321.

Baklaci, Hasan and Hülya Tutek. (2006). *The impact of the futures market on spot volatility: an analysis in Turkish derivatives markets.* Computational Finance and its Applications II, Section 5, 237-247.

Baklaci, Hasan. (2007). *Türkiye'de vadeli döviz işlemlerinin spot döviz piyasa volatilitesi üzerine etkileri.* İktisat İşletme ve Finans, Cilt: 22, Sayı: 250, Sayfa(lar): 53-68

Bekaert, Geert and Campbell R. Harvey. (1997). *Emerging equity market volatility.* Journal of Financial Economics, Volume 43, Issue 1, Pages 29-77.

Bhar, Ramaprasad. (2001). *Return and Volatility Dynamics in the Spot and Futures Markets in Australia: An Intervention Analysis in a Bivariate EGARCH-X Framework.* Journal of Futures Markets, Volume 21 Issue 9**,** Pages 833 – 850.

Booth, G. Geoffrey, Raymond W So and Yiuman Tse. (1999) *Price discovery in the German equity index derivatives markets.* The Journal of Futures Markets, Vol. 19, No. 6, 619-643.

Booth, G. Geoffrey and et al. (2002). *Trading and Pricing in Upstairs and Downstairs Stock Markets.* Review of Financial Studies , Volume 15, Number 4 Pp. 1111-1135.

Booth, G. Geoffrey and Raymond W. So. (2003). *Intraday volatility spillovers in the German equity index derivatives markets.* Applied Financial Economics, 1466-4305, Volume 13, Issue 7, Pages 487 – 494.

Chan, Kalok, K. C. Chan and G. Andrew Karolyi. (1991). *Intraday Volatility in the Stock Index and Stock Index Futures Markets.* The Review of Financial Studies, Vol. 4, No. 4 , pp. 657-684.

Chan, Kalok. (1992). *A Further Analysis of the Lead-Lag Relationship Between the Cash Market and Stock Index Futures Market.* The Review of Financial Studies, Vol. 5, No. 1, pp. 123-152.

Chu, Quentin C., Wen-liang Gideon Hsieh and Yiuman Tse. (1999). *Price discovery on the S&P 500 index markets: An analysis of spot index, index futures, and SPDRs.* International Review of Financial Analysis, Volume 8, Issue 1, 1999, Pages 21-34.

De Jong, Frank and Monique W.M. Donders. (1998). *Intraday Lead-Lag Relationships Between the Futures-, Options and Stock Market.* European Finance Review 1: 337–359.

De Jong, Frank. (2002). *Measures of contributions to price discovery: a comparison.* Journal of Financial Markets 5, 323–327.

Dickey, David A. and Wayne A. Fuller. (1981). *Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root.* Econometrica, Vol. 49, No. 4, pp. 1057-1072.

Easley, David and Maureen O'Hara. (1987). *Price, trade size, and information in securities markets*. Journal of Financial Economics, Volume 19, Issue 1, Pages 69-90.

Engle, Robert F. and C. W. J. Granger. (1987). *Co-Integration and Error Correction: Representation, Estimation, and Testing.* Econometrica, Vol. 55, No. 2 ,pp. 251-276.

Fleming, Jeff, Barbara Ostdiek and Robert E. Whaley. (1996). *Trading Costs and The Relative Rates of Price Discovery in Stock, Futures, and Options Markets.* The Journal of Futures Markets, VoI. 16, No. 4, 353-38.

Finnerty, Joseph E. and Hun Y. Park. (1987). *Stock Index Futures: Does the Tail Wag the Dog.* Financial Analysts Journal, Vol. 43, No., pp. 57-61.

French, Kenneth R. and Richard Roll. (1986). *Stock return variances : The arrival of information and the reaction of traders.* Journal of Financial Economics, Volume 17, Issue 1, Pages 5-26.

Garbade, Kenneth D. and William L. Silber. (1979). *Dominant and Satellite Markets.* The Review of Economics and Statistics, Vol. 61, No. 3, pp. 455-460.

Garbade, Kenneth D. and William L. Silber. (1983). *Price Movements and Price Discovery in Futures and Cash Markets.* The Review of Economics and Statistics, Vol. 65, No. 2 , pp. 289-29.

Glosten, Lawrence R. and Paul R. Milgrom. (1985). *Bid, ask and transaction prices in a specialist market with heterogeneously informed traders.* Journal of Financial Economics,14, 71-100.

Gonzalo, Jesus and Clive Granger. (1995). *Estimation of Common Long-Memory Components in Cointegrated Systems.* Journal of Business & Economic Statistics, Vol. 13, No. 1, pp. 27-35.

Granger, C.W.J. (1981). *Some Properties of Time Series Data and Their Use in Econometric Model Specification.* Journal of Econometrics 16, 121-130.

Harris, Lawrence. (1989). *The October 1987 S&P 500 Stock-Futures Basis.* The Journal of Finance, Vol. 44, No. 1, pp. 77-99.

Harris, Frederick H. deB., Thomas H. McInish and Robert A. Wood. (2002). *Common factor components versus information shares: a reply.* Journal of Financial Markets, Volume 5, Issue 3, Pages 341-348.

Hasbrouck, Joel. (1995). *One Security, Many Markets: Determining the Contributions to Price Discovery.* The Journal of Finance, Vol. 50, No. 4, pp. 1175-1199.

Hasbrouck, Joel. (2002). *Stalking the "efficient price" in market microstructure specifications: an overview.* Journal of Financial Markets, Volume 5, Issue 3, Pages 329-339.

Iihara, Yoshio, Kiyoshi Kato and Toshifumi Tokunaga. (1996). *Intraday return dynamics between the cash and the futures markets in Japan.* Journal of Futures Markets, Volume 16 Issue 2, Pages 147 – 162.

Ira G., Kawaller, Paul D. Koch and Timothy W. Koch. (1987). *The Temporal Price Relationship Between S&P 500 Futures and the S&P 500 Index.* The Journal of Finance, Vol. 42, No. 5, pp. 1309-1329.

Johansen, Søren. (1988). *Statistical analysis of cointegration vectors.* Journal of Economic Dynamics and Control, Volume 12, Issues 2-3, Pages 231-254.

Johansen, Søren. (1991). *Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models.* Econometrica, Vol. 59, No. 6, pp. 1551-1580.

Kasman, Adnan and Saadet Kasman. (2008). *The impact of futures trading on volatility of the underlying asset in the Turkish stock market.* Physica A: Statistical Mechanics and its Applications, Volume 387, Issue 12, 1, Pages 2837-2845.

Kawaller, I.G., P.D. Koch, and T.M. Koch. (1987). *The Temporal Price Relationship Between S&P 500 Futures and the S&P 500 Index.* The Journal of Finance*,* Vol. 42, No. 5, pp. 1309-1329.

Koutmos, Gregory and Michael Tucker. (1996). *Temporal relationships and dynamic interactions between spot and futures stock markets.* Journal of Futures Markets, Volume 16 Issue 1, Pages 55 – 69.

Lafuente, Juan A.. (2002). *Intraday return and volatility relationships between the Ibex 35 spot and futures markets.* Span. Econ. Rev. 4, 201–220.

Lehmann, Bruce N. (2002). *Some desiderata for the measurement of price discoveryacross markets.* Journal of Financial Markets 5, 259–276.

MacKinnon, James G. (1996). *Numerical Distribution Functions for Unit Root and Cointegration Tests.* Journal of Applied Econometrics, Vol. 11, No. 6 , pp. 601-618.

Osterwald-Lenum, Michael. (1992). *A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics.* Oxford Bulletin Of Economics and Statistics, 54 3.

Phillips, Peter C. B.and Pierre Perron. (1998). *Testing for a Unit Root in a Time Series Regression.* Biometrika 75(2):335-346.

Ross, Stephen A. (1989). *Information and Volatility: The No-Arbitrage Martingale Approach to Timing and Resolution Irrelevancy.* The Journal of Finance*,* Vol. 44, No. 1 , pp. 1-17.

Schwartz, G. (1978). *Estimating the dimension of a model.* Annals of Statistics, Vol.6, pp. 461-64.

Stoll, Hans R., and Whaley, Robert E. (1990). *The Dynamics of Stock Index and Stock Index Futures Returns.* The Journal of Financial and Quantitative Analysis, Vol.25, No. 4, pp. 441-468.

So, Raymond W. and Yiuman Tse. (2004). *Price discovery in the hang seng index markets: Index, futures, and the tracker fund.* Journal of Futures Markets, Volume 24 Issue 9, Pages 887 – 907.

Tse, Yiuman. (1999). *Price discovery and volatility spillovers in the DJIA index and futures markets.* Journal of Futures Markets, Volume 19 Issue 8, Pages 911 – 930.

Working, Holbrook (1948). *Theory of the Inverse Carrying Charge in Futures Markets.* Journal of Farm Economics, Vol. 30, No. 1 (Feb., 1948), pp. 1-28